Ornamental Plants: With Their Features and Usage Principles

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CONTENTS

Ornamental Plants are plants that affect both the eye and the soul, and are always present in our lives with their unknown aspects. We love and use some of them for the color of their leaves changing according to the seasons, some for its distinctive visual stem, some for its fragrant and colorful flowers, some for its refreshing body and other ingredients that concern our health. We have always had contact with these plants without realizing it. Because we are always intertwined with ornamental plants in daily life, especially in landscaping.

As in every subject, new research results are revealed and continuous information updates are also made in ornamental plants every day, and as a result, different perspectives are brought to applications and subjects. In this book, there are studies that give information about the growing techniques of ornamental plants and especially their use in landscape. For this reason, I would like to express my special thanks to our valuable authors who shared their research with us in the creation of our book.

Sincerely Yours

Arzu ÇIĞ

CHAPTER 1

THE IMPORTANCE OF LANDSCAPE ARCHITECTURE AND ORNAMENTAL PLANTS IN SUSTAINABLE CITIES

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INTRODUCTION

Landscape architecture is a multidisciplinary profession, it works with many professions and plays an important role in urban planning. It differs from other professions with the use of living and non-living materials in design and planning. Urban landscape concepts should be examined in planning sustainable, holistic, and identity cities. Ornamental plants are of great importance in landscape planning and designs. In this context, the ecological demands, physiological and morphological characteristics of ornamental plants should also be known. Recently, interest in ornamental plants, which will contribute to the urban landscape in an aesthetic and functional way, has increased and its cultivation has developed as an alternative agricultural product. In planting design studies; the ecological characteristics of plants, their importance in terms of landscape, the correct selection of their use, and purpose in the landscape are also of great importance. In addition, the primary purpose of herbal design is to contribute to space functionally, and thus, it can respond to the requests of the users. Plants play an important role in preventing the "urban heat island" effect. In this direction, basically; Examining the landscape and ornamental plants, which can be classified as trees, shrubs, ground cover, in the light of current concepts and by scanning the literature after 2000 will form a basis for studies on this subject.

The relationship between plants and humans is based on historical ages. People have used plants since ancient times to meet their basic needs for a number of instinctive reasons (protection, shelter, food, etc.). In addition to these functional needs, they also used organs such as flowers, leaves, or fruits and visually effective plants to express their feelings and thoughts. The concept of "garden", which is of Persian origin, which is of great importance among the mentioned spatial concepts, should be examined in this context. Large or small-scale, introverted gardens integrated with the environment, reflecting the living conditions, economic, and cultural qualities of the societies in certain periods of history, were specified as spaces shaped in line with the ecological conditions of the region. In light of this definition; Unlike many other fine arts, 'garden art' started with first people settling on the land, and the need to organize it as a living environment outside economic activities (Khabbazi & Erdoğan, 2012; Yerli & Kaya, 2015).

In this context; Sustainable and holistic cities are planned to emerge with positive features such as the beauties of nature, social opportunities, open green areas at accessible distances, infrastructure services, and wide investment opportunities. In cities that are planned to be an optimum living environment for human beings, aesthetic concerns are as important as a functional connection between departments. Functional and aesthetic concerns are not considered, especially in cities that are considered as symbols of civilization (Gül, 2000).

In rural areas where agriculture, transhumance, and forestry activities are carried out intensely, the city has no function and facilities. The population shows a homogeneous distribution, the density of residential workplaces is low, and deficiencies are observed in the infrastructure system. In this context; Rural settlements are areas with poor functional diversification in land use, and the proportion of elderly and children population over the young population (Çekiç, 2014). Also, rural areas; includes many different activities with changing social and economic conditions over time. The increase of people's inclination towards nature, the curiosity to learn different cultures, and the desire to get away from crowded urban environments bring rural settlements to the agenda. When this information is examined, in a general sense, rural settlements; It can be expressed as settlements that can offer unique identity qualities with their density, social structure, and life culture, spatial and functional structure, economic structure, recreation areas and activities, relations with the natural environment and landscape appearance (Eminağaoğlu & Çevik, 2007).

In order to increase the comprehensibility of these concepts, to know the principles of rural and urban planning, and to evaluate these two buildings under one roof, it is very important to know the concept of 'landscape' in detail (Table 1).

Landscape (*Paysage*), a word of French origin, means landscape. When viewed from a certain point, it can be defined as the area that includes all the natural and cultural data that fall into the viewpoint.

According to the European Landscape Convention organized by the European Council on 2000; as perceived by humans, its character refers to a field that is the result of natural or human (anthropogenic) interactions.

Table 1: Classification of landscape

Natural Landscape	**Cultural Landscape**	
	Rural Landscape	**Urban Landscape**
Meadows (Grasslands)	Villages	Parks
Forests	Afforestation areas	Home gardens
Wetlands	Agricultural areas	Roof gardens
	Wildlife corridors	Vertical gardens
	Groves	Wildlife corridors
		Road afforestation
		Hobby gardens

In this context, natural, rural, urban, semi-urban areas, land, inland waters, marine areas and wetlands, landscapes that are considered to stand out with their features, as well as ordinary or degraded landscapes, ecological research on the protection, repair, management and sustainable use of degraded ecosystems. restoration and rehabilitation include general and specific principles, stages, planning, implementation, monitoring and supervision, repair obligation, and enforcement (Sönmez, 2014). So the landscape is a system and this system contains many biotic and abiotic elements (Table 2).

Table 2: Abiotic, biotic and cultural factors in the landscape

Abiotic factors	**Biotic factors**	**Cultural Factors**
Climate and microclimate	Fauna	Residential areas
Geology	Flora	Transport networks
Geomorphology	Biological diversity	Agricultural areas
Hydrology		Historical sites
Soil structure		Infrastructure elements
Topography		

The concept of "cultural landscape" has emerged with the human impact on the natural landscape. Throughout the historical process, human beings have begun to use mountains and rivers in line with their own needs and shaped the landscape under many sub-headings. In this framework, it is possible to divide the cultural landscape into two as the rural and urban landscapes. Rural landscape; it covers the areas where the natural landscape is first affected by human use and where activities such as agriculture and forestry are common. These areas are; it essentially acts as a buffer zone between urban and rural areas. As the subheadings of this concept; Concepts such as agricultural landscape, industrial landscape, forest landscape, tourism landscape, and transportation landscape can be listed.

When the literature that deals with the expectations of people about a city is examined; it is seen that cities are handled in two ways. In the first, cities appear like the place imagined by the author and where the people living in it are happy. In the second, the city itself has been constructed as a utopia. The search for an ideal city from antiquity to the present has developed in different directions within reality as well as in utopias (Yüksel, 2012). In many books, films, and animations, the phenomenon of "*urban*" has been examined on an imaginary scale. Edward Bellamy's novel "Looking to the Past", published in 1988, describes a character who slept in 1887 and awakened to a different "city" structure in the 2000s, while Fritz Lang's 1927 film "Metropolis II. The city, which was formed with World War II, describes the structure of a city called Orbit in 2062 in "The Jetsons", an animation made in 1962. The success/failure status of urban planning studies and highlighting the problems that may be experienced can be possible with retrospective analysis. It is important to know the identity of the space in planning the mutual living spaces of the city people (Sharifi, 2016).

In summary; as a result of the different perspectives of the city and space phenomenon at the intersection center of all the works mentioned, it is observed that the said areas have similar strategies in the planning and design process. Apart from this homogeneous feature, some differences are witnessed by looking at the differences in the socio-cultural and ecological structures of the spaces and cities, and the change experienced by the space over time from different points. However, the solutions of these perspectives, which differ from each other at some points according to the nature of these differences, may show similarities and in this context, it is not possible to separate these ideas from each other with sharp boundaries. Because the factor that plays the leading role in the implementation of all these thoughts is "human", these designed and planned areas are thought with the basis of ergonomic anxiety. The most important fact here is that this balance between nature and humans becomes "sustainable" in a way that equality will not be disrupted in urban spaces.

The concept of sustainability has entered our daily language as “sustainable development” in relation to development through the Brundtland Report titled “Our Common Future” prepared by the UN World Commission on Environment and Development [WCED] in 1987 for the first time and became very popular in the following years. In the report in question, the concept of sustainability has been discussed on the axis of sustainable development and sustainable development is defined as "development that meets today's needs without jeopardizing the possibilities of meeting the needs of future generations". This definition draws attention to the fact that such needs of future generations are not neglected while meeting the needs of today's generations, and in this context, it guarantees that today's economic development will not make the economic situation of future generations worse than the economic situation of today's generations (Şen et al., 2018).

For sustainable cities, planting design and ornamental plants to be used in this design should be revealed with all the details. Herbal design is science, art, and natural phenomenon. Science and art is the process of establishing the most accurate, effective, and continuous relationship between man and nature. Herbal design is to be able to create the best effect with plants in terms of aesthetics, functionality, ecology, and symbolism. Creating decent living spaces of our rich natural resources without damaging these resources in natural and cultural balance should be the main concern of all disciplines related to the subject, and necessary studies should be done in this regard. Although there are many garden designs in the world, there are two main systems in terms of vegetative design. These are formal and naturalistic herbal designs. Some Egyptian, Persian, Islamic, Italian, French, American, and English gardens are examples of formal gardens. Naturalistic gardens are represented by traditional Chinese gardens, some English, Japanese and American gardens (Chen 2007; Eren & Var, 2016).

According to another definition, vegetative design; It is the whole process that follows the selection of the plant material necessary for achieving the present and future goals of Landscape Architecture for different purposes, designing it in a way that requires specific and specific creativity and evaluating it for application in the places where human activities will be carried out and the ecosystems that are subject to other landscapes. Accordingly, the herbal design requires a scientific process that requires expertise in designing plants that can be grown from a flower pot that can be regarded as the smallest place where the plant is located, in areas the size of a large park or basin. Selection and design of plants; The dendrological and design features of the plant are closely related to factors such as the plant's growing environment features and conditions, the aesthetic and functional purposes of landscape design (Eren & Var, 2016).

In light of this information, the landscape and ornamental plants sector has gained great importance in rural and urban planning studies in recent years. It is necessary to know not only the aesthetic properties but also the functional properties of the plants in question, as well as the natural and physical properties of the area to be treated. With the concepts such as increasing population, unconscious urbanization, and industrialization, the aspirations of the city people for the green tissue have increased. In this context; Urban parks provide aesthetic and physical value to the city they are in, as well as satisfying this longing of the city people. In cities, roads, and buildings covered with flooring change the climate structure and temperature values in city centers are higher than in rural areas (Doygun & İlter, 2007).

In planting design studies; The ecological characteristics of plants, their importance in terms of landscape, and the correct selection of their use and purpose in landscaping are also of great importance. In addition, the first purpose of herbal design is to contribute to space functionally and in this way, it can respond to the requests of the users. Plants play an important role in preventing the "urban heat island" effect, increasing the relative humidity, air filter, oxygen production, and noise absorption.

1. HISTORICAL DEVELOPMENT OF PLANTING DESIGN

It is an undeniable fact that the physical environmental conditions have a shaping effect in the period from the hunting-gathering activities of humanity to the settled life, from the establishment of the first cities to the present day. Since historical times, people have used natural resources unconsciously for their personal needs, so living areas that are in harmony with nature have emerged, which are in danger of global damage. In line with these facts, people not only in living spaces but also in rural and urban scale; They have sought a new design and planning in agricultural, industrial areas, and transportation axes.

Today, it is observed that the natural landscape areas are decreasing day by day and the (cultural) areas formed by anthropogenic effects have increased intensely. While the impact of people on nature increases day by day, land use patterns show significant changes. In the first place, people used nature only enough to be self-sufficient and limited their agricultural and hunting activities to certain measures. While there was a sense of trust in nature during this period, primitive hunting tribes had an emotional passion for interesting forms and dramatic landscapes in nature. They even preferred such natural areas for social gatherings and religious ceremonies (Gül, 2000).

The first impact of humans on the natural landscape was through agricultural activities. The first examples of landscaping emerged with the settlement of agriculture and livestock activities. With the fertility that people get from the soil and the phenomenon of living in the same place, the desire to organize the areas they live in has emerged. In this context; It can be said that the first structural arrangements appeared during these periods. These areas created by people for agricultural activities; It is in harmony with factors such as climate and soil.

Starting from the ancient civilizations (Egypt, Assyria, Greek, Roman); Urban centers until the industrial revolution in the 19th century, including the Medieval, Renaissance and Baroque periods; a focal point is planned as an imposing building in which the leader or tribal chief lived, and agora-like structures surrounding it. Throughout the ages, natural areas have been a kind of shelter where people can get rid of the troubles of their daily lives and establish close relationships with natural beings. In the holy books, the expression of paradise as a garden place is seen as a reflection of the desire of people to have a small place of paradise in their lives on earth. The first gardens were generally in the form of temples and boulevard arrangements, hunting parks, woodland, orchard, and vegetable garden. The first garden examples known in history were seen in Mesopotamia, Egypt, Iran, Ancient Greek, and Ancient Roman civilizations. Palace gardens, tomb and temple gardens, and house gardens of Ancient Egypt are works of art. Ducks, fish, and especially sacred lotus flowers, great trees, flower beds, and garden pavilions, floating in the lake-pool, these gardens were a place of pleasure and entertainment. Also; Ancient India, Ancient Greek and Roman, Byzantine gardens and garden art history dates back to the fourth century (Gül, 2000; Yerli & Kaya, 2015).

As a result of *the Industrial Revolution* in the 19th century, residential areas have gone through a global social and physical change. Migration from rural areas to urban areas has accelerated and urban development has increased in a very short time. In this rapid urbanization process, people from the high-income group lived in healthy environments, while people with low-income groups had to live in unhealthy and crowded buildings. Unlike ancient times, human beings preferred destruction (such as opening stone and sand quarries, destruction of forests) instead of coming to terms with nature.

The differences in the lifestyle and cultural structure of the human profile that emerged with the industrialization period made the demand for new housing and urban structure inevitable. These individuals prefer areas close to their workplaces and dominate social and cultural activities and recreation areas. Factors such as population growth and excessive urbanization have led to changes in the physical and social structure of the city. Housing and industrial areas have changed.

Detached houses with gardens left their place to relatively smaller apartments with fewer people, and the concept of *mixed-use buildings* that became the symbol of life in the city center was born (Tallon, 2010; Başyazıcı, 2012).

Howard (1902) planned green areas in the urban structure where all people can meet all their needs in his '*City Garden*' design. In this design, urban areas, agricultural areas, buildings are determined as number and parcel (Table 2).

Table 2: Urban elements of city garden (Howard, 1902)

Elements	**Quantity**
Urban area	400 hectares
Agricultural area	2020 hectares
Buildings	5050 pieces
Average parcel size	(6 x 40) m
Total population	32.000 people

At the beginning of the twentieth century, thinkers from different nations contributed to the emergence of the perception of modern urban planning, but England, which played an important role in the industrial revolution, was the first geography where modern urban understanding gained meaning in theory and practice. In this context; The factory zone, in which the socio-economic life in the city is indexed, constitutes the main core of the new urban organism. The factory, regardless of the industry; is being built in the urban area near the vital resources for itself. For this reason, factories in modern cities are established very close to artificial physical environments such as rivers, lakes, and similar water resources and transportation networks without worrying about polluting the environment (Çınar, 2000).

In light of this information, humanity destroying natural resources with excessive consumption ambition; recognizing the danger and considering environmental concerns, started to review the relationship between humans and the environment in order to create sustainable living spaces. This phenomenon is parallel to the historical process. Because in the Roman Garden Art Period, high-rise buildings (*insuleae*) were built due to the dense population, and the rich section of the people, who were negatively affected by this urban pressure, built villas with gardens outside the city with the *Renaissance Period*.

RESULTS AND DISCUSSION

Developed countries; considering the consequences of the damage they caused to the environment, they sought new planning to reshape their living spaces. For this purpose, new planning principles are formed with the cooperation of relevant professional groups on a rural or urban scale in order to develop methods that can rationally meet the needs of people in a sustainable way and to design living spaces where people who are separated from nature and under the pressure of pollution can interact with nature.

The number of 'ecological' concerned city designs from the 1970s to the present day is increasing rapidly. In this direction; As the number increases, obvious differences are observed between these drafts. While some ecological designs stay further away from technology, some include a design that blends technology with the city. One of the important inventions in urban landscape design is the discovery and spread of aircraft. Along with this concept, concepts such as airplane landscape or sky landscape stand out as new concepts emerging in urban planning. The city structure, which is seen as a bird's eye view by people entering the city by plane, constitutes the first ideas of the visitors about the spatial order. The role of landscape and ornamental plants is extremely important in understanding ecologically based urban planning on a correct basis. The main material of landscape planning and design studies is basically examined in two parts as vegetative and structural materials. Vegetative materials used in this context; they are called 'design plants' or 'ornamental plants'.

For example, in Turkey, species diversity, genetic diversity is extremely rich in terms of ecological and ecosystem diversity. In the fact that Anatolia is one of the richest areas in the world in terms of biodiversity; Factors such as climatic diversity, topographical differences, habitat diversity, and its location at the intersection of three different phytogeographic regions play a role. There are also many endemic plants in this region. In the mentioned, landscape planning studies, researching the usability of these plants, ensuring their adaptation to urban landscapes, and protecting this resource is of great importance.

With the increase in migration from the village to the city and the rapid population growth in recent years, the increased building areas are a source of environmental pollution; It adversely affects the temperature of the urban environment, the humidity economy of the soil and air, and air movements, in short, the urban climate and bioclimatic conditions. On the other hand, noise in cities, monotony of color and lack of aesthetics create negative effects on human psychology. Despite these findings; adequacy of urban green spaces in terms of quality and quantity is not given due importance (Çınar, 2000).

It is clear that the city structure in the coming years will not be a continuation of the present. The interdependencies of economies, cultures, and institutions on each other both on a global and local scale, the interaction of stakeholders, and the information and communication spread through the various networks created by this interaction shows how cities will differ. With the rapid growth of cities and the increase in urbanization, the growth potential of metropolises with a population of more than 10 million today, mostly in developing countries, indicates that we will face new and important urban problems in the coming years (Yetişkul, 2017).

Today, the widespread use of artificial intelligence and computer games causes the use of new applications on the urban phenomenon. In a computer game that is called "Cities: Skyline"; urban designs are made with phenomena such as roads and buildings, parks. In recent years, new concepts related to cities have come to the fore. In addition to the aesthetic features of vegetal materials used in urban landscape planning, preventing air pollution, masking noise, reducing the effects of wind, dust, and gas, giving a dynamic effect to the city form, improving transportation axes, climate conditions, creating protection and living areas for plant and wildlife species, With the introduction of functional features such as 'organic planning', 'ecological networks', 'open-green spaces', 'urban corridors', 'green transportation' have gained importance. Ecological networks are an important part of the city's ecological framework. Often the ecological corridor is small rivers or valleys that run through the city and form a habitat for the flora and fauna surrounding important areas. The advantages of these areas for the urban climate should not be ignored (Semina & Maximova, 2018).

In today's particular, urban landscape elements should not only be considered parks, gardens, and medians (road afforestation). With the decrease in urban green areas, roof gardens, vertical gardens (green walls), and hobby gardens have become important elements of urban landscape planning in recent years. For example, vertical gardens are defined as covering the facade walls using various types of plants with the help of various systems.

In addition to increasing the amount of green space in cities, vertical gardens have functions such as sound and heat insulation, energy efficiency, improving air quality, reducing the heat island effect, making a positive contribution to human psychology with their aesthetic appearance. Factors such as the constant maintenance difficulty, cost, lack of knowledge, and awareness of vertical gardens prepare the ground for their use only for aesthetic purposes but prevent the spread of applications. However, limiting the maintenance and repair costs of the plant material to be used in these planning studies is necessary to ensure its sustainability (Ekren, 2017).

Transportation circulation has positive/negative effects on visual quality, noise, land and water quality, spatial use, and historical sites. It is seen that the concept of "urban green transportation" should be emphasized with the insufficiency of public transportation elements in the cities, the increase in the number of motor vehicles per person, and the increase in environmental pollution. This phenomenon is being developed with suggestions such as popularizing the use of bicycles and environmentally friendly spring system. Cities such as Tokyo / Japan, where public transportation is widely used, Amsterdam / Netherlands, where bicycle paths are used extensively, and Seoul / South Korea are considered as important examples in this regard.

Urban planning includes an organization in which multidisciplinary work is absolute. Planning and design phenomena are physical planning processes that follow each other in line with planning decisions. In line with the development and change of the world, new professional disciplines are emerging. This situation also increases the importance of interdisciplinary cooperation in city planning. The urban planning process, although different scales are used, in general; consists of the determination of problem and purpose, current situation determination (survey), analysis, area use diagram, evaluation / final product stages. On the other hand, a difference can be observed in the approach of people belonging to the same profession or from different professions to the planning/design process. The main purpose of bringing these professional disciplines together is that many basic phenomena such as social and physical factors, ecological structure are important concepts that should be addressed in the formation of the urban structure (Korkut & Topal, 2015).

In planting design studies; unlike other design disciplines, the material (plants) used is alive. Since changes occur in the size of plants over the years, the time factor should definitely be taken into consideration in planting studies, and planting studies should not be carried out without paying attention to the size of the plants in planting studies.

When this subject is examined in terms of the plant material used; In order to emphasize the place and importance of natural species in the urban landscape, the rates of plants being natural or exotic should be examined. production of public and private sector nurseries even in a country like Turkey with a high rate of endemism of more cosmopolitan or exotic taxa have given weight to indicate that a number of problems in this regard.

CONCLUSION

It is observed that physical environmental conditions have an effect on the demographic, socio-economic, and cultural structure of rural and urban settlements. The spread of infrastructure activities such as construction and transportation in rural areas and the preference of such places for recreational transhumance activities threaten the sustainability of natural resources with local and national values. The use of plants in the urban landscape ensures bioclimatic comfort and high quality of urban areas. In this context; By knowing the functional properties of the plants as well as the aesthetic properties of the plants, the urban building materials will be preserved, the proportional humidity will increase, the supply of clean air, air filtration, noise absorption, and the greenhouse effect will be reduced. In this direction; It is stated that the determination of these characteristics of the plants used in urban road afforestation and the species selection should be made taking into account the effects of the factors such as road widths, infrastructure and superstructure facilities, traffic density, and their contribution to the urban landscape (Hatipoğlu, 2016; Hatipoğlu & Ak, 2018).

Plants are very important elements that contribute to the design or shaping of parks with all their features. If an evaluation is made within the scope of this research; Among these features, the concept of measure is one of the most important issues that a landscape architect should focus on sensitively in the vegetative designs of park areas and other outdoor spaces. A landscape architect should be able to use not only the concept of the measure but also all the necessary features related to the plant material in plant designs. Thus, thanks to the planting designs made, the users are satisfied both visually and functionally from the outdoors.

The use of plants in the urban landscape ensures bioclimatic comfort and high quality of urban areas. In this context; By knowing the functional properties of the plants as well as the aesthetic properties of the plants, the urban building materials will be preserved, the proportional humidity will increase, the supply of clean air, air filtration, noise absorption, and the greenhouse effect will be reduced.

In this context, as in all planning approaches, in sustainable cities created by preserving the balance of resource use/conservation in urban planning studies, the plants to be used in plantation and green area facilities are selected from endemic taxa that are suitable for local ecology or whose landscape use value has been demonstrated, making the urban green tissue more resistant will ensure that their qualities are preserved.

Ecological networks, urban corridors, and open-green areas should be used to protect natural assets by connecting people to nature and one wildlife environment to another, with the collective nature of planning. The concept of green transportation in cities is of great importance for human and environmental health. In order to prevent environmental pollution, ensure urban health, and reduce the effect of urban heat islands, it is of great importance to expanding the rail systems and bicycle paths in the city.

In this direction; environmental and socio-economic sustainability can be achieved with transportation master plans. In light of this information; Our country's rich natural resources should be the main concern of all disciplines related to the issue, and the creation of decent living spaces without harming these resources in natural and cultural balance, should be the main concern of all disciplines. In addition, in order to prevent the increase of migration from rural areas to the city and to motivate a proactive planning approach, it is extremely important to plan contemporary agricultural activities that will ensure the development of the people living in the village without going to the city and to consider the concepts such as 'urban village' and 'rural city' in planning studies.

REFERENCES

Başyazıcı, B. (2012). Effects of the gentrification process in Cihangir on the commercial ıdentity of the district. Journal of Ideal City/Urban Studies, ADAMOR Urban Studies Center, 5: 198-219.

Chen, G. (2007). Planting Design Illustrated. ArchiteG, Inc., p. 288.

Çekiç, İ. (2014). Rural Planning Lecture Notes, Istanbul: Yıldız Technical University Publications.

Çınar, T. (2000). Intellectual origins of Bahçekent model and its contribution to urban science, Ankara University SBF Journal, 55(1): 27-51.

Doygun, H. & İlter, A. (2007). Investigating adequacy of existing and proposed active green spaces in Kahramanmaras city. Journal of Ecology, 17(65): 21-27.

Ekren, E. (2017). Advantages and risks of vertical gardens. Journal of Bartin Faculty of Forestry, 19(1): 51-57.

Eminağaoğlu, Z. & Çevik, S. (2007). Design policies and tools for rural settlements. Gazi University Journal of Engineering and Architecture Faculty, 22(1): 157-162.

Eren, E. T & Var, M. (2016). Taxa used in planting design in parks: The case of Trabzon city centre. Artvin Coruh University Journal of Forestry Faculty, 17(2): 200-213.

Gül, A. (2000). Landscape-human relationship and landscape architecture. Süleyman Demirel University Journal of the Faculty of Forestry, 1: 97-114.

Hatipoğlu, İ. H. (2016). The Effects of Physical Environment Conditions on Local People's Interactions with Natural Environment: Example of Kahramanmaraş Ahir Mountain. Master's Thesis. Kahramanmaraş Sütçü İmam University Institute of Science, Kahramanmaraş.

Hatipoğlu, İ. H. & Ak, B. E. (2018). Investigation of the ımportance of planting in urban texture in the sample of Karaköprü District of Şanlıurfa Province, Eskişehir; ISUEP2018 International Symposium on Urbanization and Environmental Problems: Change / Transformation / Originality 28-30 June 2018, Vol. 4, p. 57-60.

Howard, E. (1902). Garden Cities of To-Morrow (Re-printed, edited with a Preface by F.J. Osborn and a Introductory Essay), London, England.

Khabbazi, P. A. & Erdoğan, E. (2012). Islamic Gardens. Namık Kemal University Journal of Agriculture Faculty, 9(2): 20-31.

Korkut, A. & Topal, T. (2015). Interdisciplinary approach to the planning/design process, İnönü University Journal of Art and Design, 5(11): 49-63.

Semina, A. & Maximova, S. (2018). Ecological corridors' morphology ınside the urban structure in forming the enviromental frame of the city, urban form and social context: from traditions to newest demands: Proceedings of the XXV ISUF International Conference, Krasnoyarsk, July 5–9, 2018, p. 963-967.

Sharifi, A. (2016). From Garden City to Eco-urbanism: The quest for sustainable neighborhood development, England, ELSEVIER, Sustainable Cities and Society.

Sönmez, G. (2014). European Landscape Convention and Turkey, Ankara, Sustainable landscape on the ımplementation of the European landscape convention and the council of Europe economics theme 15. International Labor Conference.

Şen, H., Kaya, A., & Alpaslan, B. (2018). A historical and current perspective on sustainability. Economic Approach, 29(107): 1-47.

Tallon, A. (2010). Gentrification in United Kingdom, London, Routledge.

Yerli, Ö. & Kaya, S. (2015). Historical development of garden art, Adana, Çukurova University, I. International Art Research Symposium, April 2015, p. 407-417.

Yetişkul, E. (2017). Complex Cities and Complexity in Planning, Journal of Planning, 27(1): 7-15.

Yüksel, Ü. D. (2012). Urban utopias from ancient until today. Journal of Ideal City / Urban Studies, ADAMOR Urban Studies Center, 5: 8-37.

CHAPTER 2

USE OF OUTDOOR ORNAMENTAL PLANTS IN LANDSCAPE PLANNING

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INTRODUCTION

Turkey is located at the intersection of a phytogeographic zone between Euro-Mediterranean, Sibirya- and Iran-Turan Zones. For this reason, our country is a bridge between the flora of Southern Europe and South West Asia and has a very rich biodiversity as the center of many plant species (Davis, 1965; Davis, 1978; Tan, 1992; Şirin, 2003). This situation provides a great opportunity especially in terms of increasing the number of plant species used in landscape works. However, it is known that some plant species that grow naturally in our country are used as ornamental plants in many foreign countries (Şirin, 2003).

Ornamental plants are herbaceous and woody plants that stand out with their shape, form, color and aesthetic features. Ornamental plants are plants that have symbolized the suffering and joys of mankind for ages and have also been a source of consolation. It is not correct to consider the historical background of ornamental plants within a time frame that has certain limits. Today, the cultivation of ornamental plants is carried out under headings such as cut flowers, indoor, outdoor, seasonal, ground cover and natural flower bulbs (Baktır, 2013).

Landscape architecture is a professional discipline that takes into account the protection-use balance of the natural and cultural components that make up the landscape and produces projects on the basis of science and art in the fields of planning, design, repair, conservation and management in accordance with ecological, economic, aesthetic and functional criteria (PMO, 2007). One of the materials used in landscape architecture works is undoubtedly plants. Plants are used in these works for many different purposes such as ensuring ecological balance, increasing aesthetic values and landscape quality, increasing human comfort and quality of life, and restoring landscape. In this study, the use of outdoor ornamental plants in the field of landscape planning, which is one of the main subjects of the landscape architecture profession, is mentioned.

1. LANDSCAPE PLANNING

In the Dictionary of Landscape Architecture Terms, landscape is a space belonging to the earth whose boundaries can be determined according to its external appearance or development or structure; or the appearance of a piece of land along with its ecological, biological, structural and functional characteristics; or the whole view of natural and cultural elements in various characters in an environment that can fit into the viewing angle from any point (Yücel et al., 2008).

In the "8th Council of Europe Conference on the European Landscape Convention" organized by the Council of Europe in Strasbourg, the definition of landscape in Turkish was put forward as "a holistic perception of the composition of natural and cultural values in the environment" (Council of Europe, 2015). As the official definition of the word landscape, the definition specified in the European Landscape Convention is now used. According to this, Landscape is “means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000).

The concept of landscape planning is defined in the Dictionary of Landscape Architecture Terms as an integrative activity aiming to protect, restructure and develop existing landscapes and to create and arrange landscapes that include new land uses (Yücel et al., 2008). Here, the basic issues of landscape planning are stated as follows (Yücel et al., 2008):

- Ecological and environmental change processes at the landscape level
- Historical and cultural dimensions of landscape changes
- Social and economic forces that form the infrastructure of human activities and land uses that shape the landscape
- Landscape evaluation that forms the basis for landscape planning
- Geographic information systems
- Strategic environmental impact assessment
- Techniques such as large-scale field surveys
- Legal, executive, corporate issues related to professional practices

In the European Landscape Convention, "Landscape planning" means strong forward-looking action to enhance, restore or create landscapes (Council of Europe, 2000).

The following topics are included in landscape planning studies:

- Strategic landscape planning,
- Landscape planning for protection,
- Landscape planning for restoration - improvement and / or development,
- Landscape planning of solid waste landfills,
- Landscape planning of transportation routes,
- Coastal and wetland landscape planning
- Tourism and / or recreation areas landscape planning etc.

In landscape architecture in general and more specifically in landscape planning, plants are one of the materials used.

2. OUTDOOR ORNAMENTAL PLANTS

According to Yazgan et al. (2005), outdoor ornamental plants are trees, small trees, shrubs and herbaceous plants that are generally used in the arrangement of parks and gardens, in the afforestation of highways and metropolises and in recreation areas.

Outdoor ornamental plants are examined in 5 groups according to their sizes, forms, functions and vegetative features (Karagüzel et al., 2010):

- Broad-leaved trees, small trees and shrubs,
- Needled trees and shrubs (Conifers)
- Ground cover, annual and perennial plants
- Climbing and hugging plants
- Seasonal flowers

Plants have many positive effects on humans and other living beings as well as adding value to their environment. Plants, which host many living species, increase the quality of life and provide diversity, especially with their visual / aesthetic functions. In addition, outdoor ornamental plants also have functional effects.

Ertunç (2011) lists the functional effects of plants as follows:

a. Connecting structures with their surroundings and with each other, connecting outdoor spaces
b. Defining, highlighting or separating borders and areas

c. Separating vehicle traffic, directing pedestrian traffic, creating physical barriers to avoid traffic, highlighting linear axes or corner points
d. Providing cascading scale that carries elements such as surrounding buildings from trunk to branches, branches to stems, leaves
e. Ensuring privacy by creating visual barriers
f. Creating and defining outdoor spaces, separating various areas by giving ceiling effect, giving identity to outdoor spaces
g. Identifying level differences, highlighting slopes
h. Creating vistas
i. Protection from wind, dust, excessive sun and noise if used in sufficient intensity
j. Providing lower climate control
k. To spread a nice smell
l. Harmonizing or contrasting a building floor or water surface through form, texture and color
m. Highlight an important landscape element
n. Preventing rainwater from falling rapidly to the ground and causing damage
o. Erosion control

3. USING POSSIBILITIES OF OUTDOOR ORNAMENTAL PLANTS IN LANDSCAPE PLANNING

The selection of the species to be used in landscape planning studies varies locally, regionally or nationally, as well as country by country. The main reasons for this are factors such as ecological data, socio-economic structure and lifestyles. At the same time, plant species selection changes according to the nature of the area where the landscape planning study will be done and the type of the study.

In addition to natural vegetation, all types of outdoor ornamental plants are used in landscape planning studies. But among these, the most preferred groups are trees and shrubs. Examples of tree types that can be preferred in landscape planning studies are given in Table 1 and examples of shrub types are given in Table 2.

Table 1: Examples of tree types that can be preferred in landscape planning studies

Acacia sp.	*Acer campestre*	*Acer platonoides*	*Acer pseudoplatanus*
Acer negundo	*Aesculus hippocastanum*	*Alnus glutinosa*	*Carpinus betulus*
Cupressus sp.	*Eucalyptus cameldulensis*	*Fagus orientalis*	*Fraxinus excelsior*
Juglans sp.	*Malus sylvestris*	*Platanus orientalis*	*Populus alba*
Populus nigra	*Populus tremula*	*Prunus mahalep*	*Prunus amygdalus*
Quercus sp.	*Robinia pseudoacacia*	*Salix* sp.	*Tilia* sp.
Ulmus sp.	*Pinus* sp.		

Table 2: Examples of shrub types that can be preferred in landscape planning studies

Arbutus andrachne	*Berberis* sp.	*Cornus* sp.	*Cotoneaster* sp.
Creategus sp.	*Eounymus* sp.	*Ilex aquifolium*	*Juniperus excelsa*
Juniperus orientalis	*Juniperus sabina*	*Ligustrum vulgare*	*Rhamnus sp.*
Rosa canina	*Sambucus nigra*	*Taxus* sp.	*Thuja orientalis*
Thuja oxidentalis	*Viburnum* sp.		

Apart from the tables given above, there are many more outdoor ornamental plants that can be used in landscape planning studies in different areas of our country. The tables here are given as examples in general.

CONCLUSION

Man is a part of nature. For this reason, meeting the spiritual and social needs as well as human biological and physical needs is a way to be followed in order to improve living conditions (Bayraktar & Aslanboğa, 1985; Ertunç, 2011). In this way, integration with nature can be achieved with plants in the easiest and simplest sense.

The demand for outdoor ornamental plants in our country started to accelerate after 1986. One of the main reasons for this increase in demand is the increase in people's interest in nature as a result of rapid urbanization and construction. Apart from this, the reasons such as the increase in the importance given by local administrations to park and garden arrangements and urban landscape areas in landscape planning and design works; increase in afforestation works in highway construction; the opening of new tourism facilities with the development of the tourism sector and considering the landscape arrangements of new tourism facilities more seriously can be counted. As a result, increases in plant prices and production have occurred. However, the increase in production was not sufficient to meet the demand. As a result, while meeting the plant need was provided by producers concentrated in certain regions in the domestic market, most of them were imported from abroad (Şirin, 2003). Landscape Architecture has emerged with the triggering efforts to protect natural landscapes and processes, which started to deteriorate and disappear due to the environmental problems caused by industrialization in the late 1800s and the resulting intense urbanization, in other words, to produce solutions for them. For this reason, one of the most basic occupations of landscape architecture is the sustainable protection, planning and management of natural balances and assets in the longest term. Naturally, ecological planning or landscape planning shapes current and future natural resource planning and land use forecasts and suggestions on this basis (Özkan et al, 2010; Türkdoğdu, 2016). Plants are the main actors of these studies based on sustainability. As a result, the importance and functions of plants should be taken into consideration in landscape architecture studies, which are carried out with the goals such as ensuring the sustainability of natural resources by transferring them to future generations, protecting the ecological balance, increasing the quality of life and living with nature. Here, plant species selection should be made in accordance with the purpose of the study and the characteristics of the area.

REFERENCES

Baktır, İ. (2013). Türkiye'de süs bitkilerinin dünü, bugünü ve yarını. V. Süs Bitkileri Kongresi, Atatürk Bahçe Kültürleri Merkez Araştırma Enstitüsü, Yalova, s. 13-16.

Bayraktar, A. & Aslanboğa İ. (1985). Kentleşme sanayileşme etkileşiminin İzmir kentinde yaşama ortamında yarattığı sorunlar. Türkiye 9. Şehircilik Günü, 6-8 Kasım, Eskişehir, s. 176-183.

Council of Europe (2000). European Landscape Convention. Floransa.

Council of Europe (2015). Landscape in Languages and Laws of the States Parties to the European Landscape Convention. 8th Council of Europe Conference on the European Landscape Convention. CEP-CDCPP (2015)5E, Strasbourg.

Davis, P. H. (1965). Flora of Turkey and The East Aegean Island. University of Edinburgh, London.

Davis, P. H. (1978). Flora of Turkey and The East Aegean Island. University of Edinburgh, London.

Ertunç, Z. (2011). Antakya Kent Dokusunda Kullanılan Çok Yıllık Süs Bitkilerinin Peyzajda Kullanımları. Yüksek Lisans Tezi. Mustafa Kemal Üniversitesi Fen Bilimleri Enstitüsü, Peyzaj Mimarlığı Anabilim Dalı, Hatay, s. 127.

Karagüzel, O., Korkut, B., Ökan, B., Çelikel, G., & Titiz, Ç. (2010). Türkiye'de Süs Bitkileri Üretiminin Bugünkü Durumu, Geliştirme Olanakları ve Hedefleri. http://www.zmo.org.tr/resimler/ekler/e915db6326b6fb6_ek.pdf (Access date: 05.11.2020)

Özkan, M. B., Hepcan, Ş., & Hepcan Coşkun, Ç. (2010). Yaban Hayatı, Üniversiteliler Ofset Yayınları, İzmir.

PMO (2007). Mesleki Tanınırlığımızdaki En Önemli Adım. TMMOB Peyzaj Mimarları Odası. http://www.peyzaj.org.tr/genel/bizden_detay.php?kod =19&tipi=25&sube=0 (Access date: 05.11.2020)

Şirin, U. (2003). Peyzaj Planlama Çalışmalarında Kullanılabilecek Bazı Çalı ve Ağaççık Formundaki Bitkilerin Farklı Üretim Teknikleri İle Çoğaltılabilirliklerinin ve Fidan Performanslarının Belirlenmesi. Doktora Tezi. Adnan Menderes Üniversitesi Fen Bilimleri Enstitüsü, Bahçe Bitkileri Anabilim Dalı, Aydın, s. 222.

Tan, A. (1992). Türkiye’de Bitkisel Çeşitlilik ve Bitki Genetik Kaynakları. Anadolu, J. Of AARI, Ege Tarımsal Araştırma Enstitüsü Dergisi, 2(2), İzmir.

Türkdoğdu, H. (2016). İstanbul O – 1, O – 2 Otoyolları ve Bazı Bağlantı Yollarının Güncel Bitkilendirmelerine İlişkin Araştırmalar. Yüksek Lisans Tezi. İstanbul Üniversitesi Fen Bilimleri Enstitüsü, Peyzaj Mimarlığı Anabilim Dalı, İstanbul, s. 167.

Yazgan, M. E., Korkut, A.B., Barış, E., Erkal, S., Yılmaz, R., Erken, K., Gürsan, K., & Özyavuz, M. (2005). Süs bitkileri üretiminde gelişmeler. Türkiye Ziraat Mühendisliği VI. Teknik Kongresi, Ankara, s. 589-607.

Yücel, M., Aslanboğa, İ., & Korkut, A. (2008). Peyzaj Mimarlığı Terimleri Sözlüğü. TMMOB Peyzaj Mimarları Odası Yayın No: 2008/4, Ankara, s. 128.

CHAPTER 3

THE USE OF DECORATION (TEZYİN) AND ILLUMINATION (TEZHİP) ARTS AND ORNAMENTAL PLANTS IN OTTOMAN ARCHITECTURE

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INTRODUCTION

The decorative arts, which mean the arts of decoration, have become indispensable for the Ottoman Empire over time. It showed itself from book bindings, Quran writings, and architectural details to box decorations, and left its mark both inside and outside the country. Among the decorative arts, the art of illumination has been one of the mostly made arts. The art of illumination is divided within itself by certain techniques and motifs. It is influenced by nature, abstract and symbolic meanings (URL-1). Ottoman artists were mostly influenced by ornamental plants and plants that mentioned in the Qur'an, and they used these plants in their motifs. These are plants such as date tree, rose, tulip, pomegranate, water lily flower (URL-2). Like today's usage areas, it has been used as well as in plates, manuscripts, bindings, edicts, tughras, lacquer works and miniatures in ancient times. The aim of this study is to investigate the decorative arts and illumination arts and to show how ornamental plants are used in art.

1. ART IN THE OTTOMAN EMPIRE

The Ottoman Empire, the foundation of which was laid in 1299, was one of the largest and most glorious empires of the Islamic civilization. It set an important example for the Western world with its justice and tolerance based understanding of the state, the superior architecture it left the traces in the lands under its domination, the excellent structure it developed in textile, calligraphy and education. The kindness and artistic taste of the Ottoman sultans were remembered with admiration by the Westerners, and the Westerners who saw the Ottoman lands were deeply impressed by the magnificence they observed.

Ottoman art produced magnificent works in many different fields. It created magnificent works in different branches of art such as architecture, tile making, miniature fields, carpet, cloth, leather making, bookbinding, bookselling, gilding, porcelain, amber and furniture (Figure1-4) (Güney & Güney). The main factor that constituted all the general characteristics of Ottoman art was the religion of Islam and it was originated from the Quran. The Ottomans lived for centuries as subordinate to the whole of the Qur'an and signed the Second Age of Happiness Period. For this reason, the concepts of Ottoman Art and Islamic Art can never be considered different from each other.

One of the most prominent features of Islamic art is the idea of tawhid. The principle of uniqueness of the Creator is the most determining factor. This idea is difficult to understand with prejudices. Islamic art is an abstract style, based on contemplation outlined with revelation rather than copying what is seen. Moreover, this frame encompasses not only ornamental elements but also other art elements such as architecture. Ottoman art produced works parallel to that atmosphere in the splendor of the empire. It showed its effect in all branches of art only within its own set of values and influenced the communities outside this geography as well as within. Ottoman art followed the developed and diversified basic principles in the Islamic world (Güney & Güney).

Figure 1: Tile art in Ottoman (URL-3)

Figure 2: Carpet weaving art in the Ottoman (URL-4)

Figure 3: Bookbinding in Ottoman (URL-5)

Figure 4: Furniture in the Ottoman (URL-6)

2. ARCHITECTURE IN THE OTTOMAN

Ottoman architecture was simple, useful, fine, elegant, dignified and majestic. However, the mosques built in the name of Allah were completely monumental. The mosques were surrounded by many social institutions and they formed a "kulliye".

Ottoman was an outstanding developer. There was no imperial corner where the reconstruction was not seen. Even the neighborhood's modest wealthy people, who could not build a mosque, would have a fountain built or a school repaired. The sense of society was extremely strong. The idea of compassion had developed a lot in the generations that followed them (Tolga, 1981).

In addition, the value Islam attaches to science and education has developed the architecture of the madrasa, the art of books and calligraphy, the importance it attaches to human health also has developed the architecture related to health institutions. Likewise, the duty of cleaning improved the water architecture. The most famous architect of the Ottoman Empire is Mimar Sinan.

3. ART OF DECORATION IN THE OTTOMAN

It is a well-known fact that various styles and motifs, which were used in all branches of Ottoman art developed with the admiration and protection of the palace, were created by the artists belonging to the palace’s muralist house. Especially in the 16th century, among the artists and craftsmen who worked for the palace, the ehli-hiref, the majority of them were the muralists. As a natural consequence of their large number, miniaturists, illuminators and painters, coming from different geographical regions of the empire and gathered in the Muralist House of Istanbul Palace, created a common form language that was effective in all art branches and determined the formation of classical Ottoman art.

Since paintings and sculptures are prohibited in Ottoman architecture, Ottoman architects mostly mastered mosque decorations. This style, which Europeans call Arabesque, reached its peak in the Ottoman Empire. Besides these geometric shapes, the most used are "Ornamental plants" (Sarı, 2016). Although these ornamental plants vary with periods, they are palmetto, lotus, pomegranate, spring branches, tulips, carnations, buttercup, poppy, poppy, bean flower, rose, hyacinth, cypress, and other plants. The curved branch motif, which has a wide variety, is widely used in both interior and exterior decorations, hand-drawn work, tiles and stone decoration (Güney & Güney).

While there were great developments in Istanbul, local artists in Anatolia reflected their personal styles. All this has shown that wall painting is now a folk art in the provinces.

Various subjects were depicted in the hand-drawn works applied in architectural structures from the first half of the 18th century to the beginning of the 20th century.

3.1. The Ottoman Art Organization: Ehli-Hiref

Ehl-i Hiref is an organization consisting of important people who performed arts and crafts such as poets, goldsmiths, binders, ceramists, carpenters, clerks, and carvers in the early 1500s (Figure 5). The talented people of the Ehl-i Hiref, who were loyal to the Sultan but were essentially independent, determined the art movement of the time, so it is important for Turkish art history.

The priority of this union was the palace, which consisted of 776 craftsmen from copper to tin-maker, from calligrapher to miniature master, from carpenter to glass master, from arrow-bow master to those who performed Islamic art (according to the record of 1545).

The arts and craftsmen, who undertook the work of decorating an architectural work ordered by the Sultan or the weapons and kitchen equipment necessary for the palace, were working on a three-month salary (ulufe) (Güney & Güney).

Figure 5: A work depicting ehli-hiref (URL-7)

Figure 6: A work depicting the art of marbling (URL-8)

4. ORNAMENTAL ARTS

Arseven (1927) talks about the Turkish ornamental art as follows: Turkish ornament is the most important branch of Turkish morale. Because the most prominent aspect of nationality in art is ornamentation.

The word ornamentation is a term that includes many decorative arts and crafts. Ornamentation is derived from the Arabic word adornment, meaning ornament. Ornament means to embelish, embellishment means the plural of it, that is, ornamentation. For this reason, ornamental arts are also called decoration arts with a name that is more appropriate in terms of embellishment or meaning. Its name in European languages is decorative arts. Book arts such as book cover, illumination, calligraphy, marbling, paper cut, ornaments on stone and wood, metalwork, pencil work, revzen, textile, weaving and embroidery are gathered under the umbrella of ornamental arts. As you can see, the ornamentation has a wide application area. Except for calligraphy, marbling, kilim weaving and some embroidery, the common feature of all of them is the same motif and pattern information. Only the materials used and the techniques applied are different. Although this difference in ornamental arts affects the size, density and colors of the motifs and therefore the patterns, its essence does not change (URL-9).

If we examine some of the decorative arts; Although it is not known when and in which country the art of marbling emerged, it is thought to be an ornamental art specific to eastern countries. It is written in some Iranian sources that it originated in India. According to some sources, it was born in the city of Bukhara in Turkistan and passed to the Ottomans through Iran. In the west, marbling is called "Turkish Paper" or "Marble paper". Marbling is done by using tragacanth or carrageen obtained from the sap of aloe vera, sprinkling paints on the water with increased consistency so that it does not settle to the bottom of the water, passing the figures that occurs on surface of the water as it is or intervening with a tool called awl on a piece of paper (Figure 6).

Marbling art is a type of visual art developed using “Hüsn-ü hat” or calligraphy or calligraphy writing systems and writing elements, often used for decorative purposes.

4.1. Motifs Used in Ornamental Arts

Since figures and depictions are not used much in Islamic decorative arts, motifs have gained great importance together with geometric arrangements. Classifying the ornamental element motifs that have developed and diversified over the centuries by collecting them in certain groups will make it easier to recognize them. We can examine these motifs in three groups:

Herbal motifs (naturalist motifs)

- Palmette-lotus

- Pench
- Flowers, leaves, trees, nuts and fruits

Abstract Motifs

- Rumi
- Munhani

Symbolic motifs

- Clouds
- Cintamani and three speckles

4.1.1. Herbal Motifs

a.Palmet-lotus: Of these two motifs commonly used together, Lotus is a simplified form of water lily (Figure 7). Palmet is a motif source of which is known as the Assyrians. These motifs, which have a very rich variety, are drawn in Islamic works with their simple and elegant appearance.

Figure 7: Palmet-lotus sample (URL-10)

Figure 8: Hatai sample (URL-11)

b.Hatai: The longitudinal section of roses, rosebuds and similar flowers drawn with stylized views of anatomical lines (Figure 8). Although it is stated in some books that this motif was brought from China Turkistan during the time of the Timur State, it is not true.

At the beginning of the 11th century, an artist was sent to the country called "Hatay-Hitay-Huten" during the time of the Karakhanid State and this artist who learned the "art of Hitay" in this country, laid the foundation of the hatai style with hatai motif in Islamic decorative arts.

c.Pench: They are stylized shapes of bird's eye view of roses, rosebuds, daisies and similar flowers. Flowers are shaped according to their leaves.

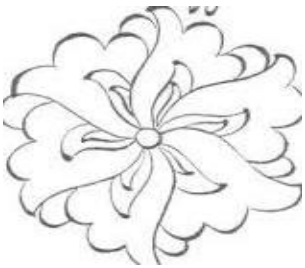

Figure 9: Pench sample (URL-12)

Penchberk; means five leaf. With the Hatai motif popularly used in the 13th and 14th centuries, in the 15th century, with the addition of other flowers such as narcissus, daffodil, and hyacinth, naturalist arrangements began to replace Greek and geometric arrangements in the ornamental art. Especially in the 16th century, when the tulip flower started to be used in ornamental arts, it started a brand new era (URL-13).

d.Leaves: When dealing with plant-based motifs of our ornamental art, naturally the leaves are not neglected and some stylization has been created in this area (Figure 10). The naturalist ornamentation style, in its various examples, has been given importance to treat each flower leaf in a way that does not contradict nature.

European rococo, baroque style affected the leaf motifs as well as other motifs, distorting the decoration away from the Turkish character. Towards the end of the 18th century, laurel, oak, olive and parsley leaves were also used for decoration, in the style known as "Turkish Rococo".

Figure 10: Leaf sample (URL-14)

Figure 11: A work inspired by the cypress (URL-15)

e. Trees: As in leaves and flowers, samples of trees with many varieties, have an important place in Turkish ornamentation (Figure 11).
Especially five kinds of tree decorations are frequently encountered.

- Cypress tree (*Cupressus sempervirens*)
- Date palm (*Fructus dactylus*)
- Tree of life (*Lignum vitae*)
- Fruit trees with specified fruits
- Trees in bloom

It is bent by the wind, sometimes in the shape of a leaf and is full of flowers. This motif found in Indian and Iranian fabrics is called "Buta" or "Almond".

f. Nuts and fruits: After the 15th century, nuts and fruit motifs were frequently used. Pomegranate and grape were adopted in these motifs and gained a symbolic meaning. Pomegranate and grape are mentioned in the Quran. This is why it is reflected in art so much (URL-13).

"It is He who sends water down from the sky. Then We bring out all kinds of plants with it. From that plant we make a sprout, and from it we produce grains and spicas that overlap one another. We grow bunches hanging from palm buds, and gardens of grapes, olives and pomegranates ..." (En 'am, 99).

Seljuks, who brought the art of illumination to Anatolia, developed the "Rumi" motif (Figure 12). In the XI century in Seljuks' illumination, more geometric forms and interlocks were used. Towards the 13th century, in addition to geometric forms, floral motifs and rumi were quite full and large. The most distinctive style of the Seljuk period is "munhani" (Figure 13).

Figure 12: Motif drawn in Rumi style (URL-16)

Figure 13: Munhani sample (URL-17)

The first examples of Ottoman illumination art that reflect the character of a school are seen in the period of Fatih Sultan Mehmet. A great development begins in illumination in the XV century, when Hatai and Rumi motifs were used with great skill. Fatih Sultan Mehmet, who attaches great importance to art and craftsmen, has an important role in this development. Many works prepared in the name of Fatih Sultan Mehmet and his vizier Mahmut Pasha are found in various museums and libraries, including the TPML and the Suleymaniye Library. The main colors in the illumination of the period are gold, dark blue and blue. In addition to these colors, black, white, burgundy and ashen green were used as background colors in small areas. Baba Nakkaş, of Uzbek origin, is the head of the embroidery shop established in the palace of Fatih Sultan Mehmet, the most important museum of the XV century (Güney & Güney).

Figure 14: Baba Nakkash work (URL-18)

Figure 15: One of the works of Sheikh Hamdullah (URL-19)

At the beginning of the XVI century, during the II Beyazıt period, a great development started in Ottoman illumination art. There are two important reasons for this development. Illuminators who came from Iran and Tabriz and joined the palace artists, played an important role in the development of the Ottoman illumination art (Figure 14). The other reason that influenced the development of illumination art during the II Beyazıt period is that an artist like Sheikh Hamdullah (D.1520) was raised, who guided the Turkish art. The admiration and interest of II Beyazıt for Sheikh Hamdullah and his art caused the Qur’an written by Sheikh Hamdullah to

be illuminated with great care. In the II Beyazıt period illumination, rumi and hatai motifs were extremely refined and diversified, and cloud motifs were also used (Figure 15). The most important illuminator of the period is Hasan bin Abdullah (URL-20).
At the beginning of the XVI century, new trends in Ottoman illumination art began with the sending of the last Timurid Sultan, Bediu'z Zaman Mirza, and the artists of Herat, to Istanbul after the Tabriz visit in 1514. Yavuz Sultan Selim brought other craftsmen from Tabriz. As a result of the works of these artists from different backgrounds, who have different tastes and knowledge, the Ottoman illumination art gained new dimensions.

The period of Suleiman the Magnificent is an extremely rich period when many new styles and techniques were applied. In the period of Kanuni, the golden period begins in the art of illumination as in other branches of art. In addition to the use of classical motifs and techniques with great skill, with half stylized use of many garden flowers and plants such as tulip, rose, carnation, hyacinth, cypress tree and spring branch for the first time in the art of illumination with “Karamemi”, the most important illuminator of the period, this interval of time is called “Classical Period”. Flowers such as tulips, roses, carnations, hyacinths: cloud, rumi and Hatai motifs are mostly used in the "Shikaf" folklore style in the decoration of the "Muhibbi Divan", which contains the poems written by Suleiman the Magnificent with the pseudonym "Muhibbi" and was illuminated by Karamemi (URL-2).

It may be correct to say that Yümnî Efendi's works have the characteristics of transition from rococo to classical style.

5. TECHNIQUES AND STYLES USED ILLUMINATION ART

- Classical Illumination
- Halkar
- Zerefsan
- Sazyolu
- Shukufe
- Münhani
- Tulip
- Rose

5.1. Classical Establishment

In the production of classical illumination, first of all, the pattern is prepared by following the composition rules. The pattern is shaken on the ground that is being illuminated, using the desired patterning method. First, gold is applied by making it clear with a brush or pen. The gold parts are sealed and polished. The flowers are painted in suitable colors after they are prepared. The flowers are colored by methods such as hatching or spotting. After the flowers are completed, the ground is filled with the desired colors. In order to show some parts of the patterns convex, white paint is applied with egg yolk before gilding and paint, and after drying, gilding and paint is applied. After contouring the composition with the darkest background color, it is painted by making a suitable crochet drawing (URL-1).

5.2. Halkar

Halkar, one of the techniques of illumination art, is the name given to the light ornamentation style made with gold or gilding (Figure 16). It has been applied in different ways such as shaded halkar and hatching halkar and has taken its names according to the way of painting.

The main halkar made with monochromatic or double color (yellow-green) gold takes names such as distorted halkar (Figure 17), colored halkar, foyal halkar, needle burnished halkar. This is the practice of flowers, leaves and shapes working with watery gold by sweeping from the center to the outside, collecting the gold at the ends. Then a thick contour is drawn around it with gold again. The same style has been worked on again, but shading is applied to the inner areas where gold is less with a color that is very diluted, and the lightly colored one of this halkar is called shikaf.

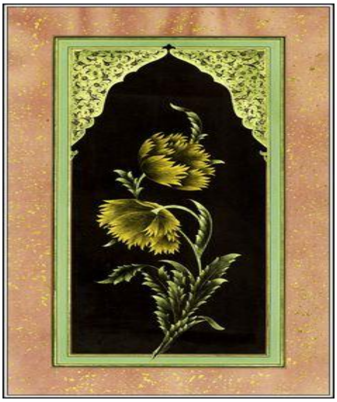

Figure 16: An illumination sample using the Halkari technique (URL-21)

Figure 17: Distorted Halkari sample (URL-22)

5.3. Zerefshan

Zerefshan is a style of decoration made in the form of sprinkled gold in Turkish decoration (Figure 18). It is the sprinkling of gold leaf over a sieve on a ground coated with gelatinous water or egg white.

Figure 18: Works made with Zerefshan technique (URL-23)

Figure 19: Works made with Sazyolu technique (URL-24)

5.4. Sazyolu

The sazyolu or saz style is a common decoration style of Ottoman art (Figure 19). This style was initiated by painter Shah Kulu, who produced works in the period of Kanuni. The saz style, which has been widely used in architectural decorations such as tile, carving, stonework, as well as in book painting, binding, fabric, carpet arts and other small arts, preserved its validity from the mid-16th century to the mid-17th century, and reinterpreted in lacquer workmanship again in 18th century.

Sazyolu are decorations made on long branches known as curved branches. The artist Karamemi also has successful works in this technique. In his works, he treated fairies, bugs, birds among the clusters of leaves, and he did not go to detail as his master Shah Kulu in his personal interpretation.

5.5. Shukufe

Shukufe, also called flower miniatures, consists of natural and stylized flowers in Turkish decoration (Figure 20). Flowers, branches and leaves are sometimes studied within the concept of close to the nature “still life” concept, by tying them in pots and vases called "Shukfedan" or with bows. Technically, this style includes hatching and pouring paint as well as spotting. Shukufe is a fine style that is practiced by shading with fine brush strokes, especially shown too many works in book art. It is an ornament adopted especially in the 18th and 19th centuries.

Numerous flower painters such as Ali Uskudari, Ahmet Ataullah, Huseyin Husnu, Salih Efendi were the most important masters of their time.

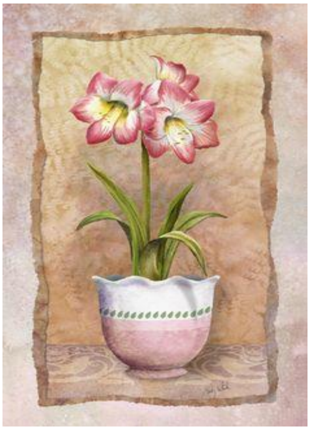

Figure 20: Works made with Shukufe technique (URL-25)

Figure 21: Samples made with the Munhani technique (URL-26)

5.6. Munhani

It is a type of decoration that emerged in the Seljuk period and was used until the Fatih period (Figure 21). It is drawn as if it is coming from the same root. Certain single motifs are combined to create borders or independent compositions.

5.7. Tulip

During the Ottoman Empire period, it was used as an ornamental plant and decoration motif between the 16th, 17th and 18th centuries (Figure 22).

Figure 22: Work made with tulip technique (URL-27)

Figure 23: Work made with rose technique (URL-28)

5.8. Rose

The rose symbolizes love and the Prophet Muhammad in the religion of Islam. It was widely used in decorative arts as semi-stylized in the middle of the 16th century (Figure 23). Stylized rose motifs have been replaced by naturalist works over time.

5.9. Usage Areas of Illumination Art

- Manuscripts
- Sheets
- Edicts and Tugras
- Book Binders
- Miniatures
- Kubur, Box, Chest (Lake Works)
- Today's Usage Areas

5.9.1. Manuscripts

The art of illumination was mostly used in the decoration of manuscripts. The most written and illuminated among the manuscripts is, of course, the Qur'an (Figure 24).

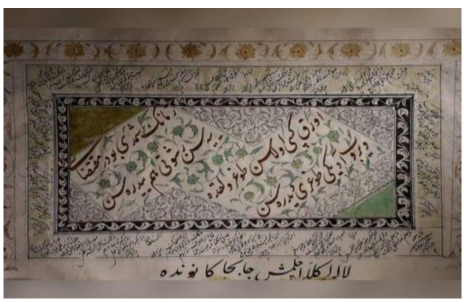

Figure 24: Manuscripts (URL-29)

The manuscripts, which are among the most valuable cultural assets of the countries and which are the most authentic sources in science, art and culture research, are works created by hand.

The first Islamic writing begins with the St. Osman's copying of the Qur'an and sending one copy to Medina and the other copies to Kufa, Basra and Sham. These mushafs are the first manuscripts in Islam.

RESULTS AND DISCUSSION

Due to the restrictions in painting and sculpture, the Ottoman Empire concentrated on mosque decoration. Decorative arts have demonstrated themselves in many branches as well as in architectural subjects. The artists who specialized in this field and made a name for themselves had been brought from all over the empire and other countries in order to develop the art and show the greatness of the state in terms of art. As a result of many fusions, arabesque art was formed that could guide other countries. These arts that were made by the miniaturists, are one of the biggest works of their period, and they were tried to be maintained with the master-pupil relationship.

Ottoman art mostly worked from nature-inspired motifs. Since tulip, rose and bean flower are the most common plants in that period, they have taken their places in motifs constantly. Ottoman took its art to the west and explained it. The West has adapted this art for themselves. The art of illumination, which was very influenced by baroque and rococo styles, showed itself in the Ottoman Empire as well.

The art of illumination lived its brightest period during the period of Suleiman the Magnificent. In addition to many new techniques and styles, the works of the most important illuminators of the period, Shah Kulu and Karamemi, are almost like their signatures. Especially the Saz Yolu technique developed by Şah Kulu was used in many works.

These arts, which paused during the collapse of the Ottoman Empire, were tried to be continued after the declaration of the Republic. The Department of Decorative Arts, affiliated with the Faculty of Fine Arts, continued its activities but could not improve itself. These arts, which are currently being taught, are continued both in the university and in the courses of the municipality or other organizations. Today, there are people who perform this art with respect and love. Competitions are organized, exhibitions are opened, art is tried to be introduced as much as possible.

REFERENCES

Arseven, C. E. (1927). Bizde temaşa sanatı. Hayât Mecmuasi, 1(17): 335-336.

Aslanapa, O. (2007). Anadolu'da İlk Türk Mimarisi Başlangıç ve Gelişmesi. Atatürk Kültür Merkezi Yayınları, Ankara, s.163.

Aslanapa, O. (2016). Türk Sanatı. Remzi Kitabevi, İstanbul, s. 454.

Güney, K. Z. & Güney, A. N. (1999). Osmanlı Süsleme Sanatı. SFN Ltd. Şti., Ankara. p. 170.

Öney, G. & Çobanlı, Z. (2007). Anadolu'da Türk Devri Çini ve Seramik Sanatı, T.C. Kültür ve Turizm Bakanlığı Yayınları, İstanbul. s. 516.

Sarı, İ. (2016). Türk Sanat Tarihi. Nokta E-Book International Publising, Antalya, s. 259.

Tolga, P. (1981). Türk Mimarisinde Süsleme Sanatı. Haşet Kitabevi A.Ş., İstanbul, s. 138.

URL-1.https://tezhipsanati.nedir.com/#2nTQIJXa1 (Access date: 01.10.2013)

URL-2. http:osmanlikulturunuyasatmadernegi.com (Access date: 06.10.2013)

URL-3.https://www.istanbulsanatevi.com/sanat-terimleri-kavramlar/cini-sanati-ve-cinicilik-nedir-teknikleri-nelerdir/ (Acces date: 10.11.2020)

URL-4.http://hakkindabilgial.com/osmanlida-halicilik/ (Acces date: 10.11.2020)

URL-5. https://islamansiklopedisi.org.tr/ciltcilik (Acces date: 10.11.2020)

URL-6.https://www.tasarimakademi.org/osmanlida-mobilya-sanati.html (Acces date: 10.11.2020)

URL-7.https://www.yenisafak.com/hayat/saraydaki-ehl-i-hiref-teskilati-ve-kitap-uretimine-katkilari-3383345 (Acces date: 10.11.2020)

URL-8. https://www.turktoyu.com/turk-sanati-nin-vazgecilmez-unsuru-ebru (Acces date: 10.11.2020)

URL-9. http://tr.wikipedia.org (Access date: 01.10.2013)

URL-10. https://en.wikipedia.org/wiki/File:Palmette.jpg (Acces date: 10.11.2020)

URL-11.http://osmanlicadersnotlari.blogspot.com/2009/06/susleme-sanati-hazirlayanlar-dursun.html (Acces date: 10.11.2020)

URL-12.https://tr.pinterest.com/pin/510595676489592321/ (Acces date: 10.11.2020)

URL-13. http://www.agaclar.net/forum/yasantimizda-ve-sanatta-bitkiler/7601.htm (Access date: 01.10.2013)

URL-14.https://www.fikriyat.com/galeri/geleneksel-sanatlar/osmanli-sanatina-yansiyan-5-bitki-motifi/3 (Acces date: 10.11.2020)

URL-15.http://trdergisi.com/wp-content/uploads/2017/03/Bo%C4%9Fazi%C3%A7i-Kasabas%C4%B1-Eski-Camii.jpg (Acces date: 10.11.2020)

URL-16.https://tr.pinterest.com/pin/182044009920964594/ (Acces date: 10.11.2020)

URL-17. https://tr.pinterest.com/pin/410812797236691827/(Acces date: 10.11.2020)

URL-18. http://www.iznikciniveseramikleri.com/tr/?s=Baba+nakka%C5%9F+d%C3 %B6nemi+d%C3%B6nemsel+%C3%B6rnekler (Acces date: 10.11.2020)

URL-19. https://tr.pinterest.com/pin/467389267569607438/ (Acces date: 10.11.2020)

URL-20. http://www.hatdergisi.com/HAT%20DERG%C4%BOS%C4%B0/hat_ferman.htm (Access date: 01.10.2013)

URL-21. Halkari tekniği uygulanmış tezhip örneği. https://tr.pinterest.com/gunnuray/tezhip-halkari/ (Acces date: 10.11.2020)

URL-22. https://sanatsozlugum.blogspot.com/2014/07/halkari.html (Acces date: 10.11.2020)

URL-23. https://tr.pinterest.com/kalemistan/zeref%C5%9Fan/ (Acces date: 10.11.2020)

URL-24. https://tr.pinterest.com/sudokucuabla/saz-yolu-%C3%B6rnekleri/ (Acces date: 10.11.2020)

URL-25. https://tr.pinterest.com/mervebzdgn/%C5%9Fukufe/ (Acces date: 10.11.2020)

URL-26. https://tr.pinterest.com/murvetbaydemir5/m%C3%BCnhani/ (Acces date: 10.11.2020)

URL-27.https://tr.pinterest.com/fatmayangoz271/lale-tarama-%C3%B6rnekleri/ (Acces date: 10.11.2020)

URL-28. https://tr.pinterest.com/pin/676665912754464955/ (Acces date: 10.11.2020)

URL-29. https://tr.pinterest.com/pin/614248836669278018/ (Acces date: 10.11.2020)

CHAPTER 4

CLASSIFICATION OF ORNAMENTAL PLANT SPECIES WITH ARTIFICIAL INTELLIGENCE APPLICATIONS

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INTRODUCTION

Today, it is very important to identify plants that exist in nature and to know their species. It is important to determine the type of plant in various fields such as horticulture, botanical research, aromatic herbs, farming, floristry, and so on. Plants are found all over the world, even where humans don't live. Plants are an integral part of the ecosystem. Many plant species are at risk of extinction due to deforestation. Plants are essential for human and other living things to exist. They are useful as a foodstuff, medicine, and in many other industries (Amlekar et al., 2014). Identifying plants can help preserve and survive all natural life. Plant identification can be accomplished with the leaves of the plant using many different techniques. Leaves are more useful for classifying plants, such as flowers that are available for a short time as they are more readily available than other biometric components. Plant classification using leaves requires the knowledge of different biometric properties of the leaf such as color, shape, texture and vascularization. This definition manually is time consuming and expensive. Leaves can be classified by color including the similarity between the two images with the help of a color histogram, but color-based classification depends on the season and the influence of sunlight (Amlekar et al., 2014).

For the protection of plants it is very important to create a database. This job can be done easily with computer applications. But first, the computer must be trained to do this job like an expert by using artificial intelligence methods. After the necessary classification techniques are developed, the computer can classify the plants we desire in a short time. Traditionally, these classifications are carried out by taxonomy. Taxonomy generally classifies plants according to the phenomenon of flowering and association. Similar biometric properties of plant leaves such as vessel facilitate this classification. For classification, classification based on leaf and flower image can be made. Sampling and photographing the leaves is a low cost and convenient task. The leaf image can be easily transferred to the computer and automatically extract features in computer image processing techniques. However, as we explained before, it may be possible to extract these features and transfer them to the computer automatically after the creation of an artificial intelligence expert (Wu et al., 2007).

The human brain is a complex non-linear parallel adaptive information processing system. The basis of the human brain is a large number (up to 10^{21}) of interconnected and interacting nerve cells - neurons. Artificial neurons (AN) are greatly simplified in comparison with their biological prototypes. AN is a unit of information processing in an artificial neural network (Fedorov, 2016).

Selection of features for classification is an extremely difficult task. Previously, this problem was solved manually; recently, effective methods called Deep Learning have appeared for automatically finding the most effective features (Vakulenko & Jixareva, 2018). Since classes are determined before the data are examined, classification falls under the supervised learning method. In the behavioral sciences and most of the biological sciences, statistical analysis using traditional algorithms does not always lead to a satisfactory solution, especially in classification analysis (Vyas & Upadhyay, 2014).

The aim of this study is to examine some artificial intelligence methods used in the classification of ornamental plants and to compile the researches on this subject and bring them to the attention of subject experts.

1. ORNAMENTAL PLANTS

Ornamental plants are plants that exhibit visual activity with their flowers, leaves, fruits and forms or stand out with these features and are grown for ornamental purposes. Though it is not correct to examine the exact history of ornamental plants in certain periods, by the same token its use as an object of beauty in past times goes back to a time as old as the existence of civilizations in shaping gardens as an art form, expressing philosophical and religious beliefs (Jaggi, 2013; Baktır, 2013). Albeit cultivation of plants in culture for use as ornamental plants dates back to ancient times, ornamental plants became an important sector in the world at the beginning of the 20th century. Ornamental plants are divided into 4 groups according to their intended use - cut flowers, outdoor ornamental plants, indoor ornamental plants and flower bulbs (Ay, 2009; Kazaz, 2012).

1.1. Outdoor Ornamental Plants

Includes the species and varieties produced and marketed for use in outdoor market applications. Trees, shrubs, seasonal annual and perennial plants, other species used as ground cover and ornamental grasses are considered in this class (Karagüzel et al., 2010; Kazaz, 2012) (Figure 1).

Figure 1: Outdoor plants (Original by Çığ) **Figure 2:** Cut flowers (Çığ & Kocaağa, 2019)

1.2. Cut Flower

Flowers, buds, branches and leaves used in baskets, bouquets, wreaths and arrangements. These plants are used in fresh, dry or bleached forms (Kazaz, 2012) (Figure 2).

Figure 3: Indoor plants (Çığ & Kocaağa, 2019)

Figure 4: Flower bulbs (Original by Çığ)

1.3. Indoor Ornamental Plants

Includes plant species grown and marketed in pots or various containers for indoor use (Karagüzel et al., 2010; Kazaz, 2012) (Figure 3).

1.4. Flower Bulbs (Geophytes)

They are plants that maintain their vitality with bulbs, tubers, corms or rhizomes under the ground after completing their vital activities with their above-ground parts, leaves, flowers and stems (Kazaz, 2012) (Figure 4).

Indoor and outdoor spaces, with their visual-aesthetic aspects, are the main areas of use of ornamental plants. It has aesthetic and renovation uses in landscape works. Some plants have medicinal values due to their biochemical content of their underground parts (root-tuber bulb), as well as their leaves, flowers and fruits. Some ornamental plants are at risk in terms of biodiversity due to the above mentioned characteristics. In order for such plants to continue their generations in first place, it is necessary to take them under protection, to establish a gene bank, to apply and develop methods for production.

In this sense, determining and identifying the natural habitats of plants is very important as a first step.

2. SOME ARTIFICIAL INTELLIGENCE METHODS

2.1. Artificial Neural Network

An artificial neural network (ANN) is a system by which hardware and software modeling of structures similar to the structure of the human brain and thinking processes. ANN implements both short-term memory and long-term memory (Gavrilova, 2001; Fedorov, 2016).

The ANN steps for the problem being solved is shown in Figure 5 (Komartsova, 2002).

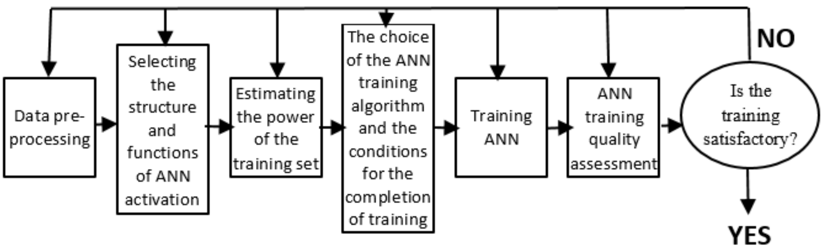


Figure 5: ANN tuning for the problem being solved

Consider the general principles of the functioning of neural networks by the example of the classification problem.

Suppose we want to create an automatic system, which distinguishes between two types of objects - A and B. Computer vision systems allow you to record data about objects (attributes of an object) in digital form. Suppose we characterize an object using the set of features (x_1, x_2, …, x_n). Signs can be expressed using integers or even Boolean variables, that is, "there is a sign" - "there is no sign".

The set of features can be considered as a vector with n components, or a point of the k-dimensional Euclidean space X=(x_1, x_2, …, x_n). Then the classification problem is reduced to the following mathematical problem: to separate two sets of points A and B of an n-dimensional Euclidean space by some hypersurface of dimension n-1.

Neural network training in classification problems occurs on the set of training examples X(1), X(2), …, X(P), for which the object belongs to class A or class B is known. To formalize this fact mathematically, let's define an indicator:

$$D(X) = \begin{cases} 1, & X \in A \\ 0, & X \in B \end{cases}$$

Based on the "experience" accumulated as a result of learning, we build a neural network (AI system) that conducts the dividing surface. Mathematically, this process can be described as searching some function

$$y = F(X, W),$$

where W is a set of parameters of a neural network (or other AI system). For neural networks, these parameters, in particular, set the strength of the connection between neurons and are selected so that the error training would be minimal (as close to zero as possible). The function is usually considered as a learning error

$$E_{train}(W) = \sum_j |F(X(j), W) - D(X(j))|,$$

where, X(j), $j = \overline{1, P}$ are taken from the training set.

To test the effectiveness of training a neural network, take test set of objects and calculate

$$E_{test}(W) = \sum_j |F(X(j), W) - D(X(j))|,$$

where X(j) are taken from the test set.

After the system has been trained (which sometimes requires a lot processor time), it automatically decides which class it belongs to for any object X fed into the system (Vakulenko & Jixareva, 2018).

2.2. Probabilistic Neural Network

The probabilistic neural network (PNN) is non-recurrent static two-layer or three-layer (Figure 6) ANN. Unlike MLP, classes are separated not by hyperplanes, but by hyperspheres. The output layer is linear. Usually one-step training (supervised learning) is used for PNN training.

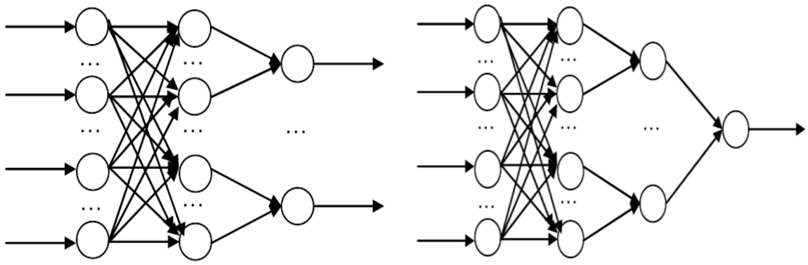


Figure 6: PNN with two layers (a) and PNN with three layers (b)

For two-layer and three-layer PNN the following are specified:

- vectors of mathematical expectations m_i of dimension $N^{(0)}$ (m_i is interpreted as a vector of weights of the i^{th} neuron of the first layer) and diagonal covariance matrices C_i of dimension $N^{(0)} \times N^{(0)}$,

$$C_i = diag\left(\sigma_{i1}^2, \dots, \sigma_{iN^{(0)}}^2\right), i \epsilon \overline{1, N^{(1)}},$$

- the weights of the second layer w_{ij}, $w_{ij} \epsilon \{1,0\}$, $i \epsilon \overline{1, N^{(1)}}$, $j \epsilon \overline{1, N^{(2)}}$, moreover, if the i^{th} neuron of the first layer is connected with the j^{th} neuron of the second layer, $w_{ij}=1$, otherwise $w_{ij}=0$, where $N^{(0)}$ is the number of neurons in the input layer, $N^{(1)}$ is the number of neurons in the first layer, $N^{(2)}$ is the number of neurons in the second layer.

For a three-layer PNN, the following are also specified:

- the cost of misclassification (value losses) for the j^{th} class l_j, $j \epsilon \overline{1, N^{(2)}}$;

- the prior probability of the appearance of an object from the j^{th} class h_j, at that $\sum_{j=1}^{N^{(2)}} h_j = 1$.

For double layer PNN, the output is

$$y_i = f_j(x) = \frac{1}{n_j} \sum_{i=1}^{N^{(1)}} w_{ij} \frac{1}{\sqrt{(2\pi)^{N^{(0)}} detC_i}} exp\left(-\frac{1}{2}(x - m_i)^T C_i^{-1}(x - m_i)\right),$$

$$detC_i = \prod_{k=1}^{N^{(0)}} \sigma_{ik}^2, \quad n_j = \sum_{i=1}^{N^{(1)}} w_{ij}, \quad j\epsilon\overline{1, N^{(2)}}.$$

For a 3-layer PNN, the output is calculated based on the minimum average risk in the form

$$y = f(x) = arg \max_j h_j l_j f_j(x), \qquad j\epsilon\overline{1, N^{(2)}},$$

where, $f_j(x)$ is interpreted as a likelihood function (Fedorov, 2016).

2.3. Support Vector Machine

In Figure 7 shows a support vector machine (SVM), which is a non-recurrent static two-layer ANN. The two classes are separated by a hyperplane, but unlike MLP, this hyperplane provides maximum separation.

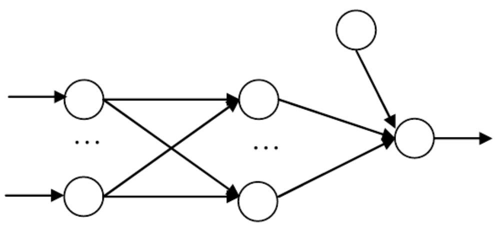


Figure 7: Support vector machine

The main idea behind creating SVM is to select a subset training data as support vectors. This subset represents the robust properties of the entire training set. The SVM supervised learning algorithm provides maximizing the Lagrange function. This algorithm is based on minimizing empirical risk (learning errors).

For SVM the following are specified:

1. A training set is given as

$$\left\{(x_\mu, d_\mu) \middle| x_\mu \in R^{N^{(0)}},\quad d_\mu \in \{-1,1\}\right\},\ \mu\epsilon\overline{1,P},$$

where x_μ - μ^{th} training input vector, d_μ - μ^{th} training output, $N^{(0)}$ - the number of neurons in the input layer, P is the power of the training sets, and the parameter C>0.

2. Calculation of the output signal for the first layer in the form of a kernel $K(x_i,x_j)$, $i,j \in \overline{1,P}$

- if we want to get a polynomial learning machine, then

$$K(x_i,x_j) = (x_i^T x_j)^p \quad or \quad K(x_i,x_j) = (x_i^T x_j + 1)^p;$$

- if we want to get a two-layer perceptron, then

$$K(x_i,x_j) = tanh(k_0 + k_1 x_i^T x_j),$$

where, the parameters k_0, k_1 satisfy the condition $k_0>0$ or $k_1>0$;

- if we want to get a radial basis function, then

$$K(x_i,x_j) = exp\left(-\frac{1}{2\sigma^2}\|x_i - x_j\|^2\right),$$

where parameter σ is the width of the function $K(x_i,x_j)$,

$$x_i^T x_j = \sum_{k=1}^{N(0)} x_{ik}x_{jk},\quad \|x_i - x_j\| = \sqrt{\sum_{k=1}^{N(0)} (x_{ik} - x_{jk})^2}.$$

3. The variables are defined (Lagrange multipliers) λ_i, maximizing the Lagrange function, i.e.

$$L(\lambda) = \sum_{i=1}^{P} \lambda_i - \frac{1}{2}\sum_{i=1}^{P}\sum_{j=1}^{P} \lambda_i\lambda_j d_i d_j K(x_i,x_j) \rightarrow \max_{\lambda} \quad ,$$

with restrictions

$$0 \leq \lambda_i \leq C,$$

$$\sum_{i \in I} \lambda_i y_i = 0, \quad I = \{i:\ 0 \le \lambda_i \le C\}$$

If $0<\lambda_i<C$, then the pair (x_i, d_i) is a support vector, i.e. is located on the border of the dividing strip.

The number of support vectors will be denoted as $N^{(1)}$, since it corresponds to the number of neurons in the first layer. We enumerate the training set and the Lagrange multipliers so that we first go support vectors and associated Lagrange multipliers.

4. Determine the optimal value of the vector of weight coefficients w

$$w = \sum_{i=1}^{N^{(1)}} \lambda_i d_i x_i.$$

5. Determine the optimal bias (threshold) b using any support vector x_i

$$b = \frac{1}{d_i} - w^T x_i.$$

The function is:

$$y = f(x) = sgn(b + w^T x) = sgn\left(b + \sum_{i=1}^{N^{(1)}} \lambda_i d_i K(x, x_i) \right)$$

(Fedorov, 2016).

2.4. Deep Learning

Deep neural network (DNN) is artificial neural network with several hidden layers between input and output layers. Like a conventional ANN, DNN can model complex nonlinear relationships. DNN architectures, for example, for object detection and parsing, generate compositional models, where an object is expressed as a layered composition of image primitives. DNNs are usually implemented in the form of feedforward networks, but recurrent neural networks are also very successfully used here.

Deep learning is part of a broader family of machine learning methods based on learning about data representations. Observations, such as an image, can be represented in many forms, such as a vector of intensity values per pixel, or in a more abstract form as a set of edges, regions of a certain shape, etc. Some representations are better than others, which simplifies the learning task (for example, face detection, or facial expression recognition). One of the benefits of deep learning is the automatic feature selection. Research in this area is aimed at choosing the best representation of objects. Some of the concepts take advantage of advances in neuroscience, in particular based on interpretations of information processing and communication in the nervous system, such as neural coding, which attempts to determine the relationship between various stimuli and associated neural responses in the brain. Various ad-hoc neural network architectures such as deep neural networks, convolutional neural networks have been successfully applied in areas such as computer vision, automatic speech recognition, natural language processing, bioinformatics (Vakulenko & Jixareva, 2018).

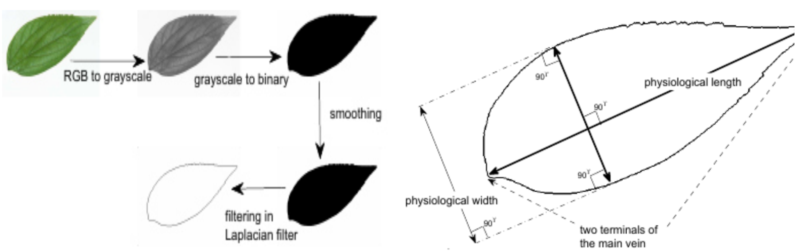
2.5. Convolutional Neural Networks

CNNs are handy for handling visual and other two-dimensional data. A CNN is composed of one or more convolutional layers with fully connected neurons. Compared to other deep architectures, convolutional neural networks have shown superior results in image processing and speech applications. They can also be trained using standard backpropagation. CNNs are easier to train than other regular, deep neural networks and have many fewer parameters to evaluate, which makes them very attractive (Vakulenko & Jixareva, 2018).

3. ARTIFICIAL INTELLIGENCE APPLICATIONS IN CLASSIFICATION OF ORNAMENTAL SPECIES

Various methods are used in ornamental plant classification, as well as some studies done with these techniques are as follows:

Timmermans & Hulzebosch (1996) developed a flexible grading system for potted plants in their study. The system consists of a color camera, an image processing system and specially developed software. The system can also be applied to various potted plants due to the application of learning techniques. Tests have been made to classify the flowering plant and cactus plant. Statistical discriminant analysis and ANN classifier techniques were used for pattern recognition. For less complex samples, NNs gave similar results to linear discriminant analysis or quadratic discriminant analysis. For more complex applications, the NN classifier gave better results than other classifiers.



(a) (b)

Figure 8: (a) A pre-processing example, (b) relationship between physiological length and physiological width (Wu et al., 2007)

Wu et al. (2007) used the Probabilistic Neural Network (PNN) method with image and data processing techniques to establish a general purpose automatic leaf recognition system in their plant classification study. For this purpose, 12 leaf features (digital morphological and physiological features) were extracted and orthogonalized to 5 main variables that constitute the input vector of PNN. Image pre-processing and feature extraction procedure implemented in the study was illustrated in Figure 8.

PNN was trained with 1800 leaves to classify 32 types of plants with an accuracy of over 90%. As a result of the study, when compared to other approaches, it is concluded that this algorithm is a fast, easy and accurate artificial intelligence approach.

In their study, Arai et al. (2013) tried to create an ornamental plant identification system based on Redundant Discrete Wavelet Transformation (RDWT), drawing attention to the drug efficacy of ornamental plants and using the leaves of the plants to enable people to recognize such plants well. This system achieved an accurate classification rate of 95.83%.

In his study, Mukane (2013) tried to classify the flowers using an Artificial Neural Network (ANN) classifier. The proposed method is based on textural features such as Gray level co-occurrence matrix (GLCM) and discrete wavelet transform. The author divided the flower image into sections using a threshold based method. The data set consists of different flower images with similar appearance. The database of flower images consists of images taken from the World Wide Web and images taken by the author. The ANN was trained with 50 samples to classify 5 flower classes and achieved over 85% classification accuracy using only GLCM features.

Sun et al. (2017) used the BJFU100 dataset, which includes 10,000 images of 100 plant species in their study. The dataset is open to the academic community at http://pan.baidu.com/s/1jILsypS. At the same time, in the study, a deep learning approach was also examined to identify and classify plants in natural environment. The proposed ResNet26 model obtained results with 91.78% accuracy in the test set, showing that deep learning is a promising technology for large-scale facility classification in natural environment.

Amlekar et al. (2014) used a total of 221 leaf images in their study. Leaf images were processed using sharp edge detection and morphological feature extraction methods. The results of the classification model are obtained using the multilayer perceptron based artificial neural network method and the KNN method. With the KNN classification technique, it was found that the plant classification according to the leaf formation morphological characteristics achieved 85.54% accuracy in education and 65.21% in test mode. The ANN-based classification model, trained with 96.53% accuracy, achieved 91% accuracy in tests to classify leaf images with morphological vessel biometric properties. In this study, it was concluded that the ANN classification model has a better classification performance than the KNN classification model.

Vyas & Upadhyay (2014) tried to identify Iris plant species automatically on the basis of plant attribute measurements. In the study, they used feed forward neural networks to identify iris plants based on the following measurements: sepal length, leaf width, petal length and petal width. EBPA algorithm was used for ANN training. The results of the simulations showed the efficiency of the nervous system in iris class identification. The results were obtained based on a total of 221 leaves images. Leaf Images were processed using sharp edge detection and morphological feature extraction methods. The results of the classification model are obtained by following the multilayer perceptron based artificial neural network method. It was found that plant classification according to the morphological characteristics of the leaf vessels with the KNN classification technique provided 85.54% accuracy in education and 65.21% in test mode. The ANN based classification model, trained with 96.53% accuracy, achieved 91% accuracy in tests. As a result, it was determined that the ANN classification model has a better classification performance than the KNN classification model.

Dyrmann et al. (2016) in their study, presented a method that can recognize plant species with color images using a convolutional neural network. In the study, convolutional neural networks were created to distinguish the images of seedlings in early growth stages. The study was carried out on vertical photographed images of seedlings covering 22 different plant species or families believed to be developed in terms of different species number. The network was tested on a total of 10,413 images containing 22 weed and cereal plant species in early growth stages. These images were created from six different datasets that differ by lighting, resolution and soil type. For 22 species, the network achieved a classification accuracy of 86.2%. The classification accuracy of the network ranged from 33% to 98% with an average accuracy of 86.2%. In particular, thale cress (*Arabidopsis thaliana*), sugar beet (*Beta vulgaris*) and barley (*Hordeum vulgaris*) are generally correctly classified, respectively with an accuracy of 98%, 98% and 97%. However, there was a problem in the classification of veronica (*Veronica*), field pancy (*Viola arvensis*) and broadleaf grasses (*Poacher*). It was concluded that this problem was caused by the small number of training samples for these species.

Yalcin & Razavi (2016) applied a convolutional neural network based approach for the classification of various plant species. The CNN architecture they established was able to automatically classify images of sixteen types of plants. SVM-based classifier, which uses features such as LBP and GIST, has also been implemented to evaluate the performance and efficiency of the deep-learning based approach. The SVM classifier has been tested with RBF and polynomial kernels. The classification rate of these methods is compared with the CNN-based approach. Algorithms are tested on experimental data obtained under natural outdoor lighting. The trial results have shown that the CNN-based approach is significantly effective on 16 varieties of plants with an accuracy of about 97.47%. Compared to other methods, the results showed that the classification accuracy of the CNN-based approach provides better performance than other methods.

Begue et al. (2017) presented a fully automated method for the identification of medicinal plants using computer vision and machine learning techniques. Leaves of 24 different medicinal plant species were collected in the laboratory and photographed using a smart phone. Many characteristics such as length, width, circumference, area, number of corners, color, circumference and stem area were obtained from each leaf. Afterwards, various properties derived from these properties were calculated. The best results were obtained from the random forest classifier using the 10-fold crossvalidation technique. With an accuracy of 90.1%, the random forest classifier performed better than other machine learning approaches such as KNN, naive Bayes, SVM, and ANN.

In their study, Murat et al. (2017) applied shape descriptors to the myDAUN dataset, which includes 45 tropical shrub species collected from Malaya University, Malaysia. Four types of shape descriptors were used in the study - morphological shape descriptors, histogram of oriented gradients, Hu invariant moments and Zernike moments. A single identifier and a combination of hybrid descriptors were tested and compared. Tropical shrub species were classified using six different classifiers - ANN, random forest, SVM, k-NN, and linear discriminant analysis. In addition, three types of feature selection methods have been tested in the myDAUN dataset: relief, orrelation-based feature selection and Pearson's coefficient of correlation. The results revealed that the hybrid of all descriptors of ANN performed better than other classifiers with an average classification accuracy of 98.23% for the myDAUN data set, 95.25% for the Flavia data set, and 99.89% for the Swedish Leaf data set. In this study, ANN performed better than others in the classification of tropical shrub species.

Jeon & Rhee (2017) developed a method to classify plant leaves using the CNN model in their study. For this, they created two models by adjusting the network depth using GoogleNet. They evaluated the performance of each model according to the color change or damage of the leaves. The recognition rate obtained was over 94% even when 30% of the leaf was damaged.

In their study, Jye et al. (2017) selected foliage images from three different *Ficus* species - *F. benjamina, F. pellucidopunctata* and *F. sumatrana*, using the pattern recognition method. A total of 54 leaf image samples were used in the study. Three main steps – pre-preprocessing, feature extraction and recognition, were carried out to develop the proposed system. Two machine learning algorithms such as ANN and SVM have been implemented as recognition models. *Ficus* is one of the largest genuses in the plant kingdom, reaching about 1000 species worldwide. Despite taxonomic keys are available to describe most *Ficus* species, it is a very difficult and time consuming task to be interpreted by non-experts. According to the evaluation results, the proposed system recognized the leaf images with 83.3% accuracy. The system developed in the present study can classify selected *Ficus* species with acceptable accuracy. The study showed that it is possible to automatically classify *Ficus* species according to leaf images. Although the developed system is not intended to replace expert taxonomists, a fast and easily accessible technique is provided to identify plants with acceptable accuracy.

Inthiyaz et al. (2018) in their study, tried to classify flower images during and after segmentation according to the features extracted using multiple layered neural networks. The segmentation models used are watershed, wavelet, wavelet fusion model, supervised active contours based on shape, color and Local binary pattern textures and color, fused textures based active contours. Multidimensional feature vectors were created from these segmented results for each flower image labeled and indexed by name. Tests with different sets of flower images from multiple sources resulted in an average classification accuracy of 92% for flower images with active contour segments controlled for shape, color and texture. In this study, 7 flower image segmentation algorithms with 4 different features were classified with back propagation trained ANN. ANN has been trained with one feature and multiple features for each of the segmented flower classes.

Seeland et al. (2019) used images of 1000 plant species representing the flora of Western Europe in their study. In order to to determine the taxonomy of species included and excluded in learning, they tested how accurately the visual representation of genuses and families can be learned from images of their species. When using natural images with random content, about 500 images per type are required for correct classification. Classification accuracy for 1000 species increased to 82.2%, at the genus and family level it is increased to 85.9% and 88.4%. When classifying the species excluded from training, the accuracy drops significantly at the genus and family level to 38.3% and 38.7% respectively. Excluded species of well-represented genuses and families were classified with an accuracy of 67.8% and 52.8%.

CONCLUSION

Ornamental plants play a very important role in the protection of foodstuffs, medicine, industry and the environment. The enormous economic value of the plant trade, the increased aesthetic value of a single area, and the medicine efficacy found in a plant are some of the beneficial aspects of an ornamental plant. But few people are aware of the medicinal efficacy of these plants. In order to make possible for people to get to know these types of plants well, we need a system that can accurately identify them. The ability to recognize plants is essential in some applications such as the conservation of endangered species and landscape restoration. Anyhow, determining plant species is not easy and requires special knowledge. Botanists and plant researchers can determine the type of plant at a glance using the properties of the leaf. Artificial intelligence methods such as machine learning are used to automatically classify leaf types.

Classifiers play an important role in testing data and checking the accuracy of the classification algorithm. In this regard, supervised classification provides higher accuracy compared to unsupervised classification algorithms. Herewith, with this compilation study, by examining automatic classification systems developed to help both experts and the public to easily identify ornamental plant species, it is predicted to form a basis and idea for future studies.

REFERENCES

Amlekar, M., Manza, R. R., Yannawar, P., & Gaikwad, A. T. (2014). Leaf features based plant classification using artificial neural network. IBMRD's Journal of Management and Research, 3(1): 224-232.

Arai, K., Nugraha, I., & Okumura, H. (2013). Identification of ornamental plant functioned as medicinal plant based on redundant discrete wavelet transformation. International Journal of Advanced Research in Artificial Intelligence, 2(3): 60-64.

Ay, S., 2009. Süs Bitkileri ihracatı, sorunları ve çözüm önerileri: Yalova ölçeğinde bir araştırma. Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 14 (3): 423-443.

Baktır, İ. (2013). Türkiye'de süs bitkilerinin dünü, bugünü ve yarını. V. Süs Bitkileri Kongresi Bildiriler Cilt-1, Yalova, 13-16.

Begue, A., Kowlessur, V., Singh, U., Mahomoodally, F., & Pudaruth, S. (2017). Automatic recognition of medicinal plants using machine learning techniques. International Journal of Advanced Computer Science and Applications, 8(4): 166-175.

Çığ, A. & Kocaağa, E. Z. (2019). Siirt kent merkezinde bulunan çiçekçilerin mevcut durumlarının belirlenmesi. ISPEC 3. Uluslararası Tarım, Hayvancılık ve Kırsal Kalkınma Kongresi. 20-22 Aralık 2019, Van. s: 669-676.

Dyrmann, M., Karstoft, H., & Midtiby, H. S. (2016). Plant species classification using deep convolutional neural network. Biosystems Engineering, 151: 72-80.

Fedorov, E. E. (2016). Искусственные нейронные сети: монография / Красноармейск: ДВНЗ «ДонНТУ», с. 338.

Gavrilova T. A. (2001). Базы знаний интеллектуальных систем / Т.А. Гаврилова, В.Ф. Хорошевский. – СПб.: Питер, с. 384.

Inthiyaz, S., Madhav, B. T. P., & Raghava Prasad, C. (2018). Flower image classification with basket of features and multi layered artificial neural networks. International Journal of Engineering and Technology, 7(1.1): 642-650.

Jaggi, D. (2013). A Micropropagation System For Carnation (*Dianthus caryophyllus*)-An Important Ornamental Plant. Master's Thesis. Thapar University, Departmant of Biotechnology and Environmental Sciences, Patiala, 8-9.

Jeon, W. S. & Rhee, S. Y. (2017). Plant leaf recognition using a convolution neural network. International Journal of Fuzzy Logic and Intelligent Systems, 17(1): 26-34.

Jye, K. S., Manickam, S., Malek, S., Mosleh, M., & Dhillon, S. K. (2017). Automated plant identification using artificial neural network and support vector machine. Frontiers in Life Science, 10(1): 98-107.

Karagüzel, O., Korkut, A. B., Özkan, B., Çelikel, F., & Titiz, S. (2010). Süs bitkileri üretiminin bugünkü durumu, geliştirme olanakları ve hedefleri. Türkiye Ziraat Mühendisliği VII. Teknik Kongresi Bildiriler Kitabı, Ankara, 539-558.

Kazaz, S. (2012). Odunsu Süs Bitkilerinin Çoğaltma ve Yetiştirme Teknikleri. Ders notları, Ankara Üniversitesi Ziraat Fakültesi Bahçe Bitkileri Ana Bilim Dalı.

Komartsova, L. G. (2002). Нейрокомпьютеры / Л.Г. Комарцова, А.В. Максимов. – М.: Изд-во МГТУ им. Н.Э. Батмана, с. 320.

Mukane, S. M. (2013). Flower classification using neural network based image processing. IOSR Journal of Electronics and Communication Engineering, 7: 80-85.

Murat, M., Chang, S. W., Abu, A., Yap, H. J., & Yong, K. T. (2017). Automated classification of tropical shrub species: A hybrid of leaf shape and machine learning approach. Peer J., 5: e3792.

Seeland, M., Rzanny, M., Boho, D., Wäldchen, J., & Mäder, P. (2019). Image-based classification of plant genus and family for trained and untrained plant species. BMC Bioinformatics, 20(1): 4.

Sun, Y., Liu, Y., Wang, G., & Zhang, H. (2017). Deep Learning for Plant Identification in Natural Environment. Computational Intelligence and Neuroscience.

Timmermans, A. J. M., & Hulzebosch, A. A. (1996). Computer vision system for on-line sorting of pot plants using an artificial neural network classifier. Computers and Electronics in Agriculture, 15(1): 41-55.

Vakulenko, S. A. & Jixareva, A. A. (2018). Практический курс по нейронным сетям – СПб: Университет ИТМО, с.71.

Vyas, S. & Upadhyay, D. (2014). Classification of iris plant using feed forward neural network. International Refereed Journal of Engineering and Science, 3(1): 65-69.

Wu, S. G., Bao, F. S., Xu, E. Y., Wang, Y. X., Chang, Y. F., & Xiang, Q. L. (2007). A leaf recognition algorithm for plant classification using probabilistic neural network. 2007 IEEE International Symposium on Signal Processing and Information Technology, 15-18 December 2007, Giza, Egypt.

Yalcin, H. & Razavi, S. (2016). Plant classification using convolutional neural networks. 2016 Fifth International Conference on Agro-Geoinformatics (Agro-Geoinformatics), 18-20 July 2016, Tianjin, China.

CHAPTER 5

JOINT USE OF REMOTE SENSING AND PHYTOECOLOGICAL FIELD DIAGNOSIS TO STUDY THE IMPACT OF DESERTIFICATION ON ORNAMENTAL PLANT BIODIVERSITY: CASE OF THE SAIDA PROVINCE ALGERIA

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INTRODUCTION

Currently, the whole problem of desertification in recent decades requires adequate strategies based on developed tools such as remote sensing and GIS for the study and ecological monitoring of arid and semi-arid environments which are subject to strong anthropozoogenic pressures resulting in the phenomenon of desertification (Arabi, 2016). These tools provide potential users and decision-makers with information on the state of the environment and natural resources in these areas (Bensaïd, 2006).

The Saida province is facing an alarming desertification which results in the degradation of the plant cover, the deterioration of the quality of the soils and the erosion of plant biodiversity (Arabi et al., 2015).

This work contributes to a dual approach. Its objectives are: (1) The characterization of the dynamics of vegetation by the development of an experimental mapping methodology based on data remotely detected by satellites and data collected in the field. (2) Highlighting the wealth of ornamental plant biodiversity in the study area. The judicious crossing between these data allows the generation of several thematic maps. The use of these techniques plays an essential role in the study in monitoring the dynamics of land use (Zakari et al., 2018). They contribute to the characterization of the phenomenon of desertification (Escadafal & Bacha, 1995; El Mazi et al., 2017).

MATERIAL AND METHOD

The region studied, located in the north-west of Algeria (Figure 1) on the northern edge of the highlands of southern Oran. It fits into the space delimited in longitude by 0.2 °W to 0.9 °E and in latitude by 34.3 °N to

34.9 °N, extending over an area of 2200.4 km^2 which administratively attaches to the Daira El Hassasna, the province of Saida.

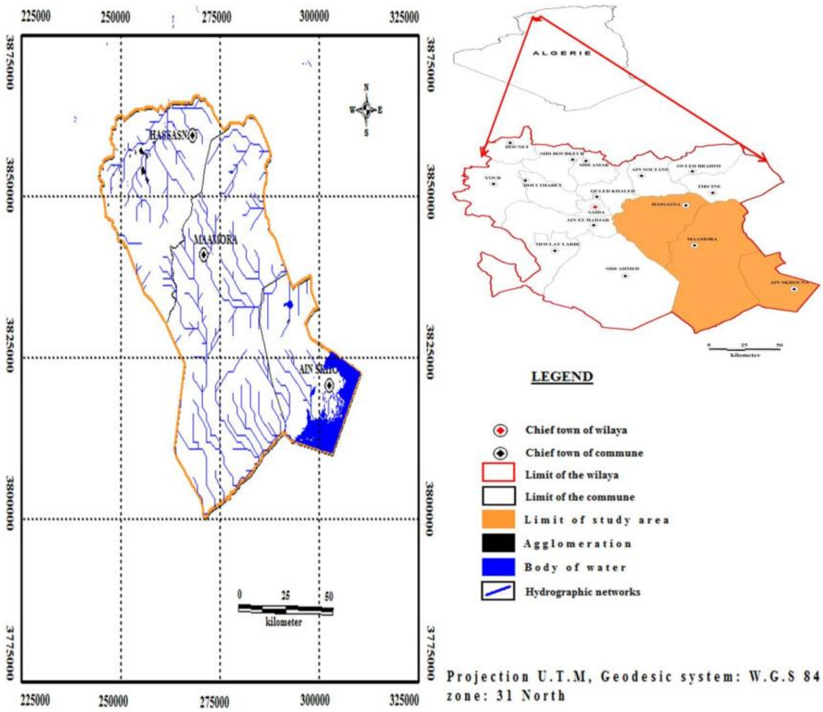

Figure 1: Location of the study area

Part A

In order to better characterize the phytodynamics of the vegetation in the study area. We have chosen two Landsat satellite images of the month of March from the years 1988 and 2020. These two images have the advantage of being spaced in time and taken from the same period (spring season) at an interval of 32 years. Several software programs were used to improve the approach adopted: ENVI 4.6, MAP info 8.0, Google Earth pro. Other types of necessary data were used jointly such as topographic maps.

Pretreatments were performed on both images in order to attenuate geometric, radiometric and atmospheric distortions. For the geometric correction, we chose 16 control and rectification points, then we used the quadratic deformation polynomial transformation technique. The choice of the number of points was based on the following formula:
$N = ((T + 1) (T + 2)) / 2$ where N is the minimum number of support points.

These reference support points appear both on satellite images and topographic maps and which are stable over time (water points, runway, etc.). The two images were georeferenced in the UTM coordinate system (WGS 84, zone 31 North). For image resampling, we used the nearest neighbor method which is used to assign each target pixel the value of the nearest source pixel. The RMS error (Root Mean Square) obtained is 0.224 for the 1987 image and 0.2856 for the 2020 image), according to Townshend et al. (1992) the mean residual error (RMS) must be less than 0.5 so that the geometric correction is acceptable for semi-arid areas with sparse vegetation.

The two satellite images have also been corrected for atmospheric effects which can cause signal modifications. We have chosen the most used method which is based on the principle of the selection of invariants (Bonn, 1996; Caloz et al., 2001), because we assume that there are sites that are unchanged over time because they retain their radiometric properties such as built-up areas, roads, track and water retention. An identical radiometric condition for the two images a simple linear computational model was applied. The goal is to calculate the coefficients A and B.

$$\text{Reflectance } 2020 = A^* \text{ Reflectance } 1988 + B$$

This technique will allow us to establish a linear relationship between the digital accounts of the two images (1988 and 2020) by a simple linear transformation of the raw digital accounts into calibrated digital accounts. The coefficients A and B are calculated from the mean and the standard deviation of the numerical counts of the invariant objects (Arabi, 2016).

Two colored compositions were produced by the superposition of the three channels (TM4, TM3 and TM1 for the 1988 image and TM5, TM4 and TM2 for the 2020 image), they allow a preliminary clarification on the land use in the study area. Vegetation indices are generally based on the ratio of reflectance measured in the near infrared to red, which increases the contrast between green vegetation and bare soil. The choice of the appropriate index is very delicate in order to clearly define the problem because in arid and semi-arid zones, soils occupy a larger surface than the vegetation cover and their contribution to the remotely detected signal is preponderant (Arabi, 2016). We chose the vegetation index adjusted to the soil SAVI, according to Huete (1988). This index provides the best model / observation correlation coefficient.

$$SAVI = [(1+L)\ (pIR-R)] / (pIR+R+L)$$

With L = 0.5 to reduce the effect of the soil.

According to Escadafal & Huet (1991) to correct the "noise" due to the soil, the corrected SAVI makes it possible to estimate the vegetation rate with an error four times lower than that of the NDVI. By analogy with the NDVI this index, RI (redness index), is defined by the equation:

$$RI = R-G / R+G$$

With: G is the green channel and R is the red channel

By subtracting this fraction attributed to soil noise, we obtain a corrected vegetation index, (VI * = VI - k. RI). The calculation of the correlation line gives k = 0.26 for the SAVI.

The phytoecological diagnosis is based on the method of Braun-Blanquet (1952). The period of fieldwork is the spring season of the year 2020. The minimum area is 100 m^2 for the entire study area, because Djebaili (1984) used a minimum area equal to 100m^2 for all the plant groups of the Algerian steppe. The determination of the taxa was made from the new flora of Algeria and the desert and southern regions of the work of Quezel & Santa (1962- 1963) and we also had recourse to the website of (http://algerianativeplants.net/). Each survey is used to establish an exhaustive list of all the species present as well as their Abundance-Dominance.

Part B

The field data collected previously was used to establish a complete list of all species present in the study area. We have derived another list on which only ornamental species are mentioned while based on the first list. This qualitative sampling technique is inspired by that used by Maaoui (2014) as part of the production of the Atlas of ornamental plants of Ziban. Then a classification of species was made by category of ornamental plants, namely: trees, shrubs, palms, climbers, herbs and succulents. The resulting data was fed into a georeferenced database which will subsequently be used for spatial analysis.

RESULTS AND DISCUSSION

The colored compositions (Figure 2a-2b) give a global overview on the zones of change but without providing quantitative and qualitative precisions on this change. Forests are defined by very dark colors from dark red to black red, crops by a bright red while bare soil appears in light blue to very light gray and sand in pale yellow.

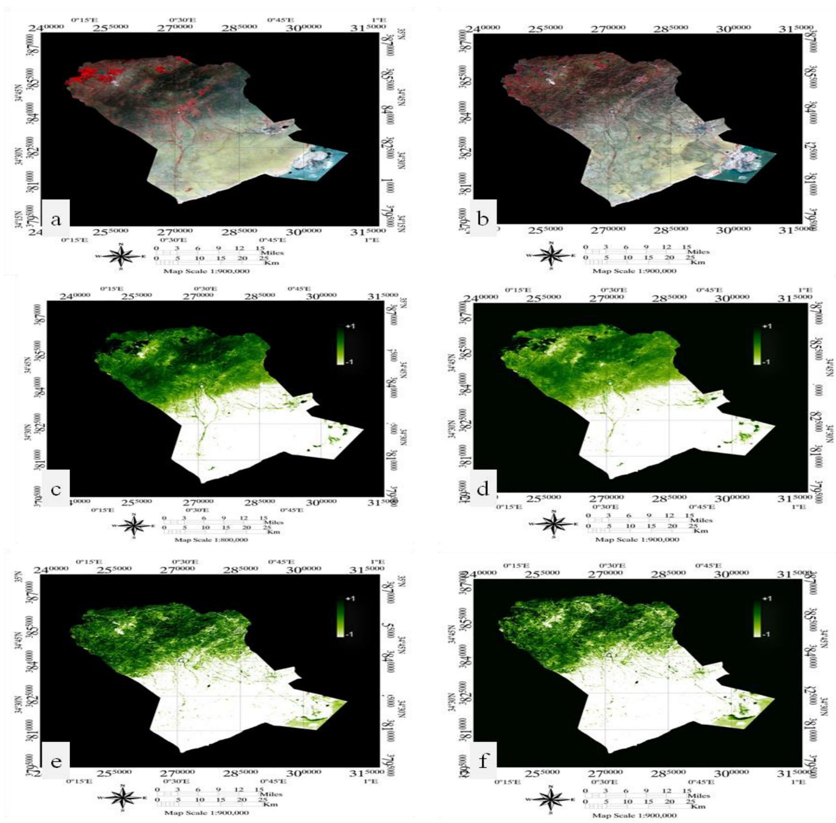

Figure 2: (a) LANDSAT image 1988 in colored composition (TM4, TM3 and TM1); (b) LANDSAT image 2020 in colored composition (TM5, TM4 and TM2); Uncorrected (c) and corrected (d) SAVI 1988 index; Uncorrected (e) and corrected (f) SAVI 2020 index

The two images do not present the same aspect because we can clearly visualize a big change in the north of the study area which is characterized by the reduction in the area of forest formations. This regression is only the result of strong human pressure exerted on the ecosystem (clearing, fires, illegal logging, overgrazing).

Figure 2c and Figure 2d represent the maps of the uncorrected SAVI vegetation index which presents certain distortions due to ground noise. In Figure 2e and Figure 2f are shown the two corrected SAVI images of the study area. Negative SAVI values are represented in shades of white and positive values in shades of green, so the darker the green, the larger the pixel value. A clear change in the plant cover is observed during this period, the SAVI values of which decrease from North to South for the two images, which testifies to the extent of the phenomenon of degradation of plant groups except for a few areas where a slight increase in the vegetation cover is observed because these areas have benefited from reforestation projects, pastoral plantations and protection.

This situation justifies the reduction in forest areas following several degradation factors which led to the appearance of bushes (Arabi, 2016). According to Kerrache et al. (2019), dense and rich forests have gradually disappeared, giving way to degraded formations and soil devoid of vegetation.

A **SAVI <0** corresponds to the water body as is the case for the Chott Ech Chergui area.

A **SAVI = 0** means areas devoid of “bare soil” vegetation.

A **SAVI> 0** means areas covered with vegetation.

Our analysis was based on the comparison of the SAVI * vegetation indices corrected by the application of a simple division (SAVI * 2020 / SAVI * 1988) to properly map the areas which have undergone changes during these 32 years of interval. The positive values (progression of radiometry) represented in green tones indicate a progressive evolution of the vegetation and the negative values (regression of radiometry) represented in red tones indicate a regression of the vegetation cover.

Figure 3 gives an overview of the vegetation changes that have occurred over these 32 years. Areas with a negative tendency represent 57.72% of the total surface (Table 1) are not necessarily areas with strong desertification but they are areas where a strong bushiness is observed.

The areas with a positive trend (42.27% of the total surface) are located in the south where the phenomenon of desertification is clearly marked, but this evolution of the vegetation is due to the major projects carried out by the state within the framework of the fight against desertification.

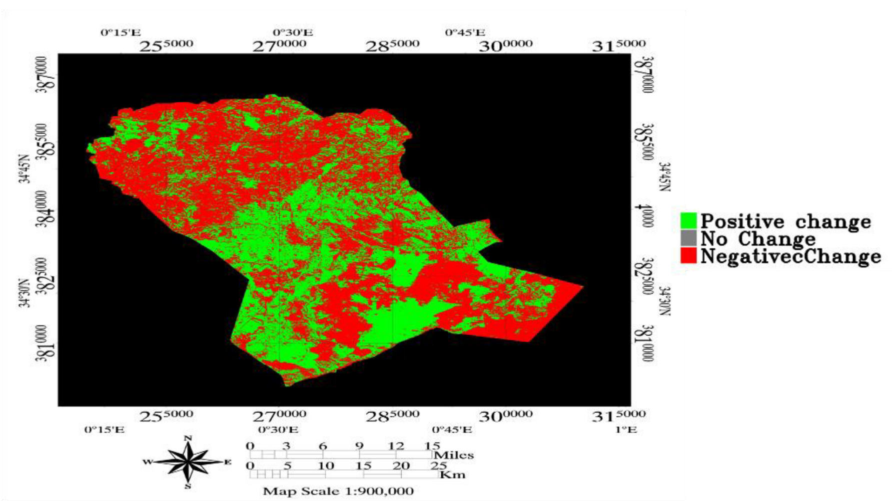

Figure 3: Map of vegetation change

Table 1: Estimation of changes

Change Class	Area (ha)	%
Positive change	93010,908	42,27
Negative change	127007,088	57,72
No change	22,004	0,01

The data obtained from the field surveys made it possible to establish a floristic list of 117 species. These results clearly illustrate the disturbance of the environment. This is marked by the dominance of invasive and even undesirable species which are generally indicators of desertification and of no pastoral utility, namely *Artemisia campestris*, *Plantago albicans* and *Peganum harmala*.

The analysis based on the comparison of old documents with recent documents made it possible to properly characterize the changes observed at the level of ecosystem boundaries. These transformations can be summarized in the following points:

• The ascending displacement of the extreme southern limit of the distribution area of the *Quercus ilex* and the *Pinus halepensis* (forest limit) towards the north marked by the decline of tree species.

• The ascending displacement of the upper limits of the steppes of *Stipa tenacissima* and *Artemisia herba-alba* towards the North to colonize the forest massifs, which justifies the phenomenon of steppization.

• The appearance in the south of new species characteristic of degradation and even indicators of desertification, accompanied by a large appearance of Psammophytes to the detriment of steppe species based on *Artemisia herba-alba* and *Stipa tenacissima*.

Table 2: List of ornamental species observed in the study area

Spieces	1988	2020	Soil	Use
Tree				
Acacia nilotica	-	+	All types	Reforestation, fodder, medicine
Acacia seyal Delile	-	+	Heavy, stony, humic.	Ornament, industry, medicine
Casuarina equisetifolia	-	+	Fertile, cool, drained	Umbrage, industry
Ceratonia siliqua	-	+	Medium, drained, stony	Umbrage, fodder
Cupressus sempervirens	-	+	Ordinary, drained,	Hedge, windbreak, ornament
Eucalyptus camaldulensis	+	+	Fertile, humid	Ornament, umbrage, medicine.
Pinus halepensis	+	+	Moderately fertile, drained	Industry, medicine
Fraxinus excelsior	-	+	All types	Industry, fodder
Pistacia atlantica	-	+	Drained, deep	Ornament, umbrage
Leucaena leucocephala	-	+	All types	Ornament, shadow
Schinus molle	-	+	Drained	Ornament
Tamarix gallica	+	+	Deep sandy	Dune fixation, windbreak, ornament
Zizyphus jujuba	+	+	Light	Orchard
Bushs, shrubs and sub-shrubs				
Acacia saligna	-	+	Deep sandy	Dune fixation, fodder
Juniperus oxycedrus	+	+	Drained calcareous or dry	Medicine
Juniperus phoenicea	+	+	Drained calcaire or dry	Medicine
Nerium oleander	+	+	Drained, rich	Hedge, medicine
Quercus coccifera	+	+	Rich, drained, deep	Medicine, leather tanning
Quercus ilex	+	+	All types	Industry, shadow
Retama raetam	-	-	Saline	Industry, medicine,
Rosmarinus officinalis	+	+	Calcareous, dry	Feeding, hedge.
Palm trees				
Chamaerops humilis	+	+	Drained light	Ornament
Washingtonia filifera	-	+	Humic, drained, neutral	Feeding
Climbers				
Asparagus plumosus	-	+	Ordinary drained	Ornament, medicine
Jasminum officinale	-	+	Rich, drained	Ornament, perfumery, medicine
Herbaceous				
Calendula officinalis	-	+	Drained	Medicine
Lygeum spartum	+	+	Drained, dry	Ornament, hedge
Peganum harmala	+	+	Sandy	Ornament, medicine
Stipa tenacissima	+	+	Drained	Fodder, industry, ornament
Juncus maritimus	+	+	Deep, rich, drained	Water plant
Typha angustifolia	+	+	Heavy, poor, immersed	
Succulent				
Agave americana	+	+	Drained, light	Cleaning, medicine
Opuntia ficus-indica	-	+	Light, drained	Feeding, fodder
Opuntia imbricata	-	+	All, drained	Feeding, fodder

Among the 117 species recorded in the study area, 34 ornamental species were identified (Table 2), which means that this number has doubled since 1988, which was of the order of 17 species. These ornamental plants found favored habitat on the soils of the study area. This shows that the newly installed ornamental species have adapted by flowering during the spring season. While some old trees continue to persist. According to Hubert (1990), the number of anthropogenic plants continues to increase in areas subject to the phenomenon of desertification.

Despite the current problem of desertification in the study area. It should be noted that the ornamental plants observed in this zone can contribute to local socio-economic development, as they are mainly pastoral and fodder plants such as *Atriplex canescens* and *Atriplex nummularia*, and *Opuntia ficus-indica*. In addition, these plants improve the quality of the soil, which helps to promote the fight against desertification.

CONCLUSION

The cartographic data used accompanied to field studies, clearly showed the degradation than knows this area. This has led to alarming desertification. This upheaval has generated a new situation characterized by an increase in ornamental floristic richness following the adaptation of these species to the semi-arid climate. The establishment of a local action plan to combat desertification requires above all the promotion of local species which are ecologically rational and economically profitable such as certain ornamental species such as *Opuntia ficus-indica*

REFERENCES

Arabi, Z. (2016). Integration of Multi-Source Data in A Geographic Information System For Phytoecological Diagnosis and The Proposal of A Fitting Out Model "Case Of The Interface of The Steppe Region-Tellian Region West Algerian". Doctoral thesis. U.S.T.H.B, Algiers. p. 200.

Arabi, Z., Mederbal, K., & Benaouf, Z. (2015). Contribution to the study of quantitative and qualitative aspects of steppe formations for the characterization of desertification in semi-arid environment: Saida, Algeria. Int. J. Environ. Res., 9(3): 953-960.

Bensaïd, A. (2006). GIS and remote sensing for the study of silting up in an arid zone: the case of the wilaya of Naâma (Algeria). Geography. Joseph-Fourier University - Grenoble I.

Bonn, F. (1996). Precise in remote sensing. Flight. 2: Thematic applications. Presses of the University of Quebec and AUPELF, Sainte-Foy and Montreal, p. 633.

Braun-Blanquet, J. (1952). Applied phytosociology. Comm. S.G.M.A. No. 116.

Caloz, R., Bonn, F. & Collet, C. (2001). Precise remote sensing. Volume 3. Digital processing of remote sensing images. AUPELF-UREF. The presses of the University of Quebec, ISBN 2- 7605-1145-6, p. 386.

Djebaili, S. (1984). Phytosociological and phytoecological research on the vegetation of the 46. high steppe plains and of the Algerian Saharan Atlas. OPU. Algiers, p. 177.

El Mazi, M., Houari, A. & El-Fengour, M. (2017). Contribution of remote sensing and GIS to the monitor the spatiotemporal dynamics of Jebel Outka Moutain forest (Central Rif, Morocco). Journal of Geography and Spatial Planning, 11: 171-187.

Escadafal, R. & Bacha, S. (1995). Strategy for the dynamic study of desertification. Proceedings of the ISSS International Symposium (Working Groups RS and MD), Ouagadougou, Burkina Faso, 6-10 February 1995, p. 19-34.

Escadafal, R. & Huete, A. (1991). Study of the spectral properties of arid soils applied to the improvement of vegetation indices obtained by remote sensing. C.R. Acad. Sci. Paris, T. 321, series II: 385-1391.

Hubert, G. (1990). Combating desertification: the benefits of defenses. Les Cahiers d'Outre-Mer . 43-172, p. 363-374

Huete, A. R. (1988). A soil- adjusted vegetation index (SAVI). Rem. Sens. of Envir. 25: 295-309.

Kerrache, G., Labani, A., Benabdeli, K., & Chafai, C. (2019). Dynamics of forest vegetation and impact of forest pre-development work in the Daïa-Saïda Mountains (western Algeria). Lebanese Science Journal, 20(2): 230

Maaoui, M. (2014). Atlas. Ornamental Plants of Ziban. CRSTRA Edition. ISBN: 978-9931-438-02-1, p. 341.

Quezel, P. & Santa, S. (1962-1963). New Flora From Algeria and The Southern Desert Regions. Paris. Tome I (1962), tome II (1963), Vol. 1170 pages.

Townshend, J. R. G., Justice, C. O., Guerney, C., & Mcmanus, J. (1992). The impact of misregistration on change detection. IEEE Transactions on Geosciences and Remote Sensing, 30(5): 1054-1060.

Zakari, S., Toko, I., Thomas, O. A. B., Djaouga, M., & Arouna, O. (2018). Application of remote sensing and GIS to the monitoring of plant formations in the classified forest of the three rivers in north-eastern Benin. European Scientific Journal, 14: 450-469.

CHAPTER 6

FLOWER GARDENS OF THE NATIONAL SEASIDE ABSHERON PARK IN BAKU

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INTRODUCTION

In addition to economic development, the Republic of Azerbaijan is carrying out extensive landscaping work in the direction of protecting the gene pool, increasing biodiversity, and maintaining ecological balance. The study of biological features, decorative traits, resistance to environmental factors by scientific methods, and the use in landscape architecture of new types of decorative herbaceous plants brought from many countries in the soil and climatic conditions of Absheron is one of the urgent tasks. New parks are being created on the central avenues of Baku, and decorative herbaceous plants are widely used in landscape compositions along with tree-shrub plants.

Love of flowers is the pursuit of beauty. Flowers with the completeness of their forms, color and aroma bring us joy, cheer up, and give a charge of vivacity and energy. The need for flowers, for beauty, is just as natural for a man as for his daily bread. Communication with nature, the cultivation of various useful and ornamental plants give the person satisfaction and joy (Dubenyuk, 2008).

At present, Absheron National Seaside Park occupies a special place in the landscape architecture of Baku, for outdoor activities, walks of the population. In the past 50 years, the boulevard has expanded significantly and has been reconstructed. In the park, various forms of compositions have been created from local and introduced from foreign countries decorative trees, shrubs and herbaceous plants. Among them, flower beds occupy a special place. Flower beds are located in compositions throughout the strip of the boulevard and, along with a beautiful view, create a cheerful, festive atmosphere for the active recreation of the population.

Flowers are a decoration of the garden and must be placed so that they are clearly visible. Successfully arranged 3-4 species of plants are more expressive than the variegation of a large number of species unsystematically planted in the beds. Therefore, plants must be carefully selected according to height, flowering time, color and reasonably position them (Gulmamedova, 2011).

For the comprehensive development of landscape architecture of the National Seaside Park, the creation of new, beautiful compositions, it is necessary to study the taxonomic composition of decorative trees, shrubs and herbaceous plants, their bioecological features, the rules for grouping plants in compositions, the trimming of trees and shrubs, the use of small architectural forms. For this purpose, research work is being carried out at the Institute of Dendrology of the National Academy of Sciences of Azerbaijan, in the laboratory "Landscape Architecture".

The article describes the research work on the taxonomic structure of decorative herbaceous plants of the National Primorsky Absheron Park, their bioecological features, the rules for grouping plants in compositions, the form of creating compositions in a regular and landscape or landscape style.

As a result of the research work, it was revealed that decorative herbaceous plants introduced from local and foreign flora are well adapted to Absheron conditions, are promising and can be widely used in landscaping, when creating compositions.

MATERIAL AND METHOD

The objects of study are various types and varieties of ornamental herbaceous plants: *Viola x. wittrockiana* L., *Petunia x. hybrida* L., *Tulipa 'Editil NL', Astra alpinus* L., Gazania *'Kiss Rosa', Dimorphotheca pluvialis* Moench., *Dahlia variabilis* Cav., *Calendula officinalis* L., *Zinnia elegans* L. and etc.

When conducting research work, various techniques were used. The morphological features of the vegetative organs were studied according to the methods of I. T. Vasilchenko and I. G. Serebryakova, the morphology of the root system according to the method of V. A. Kolesnikov. The resistance of plants to heat was studied by the method of K. A. Akhmatov, and by drought by the method of P. A. Genkel.

RESULTS AND DISCUSSION

According to the agreement between the Institute of Dendrology of ANAS and the Department of Gardening in Baku, in open areas and in greenhouses of the Institute of Dendrology, research work was carried out in the direction of studying the bio ecological features on a scientific basis and using decorative grassy plants introduced from local and foreign flora in decorative gardening from 12 species, 11 varieties belonging to 5 families and 8 genera (*Tulipa* L., *Gladiolus* L., *Hyacinthus* L., *Crocus* L., *Chrysanthemum* L., *Dahlia* Cav., *Tropaeolum* L., *Impatiens* L.). The studied decorative herbaceous plants have been introduced into landscaping for use in the National Seaside Park, parks, gardens, Absheron squares.

In Seaside Park, perennial flower plants remain in the compositions every year, and spring annual flower plants are replaced by autumn flower plants. On the boulevard, flowers look beautiful in round vases, square, rectangular, round compositions around some evergreen shrub or tree. For thousands of years, flowers have triumphantly marched around the world, brightening and ennobling, softening and decorating, captivating and delighting. Even in ancient times, man appreciated the divine beauty of a flower, making it an indispensable attribute of ordinary and spiritual life. The best representatives of this multicolor and diverse universe are captured by the efforts of famous artists.

In 1927, under the guidance of a well-known specialist in urban planning, prof. A.R. Ivanitsky prepared a new master plan for the development of the city of Baku. In the general plan, special attention was paid to the formation of the boulevard on the Caspian coast. According to the plan of 1927, according to the project of A.R. Ivanitsky, the Seaside Territory was built on 400 m. The Seaside Boulevard was created and planted from gardens and grounds (Hasanova, 2006).

Landscaping improves the microclimate and creates a comfortable climate. In connection with the process of evaporation and transpiration from the surface of the leaves of trees, the air temperature in the environment decreases and the radiation of the sun decreases. In such cases, the role of *Quercus, Acer, Castanea, Tilia, Juglans* and other broadleaf trees is great. Their conifers *Pinus, Picea, Cupressus,* and others releasing a large amount of volatile substances into the environment destroy pathogenic microbes harmful to the body and enrich the air with resinous substances (Karpisonova, 2005).

Most often, flowers are placed according to the principle of natural planning, the most common types of which are single plantings, groups, arrays. Along with this, linear or ordinary plantings, flower beds, discounts, borders, mixed borders (mixborders) are used. Each of these types of floral design has its own purposes and features when creating floral arrangements and selecting annual, perennial flowers (Mammadov, 2006).

In Seaside Park, in the compositions, floral herbaceous plants are grouped by height, shape, color, are combined with each other and with the surrounding trees, shrubs. For example, low plants should not be obscured by tall ones. Hanging flower plants in pots on high supports look beautiful. Flower plants go well with small architectural forms-sculptures, fountains, benches, pergolas, arbors, lanterns.

One of the main requirements for a plant selected for a flower garden is its decorativeness. It is determined by the whole appearance of the plant, and not just the flower. Plants of the original form are highly valued: cushion-shaped, creeping, ampelous, pyramidal (Safarov, 1977).

One of the basic principles of planning a flower garden is to choose its shape, which should be in harmony with the shapes of surrounding trees, shrubs, buildings and fences, complementing and composing a single whole with them. Most often, the correct geometric shapes are selected: rectangle, circle, rhombus, triangle, etc. However, many flower growers prefer original arbitrary forms, which can advantageously emphasize the beauty of the selected flowers, their combination, as well as terrain features (Tavlinova, 1970).

During the research work on the territory of the National Seaside Park, observations were made, the taxonomic composition of ornamental herbaceous plants (about 40 species) introduced from foreign countries and local flora into the conditions of Absheron was revealed, their bioecological features, the rules for grouping plants in compositions, and phenological phases were studied plant development (Table 1).

Plants from the local flora and introduced into the conditions of Absheron, mainly from Italy, Spain, Turkey, Iran, Belgium and the Netherlands, were planted on the boulevard. In these countries, there are areas similar to our climate, so plants brought in from these countries adapt well in the conditions of Absheron. In spring, the boulevard's flower gardens are decorated mainly with various species and varieties of bulbous plants: *Tulipa* L., *Lilium* L., *Hyacinthus* L., *Begonia* L., *Gladiolus* L., *Narcissus* L. and etc. They have a variegated color and beautiful forms create a unique flavor in the compositions (Figure 1).

When creating beautiful landscape compositions on the site, much attention is paid to conifers. Along with large areas and in small areas, many varieties of undersized conifers look beautiful. The presence of conifers on the site gives it a unique flavor, special beauty and decorative appearance. Along with this, the needles of these plants secrete phytoncides - special substances that cleanse the air of microbes (Vitviskaya, 2005).

Table 1: Phenological phases were studied plant (day/month)

№	Plant names	Seedling	Starting leaf	Bloom		Starting yellow of leaf	Fade surface part
				start	**last**		
1	*Viola x wittrockiana* L.	20.04	30.04	14.05	19.08	15.09	10.10
2	*Dianthus 'Svit Ceri'*	22.04	03.05	10.06	15.09	30.09	10.10
3	*Petunia x hybrida* L.	23.04	05.05	15.06	20.09	01.10	20.10
4	*Tulipa ' Editil NL '*	06.03	16.03	12/04	30.04	16.05	12.06
5	*Helianthus annuus* L.	26.04	08.05	11.07	12.09	20.09	30.09
6	*Gaillardia hybrida* Foug.	18.04	28.04	11.05	16.08	20.09	10.10
7	*Astra alpinus* L.	25.04	04.05	10.06	20.09	08.10	20.10
8	Gazania *'Kiss Rosa'*	21.04	02.05	13.06	18.09	25.09	03.10
9	*Dahlia variabilis* Cav.	20.04	30.04	10.06	15.09	25.09	15.10
10	*Hyacinthus 'Wood stask'*	04.03	15.03	24.03	15.04	16.05	29.05
11	*Narcissus 'Gemendil'*	02.02	15.02	03.03	15.04	15.05	29.05
12	*Dimorphotheca pluvialis* L.	25.04	07.05	10.06	05.08	15.08	25.08
13	*Calendula officinalis* L.	19.04	30.04	17.05	30.09	20.10	05.11
14	*Zinnia elegans* L.	23.04	02.05	10.06	15.10	20.10	30.10
15	*Cosmos sulphureus* Cav.	26.04	07.05	12.06	17.08	25.09	05.10
16	*Alyssum argenteum* L.	20.04	30.04	08.06	14.09	27.10	08.11
17	*Matthiola incana* R.Br.	16.04	26.04	05.05	10.08	10.09	30.09
18	*Antirrhinum majus* L.	20.04	29.04	28.05	03.09	15.09	25.09



Figure 1: Compositions of *Tulipa* L., *Hyacinthus* L. and *Begonia* L.

In the research work, the forms of creating compositions in the regular style-geometric shapes (oval, rectangular, square, round, rhombic) and in the landscape or landscape style-original forms (ornament, flower garden, labyrinth) were studied (Figures 2-7). Evergreen trees and shrubs are mainly planted in the center of the compositions, and grassy plants are planted along the edges.

Geometric shapes of compositions in a regular style:



Figure 2: Square form **Figure 3:** Rectangular form **Figure 4:** Oval form

The rich variety of colors makes it possible to use them in all types of green devices. Flowers can be planted in parks, gardens, front gardens, on boulevards and in forest parks. In each case, the appropriate forms and types of planting are used: from the simplest to the most complex compositions with lawns, shrubs, trees and a huge number of flowers that create a certain artistic landscape.

Original forms of compositions in landscape or landscape style:

Figure 5: Flowery bend

Figure 6: Flowering form

Figure 7: Flower of statue

CONCLUSION

As a result of research work in the Absheron National Seaside Park, the taxonomic composition of ornamental herbaceous plants (about 40 species) was studied, their bioecological features, the rules for grouping plants in compositions, the phenological phases of plant development were studied, and it was revealed that the ornamental flora introduced from local and foreign flora herbaceous plants adapt well under Absheron conditions, are promising and can be widely used in landscaping to create compositions.

To turn the National Seaside Park into the pearl of the landscape architecture of Baku, new, various forms of compositions must be created, perspective, decorative trees, shrubs and herbaceous plants introduced from local and foreign flora must be used.

Absheron National Seaside Park along with a beautiful and convenient park for active recreation of the population is our past, present and future. May every citizen contribute to the prosperity of his homeland?

REFERENCES

Dubenyuk, N. (2008). Flowers of The World. Exio, Moscow, p. 5.

Gulmamedova, Sh. A. (2011). The study of bioecological features of some decorative grassy plants and use in landscape architecture. Abstract. Diss. Cand. Biol. Sciences. 03.00.05 Institute of Dendrology of ANAS. Baku, p. 21.

Hasanova, A. A. (2006). Landscape Architecture of Azerbaijan. Baku: ed: "Abilov, Zeynalov and His Sons", p. 116-118.

Karpisonova R. A. (2005). Flower Bed in the Shade. Fount Books, Moscow, p. 5.

Mammadov, T. S. (2006) Gulculuk Ensiklopediyasi. Baki: Azerbaycan, p.76

Safarov, I. S, Asadov K. S, & Jalilov, G. H. (1977). Green and Health. Baku: "Youth" edition, p. 15.

Tavlinova, G. K. (1970). Floriculture. Lenizdat, p. 272.

Vitviskaya, M. Y. (2005). The Modern Design of The Site. Lada, Moscow, p. 206.

CHAPTER 7

NATURAL SPREAD ORNAMENTAL PLANTS USED BY FOLK IN TURKEY'S SOUTH-EASTERN ANATOLIA REGION

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INTRODUCTION

Turkey is located at the junction of Asia and Europe. At the same time, it has different vegetation types and a very rich flora due to its location in an important region where the Mediterranean, Europe-Siberia and Iran-Turan phytogeographical regions intersect. In addition to this special geographic location, the change of topography in short distances, different geological and geomorphological structure, containing various soil and bedrock types, and being under the influence of different climate types have enabled a wide variety of plant species to grow in these soils. That make Turkey has rich plant diversity and have a large number of unique plant species. This situation has provided the turkey into the northern hemisphere between important plant areas (Özhatay et al., 2003; Fidan, 2015). With the most recent and comprehensive study in Turkey, such as "Turkey's Plants List, Vascular Plants" with the publication of the book in Turkey, the number of taxa identified as 11707, while endemism rate was found to be as 31.82% (Güner et al., 2012). "Turkey Plant List" book study in preparation bryophyte, algae and fungi in this study these were excluded from the list. According to this book it was reported that 9753 native species were identified in Turkey. It is known that 3.035 of these species are known endemic. When subgenus taxa are added, it has been determined that the total number is 11,707 and 3,649 of these are diagnosed as endemic. Turkey is located at the intersection of the Mediterranean and Near Vavilovian gene centres. This situation leads to high plant and gene diversity (Avcı, 2005; Ekim, 2005; Özhatay et. al., 2009). Five separate "micro-gene centres in Turkey" are available.

There is found 256 varieties of cereals that have been developed and recorded in the last thirty years using local and imported strains; 95 of them are identified as wheat, 91 are corn, 22 are barley, 19 are rice, 16 are sorghum, 11 are oat and 2 are rye (Dikmen et al., 2011).

Two separate genes and diversity center where there is located in Turkey, some crops can be listed as follows as gene and origin of the center: *Triticum, Hordeum, Secale, Avena, Linum, Allium, Cicor, Lens, Pisum, Medicago* and *Vicia*. In Turkey, wheat (*Triticum* and *Aegilops*) 25, barley (*Hordeum*) 8, rye (Secale) 5 and oats (*Avena*) has 8 wild relatives. Turkey is rich in terms of wild relatives of food legumes and forage crops. There are 104 endemic species of lentil (*Lens*), 10 of chickpea (*Cicer*), 11 of Trifolium (*Trifolium*), 34 of clover (*Medicago*), 42 of sainfoin (*Onobrychis*) and 6 of vetch (*Vicia*) endemic in our country (Açıkgözet al., 1998).

Turkey is also known as a micro gene center of *Amygdalus* spp., *Cucumis melo, C. sativus, Cucurbita moshat, C. pepo, Malus* spp., *Pistachio* spp., *Prunus* spp., *Pyrus* spp. And *Vitis vinifera* species (Tan, 1998). In addition, Turkey is home of many ornamental plants, including specially tulips and snowdrops (Çağatay et al., 2012).

1. USE OF PLANTS FOR DIFFERENT PURPOSES

Plants have been used by people for various purposes for thousands of years. Among the oldest known specimens, those found in the grave besides the Neanderthal human remains in the excavations carried out between 1957 and 1961 in the Şanidar cave located in the Zagros

Mountains are considered to be the first data of the beginning of the plant-human relationship. It was found that plant species such as yarrow, canary grass, purple hyacinth, rose marshmallow, cornflower and ephedra were found in this grave, which has survived to the present day from 60 thousand years ago and is thought to belong to a shaman. It is thought that in a society that has begun to bury its dead, these plants, which are thought to be put into the grave with the thought that the deceased will be used when they come back to life, may be an indication that they started to be divided into edible and medicinal ones. Because these plant species continue to maintain their importance today, especially as medicinal and aromatic plants (Lewin, 2000; Heinrich et al., 2004; Faydaoğlu & Sürücüoğlu, 2011; Fidan & Karaismailoğlu, 2020).

People have been in constant contact with plants since ancient times. Ethnobotany science has emerged to reveal the relationship between folk and plants in all its details. Ethnobotanical studies examine plants by grouping them differently. Examines plants under different headings such as medical, food, animal feed, handicrafts, and ornamental plants.

In this chapter of the book, it was benefited from ethnobotanical study ever made in Turkey's South-eastern Anatolia Region and it was utilized from previous researchers ‘observations about ornamental plants that used by the local people were introduced (Gençay, 2007; Akgül, 2008; Güldaş, 2009; Bakır Sade, 2014; Dağlı, 2015; Furkan, 2016; Oymak, 2018; Aslan, 2019; Çiçek, 2019; Kılıç, 2019; Eksik, 2020).

Table 1: Natural spread of ornamental plants used by folk in Turkey's South-Eastern Anatolia Region

Plant family	**Plant taxon**	**Threat category**
Amaranthaceae	*Amaranthus hybridus* L.	-
Amaranthaceae	*Amaranthus viridis* L.	-
Amaryllidaceae	*Narcissus tazetta* L.	-
Amaryllidaceae	*Sternbergia clusiana* (Ker Gawl.) Ker Gawl. Ex Spreng.	-
Amaryllidaceae	*Sternbergia vernalis* (Mill.) Gorer & J. H. Harvey	-
Apiaceae	*Lagoecia cuminoides* L.	-
Apiaceae	*Malabaila secacul* (Mill.) Boiss. subsp. *secacul*	-
Apocynaceae	*Nerium oleander* L.	-
Apocynaceae	*Vinca herbacea* Waldst. & Kit.	-
Araliaceae	*Hedera helix* L.	-
Asparagaceae	*Muscari comosum* (L.) Mill.	-
Asparagaceae	*Muscari neglectum* Guss. ex Ten.	-
Asteraceae	*Glebionis coronaria* (L.) Spach	-
Asteraceae	*Anthemis haussknechtii* Boiss. & Reut.	-
Asteraceae	*Anthemis hyalina* D. C.	-
Asteraceae	*Anthemispauciloba*Boiss.var. *pauciloba*Boiss.	Least Concern (LC)
Asteraceae	*Artemisia annua* L.	-
Asteraceae	*Echinops spinosissimus* Turra subsp. *bithynicus* (Boiss.) Greuter	-
Asteraceae	*Helichrysum arenarium* (L.) Moench	-
Asteraceae	*Helichrysum pallasii* (Spreng.) Ledeb.	-
Asteraceae	*Inula crithmoides* L.	-
Asteraceae	*Matricaria aurea* Sch. Bip.	-
Asteraceae	*Matricaria chamomilla* L.	-
Asteraceae	*Tripleurospermum parviflorum* (Willd.) Pobed.	-
Brassicaceae	*Alyssum praecox* Boiss. & Balansa	Least Concern (LC)

Caprifoliaceae	*Lonicera caprifolium* L.	-
Caryophyllaceae	*Vaccaria hispanica* (Mill.) Rauschert	-
Convolvulaceae	*Convolvulus stachydifolius* Choisy	-
Convolvulaceae	*Convolvulus arvensis* L.	-
Convolvulaceae	*Ipomoea purpurea* (L.) Roth	-
Cupressaceae	*Cupressus sempervirens* L.	-
Elaeagnaceae	*Elaeagnus angustifolia* L.	-
Ericaceae	*Calluna vulgaris* (L.) Hull	-
Fabaceae	*Gleditsia triacanthos* L.	-
Iridaceae	*Gladiolus atroviolaceus* Boiss.	-
Iridaceae	*Gladiolus italicus* Mill.	-
Iridaceae	*Gladiolus kotschyanus* Boiss.	-
Iridaceae	*Iris aucheri* (Baker) Sealy	Vulnerable (VU)
Iridaceae	*Iris masia* Dykes	Vulnerable (VU)
Iridaceae	*Iris persica* L.	-
Iridaceae	*Iris x germanica* L.	-
Lamiaceae	*Rosmarinus officinalis* L.	-
Lamiaceae	*Ocimum basilicum* L.	-
Lamiaceae	*Thymbra spicata* L. subsp. *spicata*	-
Liliaceae	*Fritillaria crassifolia* Boiss. & A. Huet subsp. *kurdica* (Boiss. & Noë) Rix	-
Liliaceae	*Fritillaria imperialis* L.	-
Liliaceae	*Fritillaria persica* L.	-
Liliaceae	*Tulipa agenensis* D. C.	-
Liliaceae	*Tulipa armena* Boiss.	-
Malvaceae	*Alcea apterocarpa* (Fenzl) Boiss.	Least Concern (LC)
Malvaceae	*Alcea calvertii* (Boiss.) Boiss.	Least Concern (LC)
Malvaceae	*Alcea hohenackeri* (Boiss. & Huet) Boiss.	-
Nitrariaceae	*Peganum harmala* L.	-

Oleaceae	*Fraxinus angustifolia* Vahl	-
Orchidaceae	*Anacamptis pyramidalis* (L.) Rich.	-
Orchidaceae	*Epipactis veratrifolia* Boiss. & Hohen.	-
Papaveraceae	*Glaucium corniculatum* (L.) Rudolph	-
Papaveraceae	*Papaver rhoeas* L.	-
Pinaceae	*Pinus nigra* subsp. *pallasiana* (Lamb.) Holmboe	-
Poaceae	*Arundo donax* L.	-
Poaceae	*Phragmites australis* (Cav.) Trin. ex Steud.	-
Ranunculaceae	*Anemone coronaria* L.	-
Ranunculaceae	*Ranunculus asiaticus* L.	-
Rosaceae	*Pyracantha coccinea* M. Roem.	-
Rosaceae	*Rosa canina* L.	-
Rosaceae	*Rosa foetida* J. Herrm.	-
Salicaceae	*Salix alba* L.	-
Solanaecae	*Datura innoxia* Mill.	-
Solanaecae	*Datura stramonium* L.	-
Tamaricaceae	*Tamarix smyrnensis* Bunge	-
Verbenaceae	*Lantana camara* L.	-
Verbenaceae	*Verbena officinalis* L.	-

Some original photos taken by Dr. Mehmet FİDAN, Ph. D (Specialist of plants) from the natural habitats of ornamental plants.

Narcissus tazetta

Sternbergiavernalis

Malabaila secacul

Lagoecia cuminoides

Nerium oleander

Vinca herbacea

Muscari comosum

Muscari neglectum

Tripleurospermum parviflorum

Anthemis hyalina

Convolvulus arvensis

Ipomoea purpurea

Salix alba

Tamarix smyrnensis

Gladiolus atroviolaceus

Gladiolus italicus

Gladiolus kotschyanus

Iris aucheri

Iris persica

Iris x germanica

Fritillaria imperialis

Fritillaria crassifolia subsp. *kurdica*

Alcea apterocarpa

Alcea hohenackeri

Epipactis veratrifolia

Anacamptis pyramidalis

Anemone coronaria

Ranunculus asiaticus

Rosa foetida

Rosa canina

REFERENCES

Açıkgöz, N., Sabancı, C. O., & Cinsoy, A. S. (1998). Ecogeography and distribution of wild legumes in Turkey. In: International Symposium on In situ Conservation of Plant Genetic Diversity. N. Zencirci, Z. Kaya, Y. Anikster and W. T. Adams (eds.). Central Research Institute for Field Crops. 113-122.

Akgül, A. (2008). Midyat (Mardin) CivarındaEtnobotanik. YüksekLisansTezi, EgeÜniversitesi, Fen BilimleriEnstitüsü, İzmir.

Aslan, S. (2019). Yaslıca Beldesi ve Arıkök Köyü (Şanlıurfa)'nün Etnobotanik Açıdan Araştırılması. Yüksek LisansTezi, Harran Üniversitesi, Fen Bilimleri Enstitüsü, Şanlıurfa.

Avcı, M. (2005). Çeşitlilik ve edemizim açısından Türkiye'nin bitki örtüsü. Coğrafya Dergisi, 13: 27-55.

Bakır Sade, Y. (2014). Kahta (Adıyaman) Merkezi ve Narince Köyü'nün Etnobotanik Açıdan Araştırılması. Yüksek Lisans Tezi, Harran Üniversitesi, Fen Bilimleri Enstitüsü, Şanlıurfa.

Çağatay, A., Terzioğlu, E., & Erdoğan E. (2013). Biyolojik çeşitliliği izleme ve Değerlendirme Raporu 2012. 1. Baskı, Ankara.

Çiçek, İ. (2019). Çermik İlçesi ve Köylerinin (Diyarbakır) Etnobotanik Özellikleri. Yüksek Lisans Tezi, Bingöl Üniversitesi, Fen Bilimleri Enstitüsü, Bingöl.

Dağlı, M. (2015). Şanlıurfa Merkez ve Bağlı Köylerde Etnobotanik Bir Araştırma. Yüksek Lisans Tezi, Harran Üniversitesi, Fen Bilimleri Enstitüsü, Şanlıurfa.

Dikmen, Ç., Saraçoğlu, E., Durucan, Z., Durak, S., & Sarioğlu, K. (2011). Türkiye Çevre Durum Raporu. T.C. Çevre ve Şehircilik Bakanlığı, Ankara. s. 143.

Ekim, T. (2005). Bitkiler, Tohumlu Bitkiler, Türkiye'nin Biyolojik Zenginlikleri, Türkiye Çevre Vakfı Yayını, Ankara, 167-195.

Eksik, C. (2020). Mardin İli Artuklu, Ömerli ve Yeşilli İlçelerinin Bazı Köylerinde Etnobotanik Çalışma. Harran Üniversitesi, Fen BilimleriEnstitüsü, Şanlıurfa.

Faydaoğlu, E. & Sürücüoğlu, M. S. (2011). Geçmişten günümüze tıbbi ve aromatic bitkilerin kullanılması ve ekonomik önemi. Kastamonu Üniversitesi Orman Fakültesi Dergisi, 11: 52-67.

Fidan, M. (2015). Sine Yaylası (Balveren-Şırnak) Florası. Doktora Tezi, Van Yüzüncü Yıl Üniversites, Fen Bilimleri Enstitüsü, Van.

Fidan, M. & Karaismailoğlu M. C. (2020). Kenevirin Tarihçesi ve Sistematiği. Kenevir, Palme Yayın Evi. Bölüm 1, s. 1-14.

Furkan, M. K. (2016). Adıyaman İlinde Yetişen Bazı Bitkilerin Etnobotanik Özellikleri. Yüksek Lisans Tezi, Adıyaman Üniversitesi, Fen Bilimleri Enstitüsü, Adıyaman.

Gençay, A. (2007). Cizre (Şırnak)'nin Etnobotanik Özellikleri. Yüksek Lisans Tezi, Van Yüzüncü Yıl Üniversitesi, Fen Bilimleri Enstitüsü, Van.

Güldaş N. (2009). Adıyaman İlinde Etnobotanik Değeri Olan Bazı Bitkilerin Kullanım Alanlarının Tespiti. Yüksek Lisans Tezi, Fırat Üniversitesi, Fen Bilimleri Enstitüsü, Elazığ.

Güner, A., Aslan, S., Ekim, T., Vural, M., & Babaç, M. T. (2012). Türkiye Bitkileri Listesi (Damarlı Bitkiler). Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını, İstanbul.

Heinrich, M., Barnes, J., Gıibbons, S., & Williamson, E. M. (2004). Fundementals of Pharmacognosy and Phytotherapy, Edinburgh, Churchill Livingstone.

Kılıç, M. (2019). Artuklu (Mardin) Yöresinde Yetişen Bitkiler Üzerine Etnobotanik BirAraştırma. Doktora Tezi, Manisa Celal Bayar Üniversitesi, Fen Bilimleri Enstitüsü, Manisa.

Lewin, R. (2000). Modern İnsanın Kökeni, TÜBİTAK Popüler Bilim Kitapları, Ankara, TÜBİTAK.

Oymak, E. (2018). Bozova (Şanlıurfa) Halkının Kullandığı Doğal Bitkilerin Etnobotanik Özellikleri. Yüksek Lisans Tezi, Harran Üniversitesi, Fen Bilimleri Enstitüsü, Şanlıurfa.

Özhatay, N., Byfield, A., & Atay, S. (2003). Türkiye'nin Önemli Bitki Alanları. İstanbul, WWF Türkiye (Doğal Hayatı Koruma Vakfı).

Özhatay, N., Kültür, S., & Aslan, S. (2009). Check-list of additional taxa to the supplement flora of Turkey. Turk J Bot. 33: 191-226.

Tan, A. (1998). Current Status of Plant Genetic Resources Conservation in Turkey. In: International Symposium on In situ Conservation of Plant genetic Diversity. Zencirci, N., Kaya, Z., Anikster, Adams, Y. & W. T. (eds.). Central Research Institute for Field Crops, p. 5-16.

CHAPTER 8

THE ORCHIDS OF EVKA 3 – İZMİR

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INTRODUCTION

The family of Orchidaceae contains one of the most diverse range of flowering plants of Earth. The orchids' ability to cross pollinate causes new varieties to occur in nature over relatively short periods of time. There are 28,000 accepted species of orchids, distributed in 763 genera (Christenhusz & Byng, 2016). By comparison European orchids are approximately 250 species (Buttler, 1991). Due to highly attractive flowers of especially tropical epiphytic orchids, horticulturists have developed an estimated number of 120 thousand hybrids since the 19th century (URL-1).

The European / Anatolian terrestrial orchids are perennial plants that could be either rhizomatous or form tubers. The leaves are simple with mainly parallel veins often demonstrating a smooth surface. The orchid flowers have two sets of sterile elements which consist of three sepals and three petals. One of the petals, the middle one, which is called the lip (labellum), is a highly modified landing platform for pollinating insects (Griffiths, 2002).

In this essay, a small part of Izmir, Evka 3 district (2017 population 20,520 (URL-2)) was examined in terms of its orchid biodiversity. The district is located at the northeast border of the city (Figure 1) where mainly residential plots meet with Mediterranean maquis, olive plantations and pine forests (Figure 2). The observations were carried out over a ten-year period starting in 2010. During this time 10 species of orchids, *Cephalanthera epipactoides, Ophrys fusca, Ophrys lutea,* *Ophrys scolopax, Ophrys speculum, Orchis anatolica, Orchis italica, Orchis papilionacea, Orchis sancta* and *Serapias orientalis* were observed and photographed.

It could be claimed that this relatively small piece of land is significant in terms of the number of orchid species it contains. Also, it must be indicated that the related habitats have been under constant threat since the 1990's due to the area being under pressure from emigration related, rapid expansion in the city. Construction work and the increase in population has led to widespread destruction in the maquis vegetation and to a lesser extent in the pine forests and olive plantations which for now remain relatively protected. Although every habitat is valuable within itself, the maquis or garrigue (phrygana) together with open wild meadows are the spaces which offer the most suitable habitat for most of the orchid species observed. And yet, it is this habitat which is being exposed to anthropogenic pressure, with large scale construction work and small but accumulated scale illegal orchid tuber collection from nature.

Figure 1: The habitat of the orchids on Evka-3 city border (Original by Wallace)

Figure 2: The habitat of the orchids in Evka-3 (Original by Wallace)

1. THE OBSERVED ORCHID SPECIES

All 10 species examined here produce over ground structures with the first rains in October, and a vegetation period which lasts until May in the following year. All of them are tuberous, except *Cephalanthera epipactoides* which is a rhizomatous orchid species. Basal leaves are glossy, elliptic and in rosette formation. Blooming often occurs between February and May shifting in accordance with the temperature and rainfall. All of the examples recorded in the area are distributed widely throughout the Mediterranean, and therefore non-endemic to Turkey.

1.1. *Cephalanthera epipactoides*

The plant is rhizomatous with a tall stem of about 50 cm, which bears 15 to 20 white flowers with similar sepals and tepals facing downwards. The base leaves are often absent but appear throughout the stem, often bearing individual flowers (Figure 3).

C. epipactoides was observed where the maquis meets with *Pinus brutia* dominated pine forests. The species appears to require shaded or semi shaded locations covered by fallen pine needles, and therefore has a rich, slightly moist, and acidic soil (Figure 4).

Figure 3: Fully bloomed *C. epipactoides* (Original by Wallace)

Figure 4: A young *C. epipactoides* in its habitat (Original by Wallace)

1.2. *Ophrys fusca*

This, one of the rarest observed orchids in the area, has a height of 10 - 15 centimetres with 3-4 basal leaves. The flowers are 1-2 on the stem and distinctive with their large, brown velvety middle lip which bears a reflective grey patch (Figure 5). This flowers' shape is particularly attractive to Andrena bees which in return are used for pollination (Stökl et al, 2005) by the plant.

Only a couple of *O. fusca* individuals were observed in the area, in existence with wild *thymus* bushes in a semi shaded and rocky patches of the pine forest (Figure 6).

Figure 5: The flower structure of *O. fusca* (Original by Wallace)

Figure 6: A rare example of *O. fusca* in the area (Original by Wallace)

1.3. *Ophrys lutea*

This orchid bears a resemblance to *Ophrys fusca* yet its lip has a wide yellow border leaving the brown and grey patches relatively smaller in proportion. The flowers open from February onwards. They are pollinated by Andrena bees (Breitkopf et al., 2014) due to the flower's mimicry of the female bees. Although its remaining structures are almost identical, it contrasts with the *O. fusca* species by being observed widely throughout the area in high numbers.

The plant prefers open and dry meadows together with cultivated olive groves (Figure 7).

Figure 7: An example of *O. lutea* in an olive grove (Original by Wallace)

1.4. *Ophrys scolopax*

This orchid is another rare specimen with only three individuals were observed in the area. Its height is 10 – 20 centimetres; the stem structure and the leaves are similar to the other *ophrys* species. On the other hand, the flowers of *O. scolopax* are striking in terms of its sepals and lip. The three sepals are relatively large with a pink hue. The lip is divided into three lobes. The highly concave middle lobe is large, velvety brown with purple blotches curving upwards at the tip, turning into a smooth and yellow appendage. The side lobes are velvety brown facing upwards, again in a tubular shape giving the plant the appearance of having horns (Figure 8). The plant, which bears 1 to 4 flowers from March onwards, was found among the typical bushes of maquis such as *Thymus* and *Cistus* species (Figure 9).

Figure 8: The flower structure of *O. scolopax* (Original by Wallace)

Figure 9: A rare example of *O. scolopax* in the area (Original by Wallace)

1.5. *Ophrys speculum*

This orchid species has a height of 10 to 15 centimetres with 4 – 5 basal leaves. The 3 to 5 flowers, which appear in February, are distinctive due to the large and glossy purple lip, fringed with brown velvety hair (Figure 10). This is due to a particular mimicry designed to attract the male *Dasyscolia ciliata* wasp for pollination which causes it to mistake the flower for a female both in appearance and scent (O'Neill, 2001).

O. speculum is relatively abundant in the area and is often observed in open patches of calcareous dry soil together with a variety of other short annual plants.

Figure 10: *O. speculum*'s bee imitating flowers (Original by Wallace)

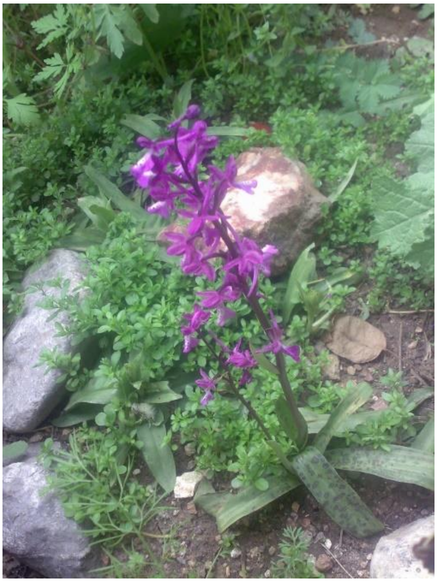

Figure 11: *O. anatolica* leaf and stem structure (Original by Wallace)

1.6. *Orchis anatolica*

This orchid species has a height of 15 to 20 centimetres. Its green basal leaves are elongated and scattered with dark purple spots which is one of its distinctive characteristics. The pink flowers appear in various numbers from 2 to 14 on a single stem (Figure 11). The flower's larger pink lip has a white stripe in the middle with pink speckles again. This middle lobe bears a distinctively elongated spur growing backwards up to a couple of centimetres (Figure 12).

The plant was often observed in rocky parts of the maquis with little competition amongst other bushes or annual plants.

Figure 12: *O. anatolica* flowers with the long spur (Original by Wallace)

Figure 13: Examples of *O. italica* (Original by Wallace)

1.7. *Orchis italica*

This orchid species has a height of 25 - 35 centimetres with 5 - 6 green elliptic basal leaves which are often wavy at the edges. With its sturdy stem it hosts an abundant number of flowers at the top in cylindrical form (Figure 13). The flowers occur from March to May and are the shades of pink vary among different individuals. The lip of the flower is strikingly divided into five pointed lobes resembling a naked man (Figure 14).

Orchis italica has been observed in open meadows and among some short but woody vegetation with richer soil.

Figure 14: Flower structure of *O. italica* (Original by Wallace)

Figure 15: The torn flowers of *O. papilionacea* (Original by Wallace)

1.8. *Orchis papilionacea*

This orchid species has not been observed in nature in this area, but the flowers were found torn and scattered around the open meadows of Evka 3 (Figure 15). This action has clearly been conducted with the aim of collecting the tubers of the plant, highly possibly for use in the preparation of the Turkish winter drink ‘salep’. This situation, again, highlights the ongoing human threat on the tuberous orchid species of Turkey.

According to the 2872 Environmental Act of Turkey (1983), section 9 (URL-3), individuals carrying out any acts that would threaten the biodiversity of the country would be fined starting from 40.913 TL.

The example presented here was found torn in 2011 and the plant was not observed in the area again. It could be suggested that *Orchis* *papilionacea* species became extinct in the Evka 3 district of İzmir due to the illegal collection of the plant from nature.

1.9. *Orchis sancta*

Orchis sancta has a height of 20 – 25 centimetres in total but the flowers it produces cover almost 2/3 of its stem. Basal leaves are often absent. The flowers are 12 to 16, compact and pale pink with a prominent lip which has got serrated and sometimes green edges (Figure 16).

The plant is often found among relatively tall wild grasses and annual plants, sometimes near pine trees (Figure 17).

Figure 16: Flower structure of *O. sancta* (Original by Wallace)

Figure 17: The habitat of *O. sancta* (Original by Wallace)

1.10. *Serapias orientalis*

The orchid has a height of 10 to 15 centimetres with 3 to 5 basal leaves. ¾ of the stem is covered with burgundy coloured flowers. The flower shape is compact yet dominated by a wide and long hairy lip. The bracts of the plant are often shielding most of the flower except for the lip. The colour variety of the bract changes from burgundy (Figure 18) to green (Figure 19) among the different individuals together with the lip shape which could be due to the subspecies of the plant.

Serapias orientalis was often observed among the wild grasses of open meadows and lightly cultivated land with calcareous or relatively rich soil.

Figure 18: An example of *S. orientalis* (Original by Wallace)

Figure 19: Flower structure of *S. orientalis* (Original by Wallace)

It could be noted that in within the pine forests, another species, *Limodorum abortivum*, was observed briefly but not photographed.

CONCLUSION

As a result, it can be claimed that a relatively small patch of land on the verge of a large city contains at least 11 species of orchids which indicates its richness in terms of its Orchidaceae biodiversity. On the other hand, habitat destruction caused by the inevitable expansion of the city is the major threat to these orchid species. The plants on these sites could be relocated to nearby parks during the vegetation period of the plant. Otherwise it would be difficult to locate the them as they lay dormant underground.

Another threat is caused by individuals who collect the tubers of some orchid species to prepare salep, a traditional Turkish drink. Although the existing environmental law carries a hefty fine on this matter, the evidence of orchid flowers that had been torn and scattered around the area shows that it has failed to prevent such behaviour. Considering salep is not an essential part of the human diet people should be taught to understand that the damage they cause is greater than the pleasure they receive from this activity. Afterall it is every citizen’s duty to protect the environment they inhabit.

The other, less immediate threat would be from the use of insecticides in the area, especially on the olive groves. Although this danger affects every organism both directly and indirectly, bees and wasp populations are particularly susceptible to damage. The extinction of these insects would prevent the *Ophrys* species in the area from being pollinated and make it impossible for them to set the seeds needed to produce future generations of individual orchids.

REFERENCES

Breitkopf, H., Onstein, R. E., Cafasso, D., Schluter, P. M., & Cozzolino, S. (2014). Multiple shifts to different pollinators fuelled rapid diversification in sexually deceptive *Ophrys* orchids. New Phytologist, 207: 377–389.

Buttler, K. P. (1991). Field Guide to Orchids of Britain and Europe. The Crowood Press. p. 288.

Christenhusz, M. J. M. & Byng, J. W. (2016). The number of known plants species in the world and its annual increase. Phytotaxa, 261(3): 201-217.

Griffiths, M. (2002). Orchids, from the Archives of the Royal Horticultural Society. Scriptum Editions, p. 335.

O'Neill, K. M. (2001). Solitary Wasps: Behavior and Natural History. Cornell University Press. p. 149.

Stökl, J., Paulus, H., Dafni, A., Schulz, C., Francke, W., & Ayasse, M. (2005). Pollinator attracting odour signals in sexually deceptive orchids of the *Ophrys fusca* group. Plant Systematics and Evolution, 254: 105-120.

URL-1. https://www.researchgate.net/post/How_many_orchid_species_are_there_on_earth#:~:text=There%20are%20differences%20in%20this,world%20and%20about%20120%2C000%20hybrids (Access date: 15.11.2020)

URL-2. http://www.bornova.gov.tr/nfus-altyapi (Access date: 13.11.2020)

URL-3.https://www.mevzuat.gov.tr/MevzuatMetin/1.5.2872.pdf (Access date: 12.11.2020)

CHAPTER 9

THE IMPORTANCE OF SOME SYMBOL ORNAMENTAL PLANTS IN URBAN IDENTITY; THE CASE OF TURKEY

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INTRODUCTION

Plants are the elements which give characteristic features to their environments with their aesthetic and functional qualities, balance, develop, enrich and revitalize them (Eroğlu et al., 2005; Temizel et al., 2019). Also, plants, which make up an important part of the earth we live in, are always needed in terms of both economic income and aesthetic use. The uses of plants as ornamental plants develop with research and development activities. The importance of ornamental plants, which form the cornerstone of green areas, is increasing day by day. Anatolia, which is the intersection point of three continents, is one of the important gene centers hosting the world's most unique plants with its rich climate and plant diversity. Turkey has rich biodiversity in where there are 11,707 plant species identified and 3649 of these species are endemic plants (Güner et al., 2012). Besides there are many trees, shrubs and plant species with herbaceous characteristics in a high variety of natural vegetation (Deniz & Şirin, 2005). However, very few species are cultivated in our country. It is very important to take natural plants into culture for product diversification. Because Turkey has a rich plant which is important for the evaluation of genetic resources. According to the studies on this subject in the world, it draws attention due to the many advantages of natural plants (Ekim et al., 2000). It is observed that the characteristics of these plants have been investigated in detail and the studies have increased rapidly (Kostak, 1992; Özhatay, 2009).Turkey is among the important regions of the world in terms of endemic plants, which only grow in a certain region or their homeland is a certain region. Natural plant species could best adapt to the local ecology when used in their geography (Bilgili et al., 2014; Erdoğan & Temizel, 2017).

It is especially important to use natural species in landscaping studies for some reasons such as reducing maintenance costs, providing a healthy plant texture, adapting to the region where it is located and improving environmental quality (Kaya et al., 2019; Erdoğan & Temizel 2019a).

Endemic species, which can be used in landscaping, especially endemic species in landscape applications, could provide great benefits both for the protection of nature and for the continuation of generations. Also, it could be contributing to the survival of our natural plants for future generations (Özhatay, 2009; Kaplan, 2018).

Vegetation is one of the most important factors determining the visual impact of the city (Erdoğan & Temizel, 2019b; Temizel & Erdoğan, 2019). Plants have functions such as providing oxygen, which is our most important source of life, providing food and fuel, creating living spaces for fauna, creating spaces, giving a symbolic meaning to the places they are used, and even adding aesthetic value to the cities they are used in and giving identity by making them different from other cities (Karaşah & Sarı, 2018). When the ornamental plants are examined in terms of urban identity; Istanbul is often referred to with the color "redbud", and when the Mediterranean region is mentioned, "palm trees" and when Bursa is mentioned, "cypress" comes to mind. Seasonal changes of plants, the compositions they create with living and non-living elements, their usage purposes and shapes change the identity of the city (Turgut et al., 2012). Especially endemic plants symbolize in the region where they are located. From this point of view, Anatolia still draws attention with its extremely interesting and valuable plant materials. Many plant species are found in natural vegetation of Turkey and they are used as ornamental plants in western countries. In recent years, studies have been carried out on the use of many species in Turkey as ornamental plants through breeding studies and it is brought to the ornamental plants sector.

In this chapter, some endemic and cultivated symbol ornamental plants, which were naturally distributed in Turkey, were introduced and their place and importance were discussed in urban identity. It was aimed that was to reveal information about the use of symbol plants. In fact that ıt had an important place in landscaping recently, as printing elements in structural elements in Landscape.

1. SOME SYMBOL ORNAMENTAL PLANTS IN TURKEY

Symbolism is a universal value and people's common language. It gives the same message to all people in different languages, cultures and writing systems and makes the same connotation. The symbol came from the word "Symbole" in French and was used to mean a concrete object or sign that denotes something that could not be expressed with the senses. For a symbol to be a universal symbol, it must contain a universal principle, law, story or truth (Özçelik, 2019). Plants that have become symbols that have gained their local name in Turkey and some ornamental plants in endemic species are included in this study. Plants that have become symbols. They have gained their local name in Turkey and some ornamental plants, which some are endemic species. This study was emphasized in symbols plants

2. ORNAMENTAL PLANTS AS SYMBOLS OF CULTURE AND RELIGIONS

In the historical process, the relationship of humans with nature has changed and developed in connection with the geographical, historical, socio-economic, philosophical and cultural conditions of each period. Plants stand out with their use in line with their cultural and belief values, as well as being an important part of nature. In Turkey culture, plants are regarded as divine blessings as symbols of death and resurrection, life force and life cycle. In this study, the meanings of the ornamental plants used from the past to the present were examined (Table 1).

2.1. *Euphorbia pulcherrima*

Euphorbia pulcherrima, whose native land is Mexico, is a type of flower belonging to the Iridaceae family. Other names of *Euphorbia pulcherrima* are Christmas flower, Christmas star, painted leaf and Mexican flame leaf. It is a flower with high appeal with its leaves and braces with the most beautiful shades of red, orange-red, pink and mottled-veined white.It is a bushy, deciduous, perennial plant (Özkan, 2012).

Atatürk brought Turkey and the plant was also called Atatürk flower because ıt was loved by Atatürk (Varış & Sağ, 2018). It is used as an indoor ornamental plant in homes and offices, especially because it reminds Atatürk.

Table 1: Photographs of some used some ornamental plants as symbols of culture and religions (*: Endemic) (URL-1)

 *Euphorbia pulcherrima* (Turkish name: Atatürk çiçeği)	 *Fritillaria imperialis* * (Turkish name: Ağlayan gelin)
 *Betula* spp. (Turkish name: Huş ağacı)	 *Rosa* spp. (Turkish name: Gül)
 *Tulipa* spp. (Turkish name: Lale)	 *Centaurea tchihatcheffii* * (Turkish name: Sevgi çiçeği)

2.2. *Fritillaria imperialis*

Fritillaria imperialis is an ornamental plant of the type *Fritillaria*, which is included in Liliaceae family. In the world, it is spread over a wide area in Asian countries, after Anatolia, and grows in Kyrgyzstan, Tajikistan, Uzbekistan, Northern Iraq, Iran, Afghanistan, Pakistan and the Himalayas. *Fritillaria imperialis* is an endemic plant belonging to the Anatolian geography. This plant, which is called tulip or crying bride in Turkey, The flowers of tulips look towards the ground as opposed to in different colors. Wild forms are usually orange or red color. The plant, which is a durable species, is famous for its flower reversing.

On the flowers, the plant has leaves in the form of a crown. There are white glands resembling pearls and secreting honey essence on the inner base of the flower petals. In addition, nectar drips from these glands from time to time (Satıcıoğlu, 2020). *Fritillaria imperialis* represents sadness, pain and tears in narratives and beliefs of Anatolian folk because of its bowed shape. It is also called the "crying tulip" because it bends its neck and its nectar spills. It especially has been used as a flower of sorrow in cemeteries for a long time in Eastern Anatolia. When their loved ones died, their relatives shared their sorrows in this way by planting tulips in the grave. In addition, inverted tulip motifs are used in the dowry of young girls (Satıcıoğlu, 2020).

2.3. *Rosa* spp.

Rose (*Rosa* spp.) is from the Rosaceae family (Gudin, 2000). Baytop, (2001) reported that there are approximately 25 natural rose species in Turkey. Thanks to its long history, symbolism, color, fragrance and unique elegance of its form, the rose is considered the most popular flower in the world. The origin of roses goes back 60 to 70 million years in Central Asia. Roses were cultivated extensively by the Egyptians, Chinese, Greeks, Romans and Phoenicians until 5000 years ago (Datta, 2018). Roses are the world's favorite flower due to their wide variety and flower characteristics (Cairns, 2001). In addition, it has influenced all cultures with its rose scent and beauty, its flowers of various colors and it has the most important place among flowers. The rose is symbolized as love, affection, and beloved (Figure 1). Rose, which is an important symbol in both eastern and western cultures, expresses beauty in Sufism culture, as well as the lover of God, Hz. He also represents Muhammad. Due to the short life of the rose, it also represents the temporality of life (İncidağı, 2015).

Figure 1: ‘Rose’ symbol of Isparta city (URL-2)

2.4. *Betula pendula*

Birch, whose Latin name is *Betula pendula*; it belongs to the Betulaceae family and has about forty species (Figure 2).

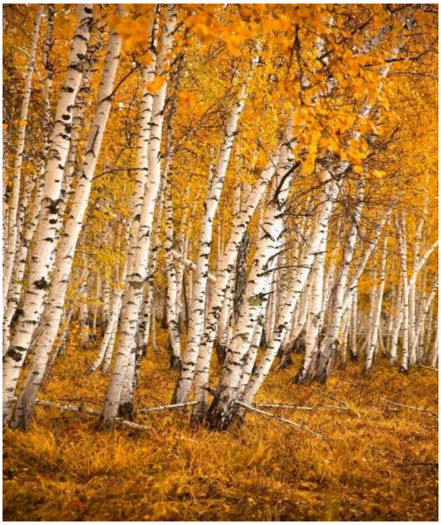

Figure 2: **'**Huş' symbol of Shamanism (URL-3)

It is a plant that is spread in Siberia and Western Russia regions of Eurasia, Central and Western Europe, Arctic Regions, North America, Polar Regions and Anatolia. Birch had been the holy tree of the Turks throughout the period from their existence to their acceptance of Islam. They regarded the beech (birch) tree as sacred because of the light that descended on them, that the Altai Turks performed rituals in the beech forests and said nine Oghuz legends in these rites. In the study titled Outline of Turkish history, "Birch was a totem wolf in the legend of Tuk-yu and a birch in the Uighur legend." (Yund, 1972; Yazici & Gülgün, 2015). Birch (*Betula pendula*) trees are an ornamental plant that can be used for various purposes in landscaping with its form, color effect and texture.

2.5. *Tulipa* spp.

Tulip is naturally grown in high altitude foothills. It is the common name of the perennial plant species from the Liliaceae family. Tulip has bulbous, long and pointed leaves, goblet-shaped flowers and all kinds of colors. Although tulip did not know in the Romans and Byzantines, tulips whose homeland is the Pamir, Hindu Kush and Tanrı Mountains; With the introduction of onions during the Turkish migration, they first moved to Anatolia from Europe during the reign of Suleiman the Magnificent (16th century). It has been used as an ornamental plant in Anatolia since the 12th century. It is widely used in parks and gardens due to its aesthetic appearance and elegance (Satıcıoğlu, 2020).

Tulip is an ornamental plant with a unique place in Turkish culture, art and literature as well as in folk narratives and beliefs. Besides it is one of the most widely used motifs in Traditional Turkish Arts such as tile, ceramic, decoration, miniature, marbling, calligraphy and illumination. It has been a preferred figure not only for the decoration of the surfaces of paper, books and architectural study, but also for fabrics and weaving. For Turks living in harsh climatic conditions, the tulip is considered to be the symbol of rebirth, awakening, life and abundance and the harbinger of the spring after winter. The numerical value of the words is 66 in the Arabic spelling of the tulip, and the word Allah is the numerical value at the same time. The fact that tulip was named after a period in Turkish history and the use of famous Sufis on tombstones is an indication of why it is an important motif in Turkish thought and art (İspirli, 2000; Satıcıoğlu, 2020).

2.6. *Centaurea tchihatcheffii*

Known as the local name *Peygamber çiçeği* in Turkey, *Centaurea tchihatcheffii* belongs to Asteraceae family and it is an endemic species in Turkey. It was first collected in 1848 by the Russian scientist Pierre de Tchihatcheffii from Ankara: Gölbaşı, Gölbek-Yavrucak. The flower of this plant is known to be iridescent around Gölbaşı because it reflects different shades of red according to the reflection angle. The name of his plant is well suited for the color of the flower; the plant is also called Gölbaşı cornflower or love flower. *Centaurea tchihatcheffii,* also known as iridescent, bridal button, tomb or cornflower and wicker flower, grows only in the world near Hacı Hasan Village of Gölbaşı district of Ankara.

Due to unconscious pesticides and applications, when faced with the danger of extinction, this plant has been protected under the Bern Convention (Erik et al., 2005).

3. SYMBOL ORNAMENTAL PLANTS WHICH GIVE PLACE NAMES

Plants seen in all areas of our lives have many symbols and meanings as a concept. Some symbol ornamental plants known as place names have been examined (Table 2).

Table 2: Photographs of some symbol ornamental plants in the place names (URL-1)

 *Gladiolus anatolicus** (Turkish name: Anadolu glayölü)	 *Dianthus ancyrensis* (Turkish name: Ankara karanfili)
 *Crocus ancyrensis** (Turkish name: Ankara çiğdemi)	 *Dianthus anatolicus* (Turkish name: Anadolu karanfili)
 *Cyclamen pseudibericum* Hildebr (Turkish name: Anadolu sıklameni)	 *Crocus antalyensis* (Turkish name: Antalya çiğdemi)

(*:Endemic)

Table 2: Photographs of some symbol ornamental plants in the place names (Cont.)

 *Iris pamphylica* (Turkish name: Antalya süseni)	 *Crocus abantensis** (Turkish name: Turkish name: Abant çiğdemi)
 *Crocus adanensis** (Turkish name: Adana çiğdemi)	 *Lilium candidum* (Turkish name: Ak zambak)
 *Galanthu splicatus* subsp. *byzantinus* * (Turkish name: İstanbul kardeleni)	 *Lathyrus undulatus** (Turkish name: İstanbul nazendesi)

(*:Endemic)

Table 2: Photographs of some symbol ornamental plants in the place names (Cont.)

 *Tulipa orphanidea** (Turkish name: Manisa lalesi)	 *Allium cappacocicum* (Turkish name: Kapadokya soğanı)
 *Centaure kilaea** (Turkish name: Kilyos Peygamber çiçeği)	 *Campanula ekimiana** (Turkish name: Kızılcahamam çan çiçeği)
 *Rosa x damascena* (Turkish name: Isparta gülü)	

(*:Endemic)

3.1. *Crocus abantensis*

Crocus abantensis, which only grow in Turkey, is endemic plant as the name suggests. The name of the plant species are from Adana.

3.2. *Gladiolus anatolicus* (Anatolian *Gladiolus*)

Anatolia gladiolus, which only grow in Turkey is endemic plant as the name suggests. It grows in red pine forests, maquis and limestone areas. It is rarely found in the Mediterranean and Aegean regions (Çelik, 2017).

3.3. *Dianthus anatolicus* (Anatolian Clove)

Anatolian carnation is a perennial ornamental plant which spreads in Western and Central Anatolia in Turkey. It grows at an altitude of about 500-2200 m, especially in rocky, stony, bushy, meadows and maquis.

3.4. *Dianthus ancyrensis* (Ankara Clove)

Angora carnation or *Dianthus ancyrensis* is a species belonging to the Dianthus genus of the Caryophyllaceae family. The name of the plant species are from Ankara and ıt is endemic in Turkey. It spreads around Ankara province and Western Black Sea. The plant, which generally blooms between June and August, grows mostly on rocky, stony, pebbly and arid slopes (URL-4).

3.5. *Crocus ancyrensis* (Ankara *Crocus*)

Ankara crocus is from the Iridaceae family and ıt has a yellow flowering crocus species which is endemic in Turkey. It is a perennial herbaceous plant that blooms between February and April and is seen at altitudes of 1000-1600 m. In Northwest and Central Anatolia region of Turkey, it spreads in the provinces of Amasya, Ankara, Bolu, Çorum, Kastamonu, Kırşehir, Kayseri, Kahramanmaraş, Samsun, Sivas and Yozgat. It is grown as ornamental plants in gardens and many cultivars are also developed (URL-5).

3.6. *Crocus antalyensis* (*Crocus* of Antalya)

It is a perennial plant. It grows at altitudes of 900-1250 meters, in *Quercus* forests. It blooms in October-December. It is located in Antalya.

3.7. *Iris pamphylica* (*Iris* of Antalya)

Antalya *iris*es belong to the Iridaceae family and are known as a rare Toros flower unique to the Antalya-Akseki region. As the name suggests, it is a perennial ornamental plant and endemic in Turkey. In March-April, they shine with their purple and orange flowers. It is found especially among the *Pinus brutia* forests and *Quercus* bushes and forests (URL-6).

3.8. *Lilium candidum* (White Lily)

Lilium candidum, it is a perennial herbaceous, ornamental plant from the Liliaceae family (Cronquist, 1968). It is known by names such as white lily, white lily, miss lily in Turkey. It is the only white flowering lily species in Turkey (Wilson and Mathew, 1980-1981; Kahraman, 2014). It naturally spreads in Lebanon, Syria, Palestine, the Greek

Islands, and the Balkans and in Southwest Anatolia in Turkey. It has been observed from Milas to Söke, environs of Bafa Lake, the northern slope of Samson Mountain, up Güzelçamlı, from Marmaris to Datça, Rhodes between Sarıyer-Büyükdere, İçel (Bolkar Mountain) and Mardin in Turkey (Davis, 1984-1988). Temeltaş (1999) and Kahraman (2014) stated that *L. candidum* spread around Sarıçayır, Sanfakılar, Keçidere, Mehmetler and Durak villages of Kepsut district of Balıkesir. Although *Lilium candidum* is not a plant endemic to Turkey, it is a species under threat of extinction. Today, *Lilium candidum* of various applications made in Tokat a symbol plant with the study of Tokat Municipality. In this way, they say that the city of white lilies is Tokat, is on its way to becoming a symbol ornamental plant (Figure 3).

Figure 3: **'**White lily' symbol of Tokat city (Original by Akca)

3.9. *Allium cappacocicum* (Kapadokya flower)

Cappadocia flower grows in Cappadocia and Central Anatolia and blooms in summer. The pinkish flower colors take on white as they mature.

3.10. *Campanula ekimiana* (Kızılcahamam campanula)

There are 90 genus and 2500 species of campanula in the world. Bellflower (Campanula) is the largest genus in this family. It takes its name from the bell-shaped flowers. Kızılcahamam campanula is a perennial plant. The plant that blooms in July is an endemic plant. Also it only grows in volcanic rock cracks between Kızılcahamam and Işık Mountain where there are 250-300 plants in a narrow area of approximately two square kilometers. The areas where the plant grows naturally are not protected today. For the first time in 1983, Prof. Dr. It was discovered by Adil Güner, it was introduced to the world of science in 1985 and named as Prof. Dr. Tuna Ekim (URL-7).

3.11. *Centaure kilaea* (Kilyos corn flower)

Kilyos cornflowers is from Asteracea family and a perennial flower species which is endemic in Turkey. This plant is grown in coastal dune field in the portion of Kırklareli and Sakarya, Düzce, Istanbul in Turkey. The endangered plant is known for its purple flowers at the ends of the branched stems on the stem (URL-8).

3.12. *Galanthus plicatus* subsp. *byzantinus* (Istanbul snowdrop)

It is from Amaryllidaceae family and endemic in Turkey. Istanbul snowdrop, primarily naturally takes its name from Istanbul in Turkey and it is located in Bursa, Kocaeli, Bolu and Kırklareli.

3.13. *Lathyrus undulates* Boiss (*Lathyrus* of İstanbul*)*

It is an endemic flowering plant, from genus *Lathyrus* and Fabaceae family. It naturally takes its name from Istanbul. It is one of the rare species on the Anatolian side and European scale. The range areas of endemic species that are found only in natural environments and cannot compete with other plants and forest edges in areas where human influence manifests itself are decreasing day by day. The plant, which has extremely beautiful flowers, has the potential to be widely used in the ornamental plants sector. When this plant is considered as an ornamental plant, it could contribute to the development of the endemic plant concept. In addition to the use of this species as an ornamental plant, its protection and its continuity in the natural environment is importance (Akkemik, 2016).

3.14. *Tulipa orphanidea* (Manisa Tulip)

Manisa tulip is a species of the *Tulipa* genus in the Liliaceae family. Besides it are grown southeast of the Balkans, west of Bulgaria, Greece, Aegean Islands, Crete and Turkey. Tulip has bulbous which grows as wild flower on the Spil Mountain /Manisa. Also, it is mostly seen in March-April. It is known as "Manisa Tulip" because it grows widely around Manisa and Izmir. It is one of our values that is about to disappear. There are more than 60 species of mountain tulips in the world. Some are used in parks and gardens or as cut flowers (URL-9).

CONCLUSION

Naming in ornamental plants; their external appearance, usage areas, and places they grew up in, traditions from the past, influences of different cultures, legends and countless features have been effective (Figure 4).

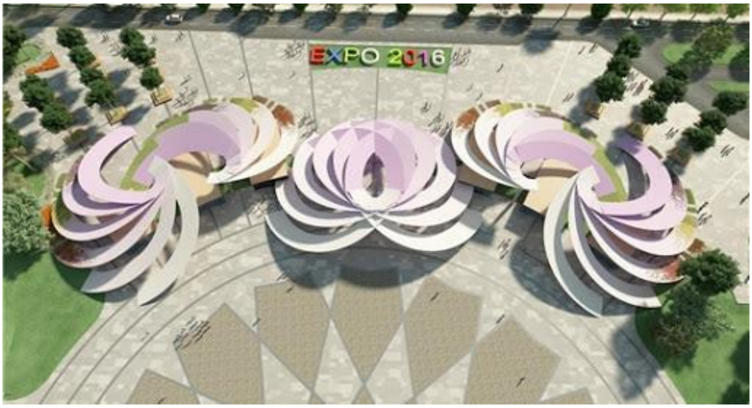

Figure 4: ‘Turk peony’ symbol of Antalya EXPO (URL-10)

When we examine the ornamental plants that grow naturally in our country, it is seen that most of them symbolize their place, religion or nation. Some of these species living in our country are extinct for humanitarian purposes such as agricultural practices, health and some of them are taken under protection.

Natural species with symbolic value in our country;

It is necessary to increase the production of ornamental plants by bringing them to the sector.

- Especially symbol ornamental plants should be used for promotion purposes in the places where they are located.
- For species with endemic and economic value, care should be taken to collect endangered plants from nature in accordance with regulations.

REFERENCES

Akkemik, Ü. (2016). İstanbul'un doğal bitki zenginliği içerisindeki üç endemik otsu bitki. Mart sayısı, Plant Dergisi. (Access link: https://www.plantdergisi.com/prof-dr-unal-akkemik/istanbul-un-dogal-bitki-zenginligi-icerisindeki-uc-endemik-otsu-bitki.html)

Baytop T. (2001). Türkiye'de Eski Bahçe Gülleri. T.C. Kültür BakanlığıYayınları, Yayın No: 2593, Ankara, s. 149.

Bilgili, C., Öner, G. & Aytaç, İ. (2014). Çankırı ili parklarının bitkisel peyzaj tasarımında kullanılan doğal ağaç türlerinin belirlenmesi. III. Uluslarası Odun Dışı Orman Ürünleri Sempozyumu, Kahramanmaraş, Türkiye, 786-795.

Cairns, T. (2001). The geography and history of the rose. American Rose Annual, Magazine- January, 18-29.

Cronquist, A. (1968). The Evaluation and Classification of Flowering Plants. Thomas Nelson Ltd., London and Edinburgh, Great Britain, p. 396.

Çelik, K. (2017). Anadolu'nun Endemik Güzelleri. Journal of Awareness, 2(3): 541-544.

Datta, K. S. (2018). Breeding of new ornamental varieties: Rose. Current Science, 114: 1194-1206.

Davis, P. H. (1984-1988). Flora of Turkey, Vol. 8-10, Edinburg.

Deniz, B. & Şirin, U. (2005). Samson Dağı doğal bitki örtüsünün otsu karakterdeki bazı örneklerinden peyzaj mimarlığı uygulamalarında yararlanma olanaklarının irdelenmesi. ADÜ Ziraat Fakültesi Dergisi, 2(2): 5-12.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z. & Adıgüzel, N. (2000). Türkiye Bitkileri Kırmızı Kitabı (Red Data Book of Turkish Plants). Barışcan Ofset, Ankara, 246.

Erdoğan, E. & Temizel, S. (2017). Yozgat İli, Büyüknefes Köyü'nün ekoturizm kapsamında değerlendirilmesi. II. Uluslararası Bozok Sempozyumu 'Yozgat'ın Turizm Potansiyeli ve Sorunları', Cilt II: 471-483, Mayıs 4-6, Yozgat.

Erdoğan, E. & Temizel, S. (2019a). Kentlerin markalaşması, marka kentler ve kent kimliği, II. Uluslararası Bilimsel Çalışmalar Kongresi 'Sanat ve Tasarım Kongresi', Mart 21-24, Ankara.

Erdoğan, E. & Temizel, S., (2019b). Kentsel mekanlar, kalite ve estetik. III. Uluslararası AVRASYA Multidisipliner Çalışmalar Kongresi Uygulamalı Bilimler Kitabı, 4-7 Nisan, Gaziantep, s. 857-864.

Erik, S., Mutlu, B., Topaloğlu, S., Tarıkahya, B. & Aldemir, A. (2005). *Centaurea tchihatcheffi* Gölbaşı Sevgi Çiçeği (*Centaurea tchihatcheffi*'nin Tarihçesi, Türkiye Florasındaki Yeri, Yayılış Alanları, Taksonomik Özellikleri ve Diğer ile olan Birlikteliği. Bizim Büro Basımevi.

Eroğlu, E., Kesim Akıncı, G. & Müderrisoğlu H. (2005). Düzce kenti açık ve yeşil alanlarındaki bitkilerin tespiti ve bazı bitkisel tasarım ilkeleri yönünden değerlendirilmesi. Tarım Bilimleri Dergisi, 11(3): 270-277.

Gudin, S. (2000). Rose: Genetic and Breeding, Plant Breeding Reviews, Editor: Jules Janick, p. 159-188.

Güner, A., Aslan S., Ekim T., Vural M. & Babaç M. T. (2012). Türkiye Bitkileri Listesi Damarlı Bitkiler, Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmalı Derneği Yayını, Flora Dizisi 1, İstanbul.

İncidağı, S. A. (2015). Mevlana'nın Mesnevi'sinde Yer Alan Bitkive Meyvelerin Tasavvuf Dünyasındaki Sembolik Anlamları. Selçuk Üniversitesi Mevlana Araştırmaları Enstitüsü Mevlana ve Mevlevililik Araştırmaları Anabilim Dalı. Yüksek Lisans Tezi.

İspirli, S. A. (2000). Türk Edebiyatında Tarih Düşürme Geleneği. Atatürk Üniversitesi Türkiyat Araştırmaları Enstitüsü Dergisi, 14: 80-81.

Kahraman, Ö. (2014). Sera koşullarında farklı katı ortam kültürlerinin *Lilium candidum* yetiştiriciliği üzerine etkisi. Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi, 31(3): 68-72.

Kaplan, N. (2018). Türkiye'nin Endemik Bitkileri, http://www.turktob.org.tr/dergi /makaleler/dergi1/34-35.pdf. (Access date: 20.10.2020)

Karaşah, B. & Sarı, D. (2018). Kent kimliğinde etkili bir bileşen: Doğal bitkiler. International Social Sciences Studies Journal, 4(26): 5539-5545.

Kaya, S., Eroğlu, E, Ak, M., Kulaç, Ş., Çetin, B., Meral, A., Doğan, T., Başaran, N., & Aydın H. (2019). Düzce ve yakın çevresindeki bazı endemik bitki türlerinin mevsimsel değişim potansiyelinin belirlenmesi. Düzce Üniversitesi Bilim ve Teknoloji Dergisi. 7(3): 1686-1697.

Kostak, S. (1992). Türkiye'nin Doğal Bitki Örtüsünde Bulunan Bazı Karanfil Türlerini Fenolojik ve Morfolojik Karakterleri Üzerinde Araştırmalar (Doktora Tezi Basılmamış) E.Ü. Fen Bilimleri Enstitüsü, Peyzaj Mimarlığı Ana Bilim Dalı, İzmir.

Özçelik, H. (2019). Sembol bitkilerimiz ve özellikleri. Nisan, Plant Dergisi. *(Access Link:*https://www.plantdergisi.com/prof-dr-hasan-ozcelik/sembolbitkilerimiz-ve-ozellikleri.html

Özhatay, E. C. (2009). Türkiye'nin peyzaj da kullanılabilecek bazı doğal bitkiler. Yüksek Lisans Tezi, Çevre Bilimleri Bölümü, Marmara Üniversitesi, İstanbul.

Özkan, Ş. (2012). Anadolu Türk Folklorunda Bitki Adlarının Veriliş Hikâyeleri Üzerine Bir İnceleme. Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Türk Dili ve Edebiyatı Anabilim Dalı. Yüksek Lisans Tezi.

Satıcıoğlu, H. (2020). Batken'de (Kırgızistan) ve Batman'da (Türkiye) ters lale efsaneleri. İnsan ve Toplum Bilimleri Araştırmaları Dergisi, 9(1): 417-434.

Temizel, S. & Erdoğan, E. (2019). Tarihi kent kimliği ve kentsel belleğin korunmasında peyzaj tasarımı, III. Uluslararası AVRASYA Multidisipliner Çalışmalar Kongresi Uygulamalı Bilimler Kitabı, 4-7 Nisan, Gaziantep, s. 865-871.

Temizel, S., Kılıç, T., & Yazıcı, K. (2019). Determination of Use Active Green Areas of Urban Public and Requirements of Open- Green Area in Yozgat City/Turkey. Research Reviews in Architecture, Planning and Design, Gece Kitaplığı, p. 39-55.

Turgut, H., Özalp Yavuz, A., & Erdoğan, A. (2012). Artvin ilinde doğal çevrenin kent kimliğine etkileri. Süleyman Demirel Üniversitesi Orman Fakültesi Dergisi, 13: 172-180.

Varış, S. & Sağ, F. S. (2018). Türk'ün sevdiği Atatürk çiçeği yetiştirme ve üretimi. Ağustos, 2019, Plant Dergisi. (Access Link: https://www.plantdergisi.com

/prof-dr-servet-varis-aras-gor-fatma-seren-sagir/turk-un-sevdigi-ataturk-cicegi-yetistirme-ve-uretimi-poinsettia-which-is-loved-by-turks-growing-an.html)

Wilson, H. F. & Mathew, B. (1980-1981). Bulbs- The Bulbous Plants of Europe and Allies. William Collins Sons & Co. Ltd., p. 329-550.

Yazici, K. & Gülgün, B. (2015). *Betula pendula* Roth. (Siğili Huş)'un bazı fizyolojik ve morfolojik özelliklerinin değerlendirilmesi. Ziraat Mühendisliği Dergisi, 362: 34-37.

Yund, K. (1972). Türklerin kutlu ağacı kayın (huş) adı, üzerine. Aylık Türk Kültür Dergisi, Ankara.

URL-1. https://www.plantdergisi.com/prof-dr-hasan-ozcelik/sembol-bitkilerimiz-ve-ozellikleri.html (Access date: 26.10.2020

URL-2. https://motorhikayesi.com/git-gor-isparta/ (Access date: 26.10.2020

URL-3. https://tr.pinterest.com/pin/9992430403740926/ (Access date: 26.10.2020

URL-4. https://tr.wikipedia.org/wiki/Ankara_karanfili. (Access date: 26.10.2020)

URL-5. https://tr.wikipedia.org/wiki/Ankara_%C3%A7i%C4%9Fdemi. (Access date: 29.10.2020)

URL-6. http://194.27.225.161/yasin/tubives/index.php?sayfa=1&tax_id=9358. (Access date: 29.10.2020)

URL-7. https://turkiyecicek.wordpress.com/2016/04/09/campanula-ekimiana-kizilcahamam-cancicegi-kizilcahamam-cingirakotu-campanulaceae-cancicegiller. (Access date: 26.10.2020)

URL-8. https://tr.wikipedia.org/wiki/Kilyos_peygamber_%C3%A7i%C3%A7e%C4%9Fi#:~:text=Kilyos%20peygamber%20%C3%A7i%C3%A7e%C4%9Fi%20(Centaurea%20kilaea,sahil%20k%C4%B1sm%C4%B1ndaki%20kumul%20sahalarda%20yeti%C5%9Fir. (Access date: 26.10.2020)

URL-9. https://tr.wikipedia.org/wiki/Manisa_lalesi. (Access date: 28.10.2020)

URL-10. www. radikal.com.tr (Access date: 12.10.2020)

CHAPTER 10

DAHLIA SPP. (STAR FLOWER) AND THEIR LANDSCAPE DESIGNS USAGE

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INTRODUCTION

Ornamental plants are defined according to aesthetic, functional and economic aims. This plants are produced, propagated and grown using different materials and methods (Tanrıverdi, 1993; Akca & Yazici, 2017; Akca et al., 2019). As can be understood from this definition, ornamental plants; it is a very wide sector in terms of its purpose, scope and production range. Increasing the range of products in the ornamental plants sector with alternatives that create climatic diversity reveals well as evaluating new varieties (Lumpking & Lumpking, 2005; Gulgun et al., 2019; Yazici et al., 2017) Since the flowers of bulbous-tuberous plants are extremely interesting in terms of shape and color, their early blooming especially at the end of the winter months, symbolic importance as the harbinger of spring, easy cultivation and growth. Thus it is the most important of gardens and parks in various countries of the world. Creates overused traditional plant material (Mathew, 1987; Mathew & Swindells, 1994; Leeds, 2000; Akca et al., 2018; Akca & Gulgun, 2019). Approximately 700 flower bulb species grow naturally in our country (Romer, 2008; Evans, 1998). The diversity and richness of the flora of our country attracted the attention of foreigners before us. Natural flower bulbs, which were bought primarily for display in botanical gardens, were replaced by trade and as a result, they were destroyed in nature and caused their dismantling. Bulbous plants are valuable plants in many ways. Also *Dahlia* is one of the most prominent plants among tuberous plants for outdoor use (Brickell, 1992).

In the scope of study; the place of star flower, which has not yet received the agenda it deserves in its product range, in landscape works, its use, ecological desires and its use in vegetal designs and its contribution to landscape studies were discussed.

1. GENERAL FEATURES

Dahlia is in the Asteraceae family. This family is the richest family of flowering plants that naturally spread in almost every region of the world except Antarctica, with 1,000 genera and nearly 25,000 species. Most of the plants are one-two or perennial herbaceous plants in this family, and the numbers of those forms are shrubs or trees The flowers are star-shaped, the leaves are simple or compound, rosette-shaped. There are 30 main types of dahlias and about 20,000 varieties.

Figure 1: The flowers of *Dahlia* (Original by Yazici)

Dahlia naturally grows in the Central American continent, especially in the high mountains of Mexico. It blooms in summer and autumn, its stem is a bush and roots are tubular. There are 27 species in nature (Alp et al., 2014). While some of these species reach 8–9 m in height, some species are stunted. It gives flowers continuously from July until the first cold. In addition it has different plant sizes and different flower shapes and sizes in temperate zone.


(a) (b)

(c)

Figure 2: *Dahlia* a: The Pictures of Seattle, b: Rebbeca; c:Le Castel (Original by Yazici)

Flower shapes; it ranges from plain, lotus, anemone, pompon, ball, semi-cactus, cactus, decorative, orchid and peony. As for the color palette, it offers a wide range of all warm colors apart from shades of blue. *Dahlia* with alternative varieties such as *D. pinnata, D. variabilis* and *D. hybrida;* It is planted in spring after being preserved in winter. Usually they are produced in the summer in open areas. If desired, they can be produced in the greenhouse during the winter months. It is possible to grow cultivars easily. It is possible to grow cultivars easily. The American Dahlia Association recognized 15 official colors of dahlia. These; white, yellow, orange, pink, dark pink, red, dark red, lavender, purple, light color mix, bronze, flame, dark color mix, motley and two colors. De Hertogh & Le Nard (1993) and Mc Claren (2004) reported that *Dahlia*s are very variable plants in terms of both flower forms and colors. It is possible for a beautiful layered variety to turn into a semi-layered shape and change its color in a short time. With two colors, one of the colors can be lost. They stated that separate branches of the same plant can produce different colored flowers.

(a) (b) (c)

Figure 3: The pictures of big flower *Dahlia* and small flower *Dahlia* (a: big flower, b: small flower c: big flower) (URL-1)

*Dahlia*s, which have this variety of colors and shapes, are also available in two types, which are used as cut flowers as well as outdoor ornamental plants. Tubers are large-flowered species and seed-grown are tiny-flowered (better if we write the exact species names). *Dahlia*s are generally used as garden plants, in other words, outdoor plants.

1.2. Ecological Requirement

Temperature; optimum germination temperature is 18–26 °C. But then the temperature should be reduced. 12 °C is sufficient for the next period. It needs sunny-airy environments for abundant and early blooming. Dahlia growers in sunny places. Thanks to the more sun, the plant sees the more flowers it. From the beginning of spring until the end of summer, they need at least 6 hours of sun per day.

1.3. Soil Requirement

Dahlia likes humus and light loam soils very much. Does not like too acidic soils; soil pH should be around 6-7. Tubers should be protected from frost in a dry and airy environment in winter.

1.4. Light Requirement

Dahlia shows a photoperiodic reaction. Its aboveground parts develop well in long-day conditions and underground parts in short-day conditions (Yazici & Gunes, 2018). At least 12 hours of light per day is required for the above-ground parts to develop well. Otherwise, development slows down. Long days are also required for flower outline formation. In short day conditions, low quality is seen especially in layered varieties. Very branching and many flowers are obtained only in long day conditions. Short day conditions should be provided for tuber development. In order to achieve this, the plants should be exposed to 8-11 hours of light daily for 20-30 days and the plants should be left in the dark at the other time. It grows in rocky, well-drained, sunny and temperate places in nature.

2. *DAHLIA* AND LANDSCAPE DESIGN

Plants are the cornerstone of herbal design study. In recent years, as a result of the contemporary approach, green space activities have gained importance both in individual and public terms; Municipalities have accelerated the efforts to establish parks and playgrounds in different parts of the city. For these reasons, it is necessary to know both the aesthetic and functional features of the plants well. Increasing the proposed use of the plant to be used increases the success of plant designs. *Dahlia* is an ornamental plant that can create an effect in various aspects of landscaping with its form, color effect, texture. *Dahlia* is a good border plant. It can be combined very well with annual seasonal flowers, ground cover plants and perennial plants (shrub, bush). It is especially used in the back row of borders due to its high height and long blooming period. When *Dahlia* is used with spring-flowering bulbous plants, it provides the area to remain in bloom for a long time. In the table below, information on how efficient the *Dahlia* plant is used for what purposes is given. As it can be seen from the Table 1, it stands out that it is a very suitable plant especially for emphasis purposes, for background purposes, for border plants and for softening of hard looks with its colorful aesthetic structure.

Table 1: The suitability of *Dahlia* plant for various usage purposes within the scope of landscape studies

Landscape feature		Landscape feature	
Usage for emphasis aim	***	Usage as road tree	*
Usage for funding aim	***	Usage as border plant	***
Usage for protection	*	Usage for hard-looking areas	***
Usage for wind breaking	*	Usage in group form	***
Noise prevention	*	Usage as solitary	**

* Unusable, ** Useful, *** Very Useful

The color-form-textural characteristics of some *Dahlia* cultivars belonging to the research experiment in Kazova ecological conditions in the Agricultural Research and Application Center of the Faculty of Agriculture at Gaziosmanpasa University are given in the following section.

3. SOME *DAHLIA* FEATURES

Dahlia 'Le Castel' has plant height; 110 cm, flower diameter; 10-15 cm, flower color; white, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 4).

Dahlia 'Ferncliff Painted' has plant height; 150 cm, flower diameter; 15-20 cm, flower color; pink speckle on white, leaf fine textured, the stem varies according to the number of bulbous tubers.

	
Dahlia 'La Castel'	***Dahlia*** 'Ferncliff Painted'
	
Dahlia 'American Dawn'	***Dahlia*** 'Marbleball'

Figure 4: Photographs of some *Dahlia* varieties (Original by Yazici)

Plant form is bush (Figure 4). As for *Dahlia* 'American Dawn', it has plant height; 90 cm, flower diameter; 10-15 cm, flower color; light pink, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 4). *Dahlia* 'Marbleball' has plant height; 80 cm, flower diameter; 6-10 cm, flower color; lilac-purple speckle, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 4).

Dahlia 'Gloriosa'

Dahlia 'Rebecca World'

Dahlia 'Mr. Optimistic'

Dahlia 'Philadelpia'

Figure 5: Photographs of some *Dahlia* varieties (Original by Yazici)

Dahlia 'Gloriosa' has plant height; 150 cm, flower diameter; 20-25 cm, flower color; red speckle on yellow, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 5). As for *Dahlia* 'Philadelpia' it has plant height; 110-120 cm, flower diameter15-20 cm, flower color; red, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 5). *Dahlia* 'Rebecca World' has plant height; 110 cm, flower diameter;

10-15 cm, flower color; white purple ribbon, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 5). *Dahlia* 'Mr. Optimistic' has plant height; 90 cm, flower diameter; 10-15 cm, flower color; reddish-ends are white, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 5).

	
Dahlia **'**Bayblon Purple'	***Dahlia*** **'**Seattle'

Figure 6: Photographs of some *Dahlia* varieties (Original by Yazici)

Dahlia 'Bayblon Purple' has plant height; 120-150 cm, flower diameter; 20-25 cm, flower color; dark pink, leaf fine textured, the stem varies according to the number of bulbous tubers. Plant form is bush (Figure 6). *Dahlia* 'Seattle' has plant height; 50 cm, flower diameter; 15-20 cm, flower color; light yellow-pink, leaf fine textured, the stem varies according to the number of bulbous tubers (Figure 6).

4. THE USAGE EXAMPLE OF *DAHLIA* IN LANDSCAPE APPLICATION

There are multifaceted components affected structural and vegetative design in landscape architecture; the experience of the designer, the perspective, the number of users, their demands, environmental factors and financial situation are some of multifaceted components. However, it is aimed that the spaces will emerge in all cases, which are functional, aesthetic, and compatible with their surroundings, balanced, simple and suitable for proportion. Considering the plant features such as the size, shape, color and texture of the planted plants, it should be aimed to create a harmonious composition by creating contrast or harmony throughout the year. In this book section, some morphological information about *Dahlia* has been given. Usage styles in landscape architecture were evaluated. As a result, usage examples in landscape are given in Figure 4; Figure 7, and Figure 8. Thanks to these examples, it is a fact that the *Dahlia* plant will create awareness in landscape architecture studies thanks to its cultivation and use in different ecological conditions.

Figure 7: The example of use in the landscape (Van/Turkey) (Original by Yazici)

(a) (b) (c) (d) (e) (f)

Figure 8: The examples of use in the landscape (a,b,c,d,e: border plant, f: potted plant) (Original by Yazici)

CONCLUSION

With the different and eye-catching colors and forms *Dahlia* has, different visual elements can be revealed in plant design. The fact that it is a bulbous plant and that it stays flowering in late spring-summer is extremely effective in creating color contrast in alternative uses. Therefore, it has the chance to create alternative areas and shapes of alternative use with different plant groups (Figure 9). As a result of this study; some of the Dahlia species and varieties that have remarkable features in terms of form and color with their leaves, stems and branches throughout the vegetation period were evaluated. Since it grows easily in areas where the summer months are cool and there is little plant material for herbal design, beautiful compositions can be created with other plants in such regions.

Figure 9: The example of use in the landscape (Van/Turkey)

This plant, which is both tall and dwarf varieties, can be used as a versatile alternative such as cutting, seasonal and outdoor, also has a very attractive space-filling image with its texture, colors, aesthetic appearance, and does not have very extra ecological demands, should be given importance to efforts to increase its use in landscape planning studies.

REFERENCES

Akca, S. B. & Gulgun B. (2019). Architecture, Planning and Design Research Papers, Chapter 10: Aesthetic and Functional Evaluation of Ornamental Plants Used In Urban Road Planting Determination Çaycuma (Zonguldak), Gece Akademi, ISBN:978-625-7958-57-8.

Akca, S. B., Gulgun, B. & Yazici, K. (2018). Kentsel peyzajda çocuk oyun alanlarının bitkisel tasarım kriterleri. Uluslararası Kentleşme ve Çevre Sorunları Sempozyumu: Değişim/Dönüşüm/Özgünlük, Eskişehir.

Akca, S. B. & Yazici, K. (2017). Çaycuma Zonguldak kentinin kentsel açık yeşil alan yeterliliği ve geliştirme olanakları. VI. Uluslararası Meslek Yüksekokulları Sempozyumu, Saraybosna.

Akca, S. B., Yazici, K. & Gulgun, B. (2019). Kentçi yol bitkilendirmelerinde kullanılan süs bitkilerinin estetik ve fonksiyonel açıdan değerlendirilmesi: Atatürk Bulvarı Örneği Çaycuma. Uluslararası Göbeklitepe Tarım Kongresi, Şanlıurfa.

Alp, Ş., Batı, B. B., Akın, A., & Paksoy, M. (2014). Yıldız çiçeği-Dahlia (*Dahlia* ssp.) yetiştiriciliği, sınıflandırılması ve kullanımı. Selçuk Tarım Bilimleri Dergisi, 1(1): 41-44.

Brickell, C. (1992). Encyclopedia of Gardening. The Royal Horticultural Society, London. p. 648.

De Hertogh, A. & Le Nard, M. (1993). The Physiology of Flower Bulbs. A Comprehensive Treatise on the Physiology and Utilization of Ornamental Flowering Bulbous and Tuberous Plants. Elsevier Science Publishers, Amsterdam, p: 617-682.

Evans, E. (1998). *Dahlia*s for The Home Landscape. Department of Horticultural Science. Cooperative Extension Service. North Carolina State University College of Agriculture & Life Sciences. North Carolina.

Gulgun, B., Akca, S. B. & Yazici, K. (2019). The importance in landscape architecture of hobby gardens. International Marmara Science and Social Sciences Congress, Kocaeli.

Leeds, R. (2000). The Plant Finder's Guide to Early Bulbs. ISBN: 0-7153-0805-X. UK. 192.

Lumpkin & Lumpkin(2005). http://www.dahlias.net/dahwebpg/Gardens/Lumpkin/Lumpkin.htm

Mathew, B. (1987). Flowering Bulbs for the Garden. Kew Gardening. ISBN: 0 600351750. London. p. 124.

Mathew, B. & Swindells, P. (1994). The Garden's Guide to Bulbs. Reed International Books Limited, ISBN: 1 8573 2744 6. London. p. 240.

Mc Claren, B. (2004). Encyclopedia of *Dahlia*s. Timber Press. USA, p. 211.

Romer, J. (2008). Growing *Dahlia*s. Instructional Technology Center.

Tanrıverdi, F. (1993). Çiçek Üretim Tekniği. Sera ve Acık Alanlarda Saksı, Kesme ve Bahçe Çiçeği Yetiştirme İlkeleri Ders Kitabı. Atatürk Üniversitesi, Ziraat Fakültesi Yayınları, Bahçe Bitkileri Bölümü, Peyzaj Mimarlığı Bilim Dalı.

Yazici, K., Akca, S. B., & Yazici, L. (2017). Determination of appropriate areas and design proposals for healing gardens. I. International Congress on Medicinal and Aromatic Plants, Konya.

Yazici, K. & Gunes, S. (2018). The effects of shading treatments on the plant growth rate of some varieties of aster flowers (*Dahlia* spp.) in the ecologic conditions of Tokat (Turkey). Applied Ecology and Envıronmental Research, 16(5): 7191-7202.

URL-1. https://www.buyukcicek.com/ (Access date: 06.09.2019)

CHAPTER 11

THE USE OF *CHAMERION STEVENII* (BOISS.) J. HOLUB.) IN LANDSCAPE DESIGN

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INTRODUCTION

Plants are to play a functional role in protecting and supporting nature's functions to improve the environment we live in (Scarfone, 2007). Although this role of plants is taken into account in landscape design studies, using plants in a way to show their character and increase their beauty is indispensable for landscape art.

However, because of the climate crisis being lived in today, there is an increasing interest in species and varieties that are suitable for local climate and soil conditions and need less water than exotic species in the arrangement of green areas. And the use of species that have ecological and biological advantages besides aesthetic and ecologic features is to set the agenda in landscape works (Alp et al., 2020).

Even so, natural species should be evaluated primarily in terms of design elements such as size, form, line, texture and color. Because, plants that have features such as form, texture, odor and color create functional spaces that are dynamic and more livable both by appealing to our senses and by contributing to our satisfaction with the outdoor spaces we live in (Sarı & Karaşah, 2018).

On the other hand, planting designs play an important role to create an aesthetic, functional and ecologically sustainable landscape. This role is possible by using plant design criteria in harmony with each other (Booth, 1990).

Also, the sustainability of the landscape includes the harmony of the planting design in terms of ecological and functional aspects, mainly visual effects. Therefore, it is an important task to accurately investigate the aesthetic, ecological and functional characteristics of plants.

Thus, the use of natural plant species in sustainable landscape practices will play a significant role between ecological restoration and conservation biology, contributing to both the prevention of extinction and the success of landscape architecture studies. For this reason, endemic, endangered, rare and other flora elements within the biological diversity of our country gain special importance.

Thus, planting design both create a landscape in harmony with nature and become more aesthetically, ecologically and functionally effective by increasing plant diversity (Akdoğan 1972; Seyidoğlu, 2009). Also, a new identity is given to natural plant species as an ornamental plant.

In this study, it is aimed to contribute usage possibilities of *Chamerion stevenii* (Boiss.) J. Holub. taxa which is naturally distributed in our country as an aesthetic, ecologic and functional in landscaping studies by evaluating the observations in the field and the literature records.

MATERIAL AND METHOD

Material

The main material of study is the biological and ecological characteristics of *Chamerion stevenii* (Acem yakısı) which naturally spread in Turkey.

Characteristic Features of *Chamerion stevenii*

Stout much-branched perennial; stems 60-80 cm, leaves densely adpressed-canescent (rarely glabrous), linear-lanceolate, (4-8 mm) x (40-47 mm), entire or very obscurely denticulate, Inflorescence a lax compound raceme. Flowers erect in bud; petals 14-16 mm, deep pink or purple, styles c. as long as stamens. Capsule 5-6 cm; seeds 1-8-2, finely papillose. Fl. 7-9. (Table 1) (Davis, 1972; Stöcklin, 1999; Akbari & Azizian, 2006).

Table 1: Some characteristic features of *C. stevenii* (Davis, 1972; Stöcklin, 1999)

Height (cm)	Form	Shot	Flower	Flowering period	Leave	Fruit	Fruit period
60 - 80	Shrub	Adpressed canescent hairy	Pink	7-9	densely adpressed-canescent hairy	Capsule finely papillose	7 - 9

Habitat; semi-arid mountain plains, screes, gravelly slopes and especially dried river gravel, etc., 900-2000 m (Davis, 1972: Stöcklin, 1999) (Figure 1). But often seen in humid habitats (Makbul et al., 2017).

Figure 1: Habitat of *Chamerion stevenii* (Hakkâri) (Original by Mutlu)

Spread in Turkey; Hakkâri, Bingöl, Erzincan, Erzurum, Giresun, Sivas and Van (Figure 2).

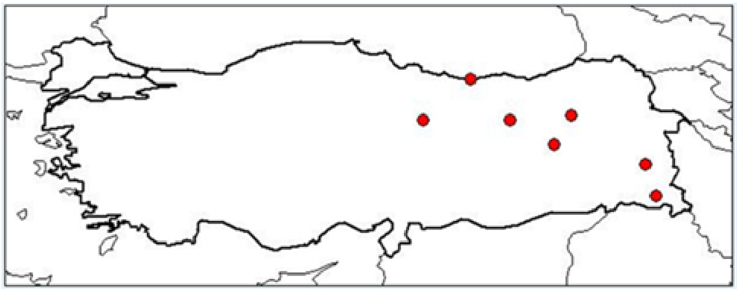

Figure 2: Distribution of *Chamerion stevenii* in Turkey (TUBIVES, 2019)

Distribution in the world; In Turkey (Anatolia, Northern Anatolia, Northeastern and Southeastern Anatolia), Iran (Iranian Azerbaijan), Armenia, Azerbaijan, Georgia (Caucasus) (IUCN, 2019).

Due to the size and number of the population, habitat quality and threats in habitat such as floods, *Chamerion stevenii* is evaluated at least concern category (LC) in Turkey (Makbul et al., 2017).

Method

In the study, observation, measurement and photographing method was used in the natural range of *C. stevenii* taxon within the borders of Hakkari province. Besides, information on flowering, foliation and form of *Chamerion stevenii* taxon were recorded.

The collected data were evaluated in terms of form, texture and color as Robinson (2004), Booth (1990), and Leszczynski (1999) suggested in planting design criteria. The aesthetic, ecological and functional usage possibilities of this species in landscape architecture applications have been determined by compiling in the previous studies about the species.

RESULTS

The evaluation of the characteristic features of *C. stevenii* in terms of design elements is given in Table 2.

Table 2: Evaluation of *C. stevenii* in terms of design elements

Size	Form	Texture	Color
Dwarf shrubs	Obconical	Medium	Pink flower canascent leaves and shoots

When Table 2 is examined;

Measure; *C. stevenii* which is in the dwarf bush group maintain its small dimensions when it grows it can serve as a low fence or low barrier in landscaping.

Form; Although it has a geometric form, the shoots open and sag as they mature (Figure 3).

Due to its predominant aesthetic linear form in winter, it can be placed on plain backgrounds or in front of the walls. It can create contrast combinations with ground cover plants.

Texture; Despite the dull appearance, dense canescent leaves, it can be described as medium textured due to the loss of shoots. Long stripe and gray hairy leaves can be used to contrast plants with green and small leaves.

Color; because of the pink cluster-shaped flowers lasting for about two months in July-September and the glamorous of gray hairy leaves and shoots of *C. stevenii* can be used in parks and gardens for ornamental purposes and depth to the field (Figure 3).

Figure 3: Characteristic and flower of representation of the *C. stevenii* form (Stöcklin, 1999) and its natural land appearance (Original by Mutlu)

Aesthetic Use

It is striking with its can ascent hairy leaves, pink flowers and form and it appeals to the eye. Due to these features, it can be considered in the creation of accentuated spaces, in parks and gardens, in waterside arrangements and stony or rocky places as an ornamental plant.

Functional Use

It can be preferred as a transitional plant in road works, especially in the transition from rural areas to cities or from cities to rural areas, as it is an abstinent species resistant to drought and cold.

It can be used to prevent headlight lights in the middle refuges because of branching from the ground and small structure, and for demonstration purpose in rock gardens and in parterre and borders as a boundary element or as a hedge plant in groups.

Because of spreading in sloping and pebbly arid slopes and dry riverbeds, it can be considered in the stabilization of slopes, in erosion control studies to prevent soil erosion and to stabilize water deposits. It can also play a functional role in the arrangement of stony streams and riverbeds.

It can be used in the establishment of forests (honey forest) for economic gain since the plant attracts some insects, mainly bees, and the extracts obtained from the plant are non-toxic (Granica et al., 2014). Considering the long flowering period, it can be a rich and long-term source of nectar.

Since in the study conducted by Averett et al. (1979), it was determined that the antioxidant properties of the flavonoids found in the leaves of *C. stevenii*, as well as the anti-inflammatory, antiviral, antiallergic, antithrombotic and other properties, have a protective effect on human health, it can be grown as a medicinal plant.

Ecological Use

Since it prefers sunny or slightly shaded areas in the areas where it grows naturally, in dry and cold or cold and humid areas it can be considered a solitary ornamental plant, In slope stabilization and erosion control works and the improvement of stream beds, it can be considered under other plants.

It is one of the best species to protect poor soil in barren areas. It can be used in fire-affected areas as it is a species that can survive in extreme conditions due to its seeds easily dispersed in the wind.

CONCLUSION

Most Chamerion taxa are invasive and few species are used as ornamental plants in a few countries. Although there is a natural distribution in Turkey, *C. stevenii* is not known sufficiently and not used in landscape works despite potential in terms of ornamental plants. However it stands out like a shrub that should be chosen in landscaping works in regions where cold and humid climates are dominant, with its habitat features as well as form, color effect, texture. *C. stevenii* can be a good border plant.

It can be used solitary in open areas or under oak forest and it is also to be chosen for large-scale rock gardens. They also look beautiful in rows on the roadside. Thus, it can serve to create sustainable parks by reducing maintenance costs in parks and gardens as well as adding wealth to urban spaces.

The transportation of this species from its natural distribution areas to the city will contribute to the recognition by the people of the city as an important plant, as an ornamental plant, as a healing plant and for the honey industry. Thereby developing consciousness of nature conservation and protecting the landscape environment.

Besides, *C. stevenii* is ethnobotanically the gene source of the future and has very valuable potential for the future as long as it is well known and protected. Therefore, its production in nurseries should be encouraged.

REFERENCES

Akbari, R. S. & Azizian D. (2006). Seed morphology and seed coat sculpturing of *Epilobium* L. species (Onagraceae Juss.) from Iran. TÜBITAK-Turk. J. Bot. 30: 435-440.

Akdoğan, G. (1972). Orta Anadolu Step Bitki Örtüsünde Bulunan Bazı Otsu Bitkilerin Peyzaj Planlamasında Değerlendirme İmkanları Üzerine Bir Araştırma. Köy İşleri Bakanlığı, Yayın No: 198, Toprak Su Genel Müdürlüğü Yayını, Sayı 282, Ankara.

Alp, Ş., Zeybekoğlu, E , Salman, A, & Özzambak, M . (2020). Doğal bitkilerin kültüre alınması süreci ve süs bitkisi olarak kullanılması. Bursa Uludağ Üniversitesi Ziraat Fakültesi Dergisi 34: 351-357.

Averett, J. E., Raven, P. H., & Becker, H. (1979). The flavonoids of Onagraceae: Tribe Epilobieae. American Journal of Botany, 66(10): 1151-1155.

Booth, N. K. (1990). Basic Elements of Landscape Architectural Design, Department of Landscape Architectural. Waveland Pres., Inc. Illinois, Ohio State University, USA, p. 315.

Davis, P. H. (1972). Flora of Turkey and The East Aegean Islands. Volume: 4, Edinburgh University Press, Edinburgh.

Granica, S., Piwowarski, J. P., & Czerwinska, M. E. (2014). Phytochemistry, pharmacology and traditional uses of different *Epilobium* species (Onagraceae): A review. Journal of Ethnopharmacology, 156: 316-346.

IUCN (2019). https://www.iucnredlist.org

Leszczynski, N. A. (1999). Planting The Landscape. John Wiley and Sons, Inc., London.

Makbul, S., Coşkunçelebi, K., & Okur, S. (2017). Contributions to biosystematic properties of *Chamerion stevenii* (Boiss.) Holub (Onagraceaea) in Turkey. 3rd International Conference on Environmental Science and Technology. 19-23 October 2017, Budapest, Hungary.

Robinson, N. (2004). The Planting Design Handbook, Second Edition. Ashgate Publishing Company, USA.

Sarı, D. & Karaşah, B. (2018). Bitkilendirme tasarımı öğeleri, ilkeleri ve yaklaşımlarının peyzaj tasarımı uygulamalarında tercih edilirliği üzerine bir araştırma. MEGARON, 13(3):470.479.

Scarfone, S. C. (2007). Professional Planting Design: An Architectural and Horticultural Approach for Creating Mixed Bed Plantings, John Wiley&Sons. Inc., Hoboken, New Jersey, p. 272.

Seyidoğlu, N. (2009). Bazı Doğal Geofitlerin Peyzaj Düzenlemelerinde Kullanımı ve Üretimi Üzerine Araştırmalar. Doktara Tezi, İ.Ü., Fen Bilimleri Enstitüsü, İstanbul.

Stöcklin, J. (1999). Differences in life hıstory traits of related *Epilobıum* species: Clonality, seed size and seed number. Folia Geobotanica, 34: 7-18.

TUBIVES (2019). http://www.tubives.com

CHAPTER 12

POTENTIAL OF SOME NATURALLY GROWN *ALLIUM* SPECIES AS AN ORNAMENTAL PLANT

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INTRODUCTION

Turkey is located in the temperate climate of Flora in three regions (Iranian-Turan, Mediterranea, Europe-Siberia) where there are more than 12,000 plants and is a suitable place for living of different species. The geographic factors in this region has potentially effects on species diversity. Alpine plants have found to grow in high elevations, while halophyte plant species grow mainly around salt lake, and drought resistant species grow well in central Anatolia without any forest cover (Avcı, 2005). Despite of diverse species which considered as ornamental plants, only limited certain species have been studied. Increasing the production, development, promotion and use of naturally growing plant species have been especially considered recently (Alp et al., 2020). Finding new species has promoted cultivation methods and led to the introduction of new products for global market.

Ornamental plants play an important role in agricultural products, and classified as indoor, outdoor, cut and natural onion plants (Karagüzel et al., 2010). This economically important sectorstarted with production of cut flowers in our country Turkey and developed along with rapid urbanization, changing life habits as well as cultural and aesthetics interests (Titiz et al., 2015). There are special considers on producing new species with new colors and tones and different uses, long flower life as well as resistance against diseases and pests. So, evaluation of native species and identification of potential species is very important. Due to high plant diversity, climatic conditions and production costs in our country, introducing new species in this sector might have many advantages (Erken & Özzambak, 2018).

Geophytes of Turkey constitute significant parts of the flora with wide distribution area and more thank 800 genera (Kamenetsky & Okubo, 2012). The *Allium* genus, as a member of geophytes belonged to the Amaryllidaceae family with more thank 800 species worlwide. Approximately, 170 species known in our country from this genus with around 40% endemic species (URL-1). *Allium* genus species are perennial herbaceous plants with bulbous and sometimes rhizome, known only food supply until the end of the 19th century but considered as ornamental plants in botanical gardens of Asia as well as Europe after 1870 (Balge et al., 2000). It is known that *Allium* species are produced in the Netherlands, Israel, France, Japan, England and America with around 26% of the total Dutch cut flower production (Karagüzel, 2016) and 20 commercially species as ornamental plants in America (Ottesen, 2014). Alp et al. (2006) showed that three *Allium* species (*Allium hirtifolium*, *Allium scabriscapum* and *Allium kharputense*) used as an ornamental plant in borders, gardens, as well as rock gardens areas in Turkey and reported that *Allium scabriscapum* can also be considered as a cut flower. Karagüzel (2005), investigated the cultivation and reproduction possibilities of three endemic *Allium* species (*Allium junceum* subsp. *tridentatum*, *Allium robertianum*, *Allium sandrasicum*) and reported that they can be used as ornamental plants.

Allium species have a lot of other uses as food, spice and medicinal purposes. Several studies indicated their antimicrobial, antiviral and antifungal effects of species (Dey & Khaled, 2015; Samani et al., 2015; Andalib & Yazdi, 2017; Hafeznia et al., 2018).

Table 1: Production and cultivated area of flower bulbs, ındoor and outdoor ornamental plants (TUIK, 2019)

Years	**Cultivated area (m²)**			**Produce amount (number)**		
	Flower bulbs	**Indoor ornamental plants**	**Outdoor ornamental plants**	**Flower bulbs**	**Indoor ornamental plants**	**Outdoor ornamental plants**
2014	567505	1081413	35995684	30059530	41448776	456026600
2015	612585	1465383	32293087	27200330	40810719	451142538
2016	597305	1312793	34877416	25337330	38150927	409239917
2017	426885	1650710	36263071	21833825	56049665	490559391
2018	493930	2081527	37306970	88657000	60149981	507183040
2019	412145	1992021	37699087	62537229	51669029	510558039

According to 5 years data reported of ornamental plants by Turkish Statistical Institute (TUIK) (Table 1), there is fluctuations in the cultivated area and production amounts of the species based on different years. In asthetic view, it is necessary to homogeneous production of these species due to verious features such as color scale and size.

In this chapter, *Allium* species, grows naturally and non-endemic in flora of Turkey, were reviewed. The brief information on altitude, flowering period, flower color, stem length, habitats and region where the species are distributed naturally summarized in Table 2 about.

1. USAGE AREAS OF *ALLIUM* SPECIES THAT CAN BE CONSIDERED AS ORNAMENTAL PLANTS

Ornamental bulbous plants with pleasent fragrance and color could be used as cut flowers in pots, as beauty landscaping in gardens as potted plants in homes. The majority of bulbous plants are used widely in parks and gardens as well as in natural habitats. Natural species that bloom in early spring or sometimes winter have been interpreted by people as a herald of spring. So, bulb flowers are one of the most popular flowers in the world and their popularity is increasing day by day (Atay, 1996). These species can be used as potted plants, cut flowers, dried flowers, garden plants, and rock plants (Kamenetsky & Fritsch, 2002). Despite of high diversity of *Allium* species in Turkey, only limited certain species are evaluated. One of the important factors in the cultivation of *Allium* species is its dormancy, which is effective in adaptation plants to different climatic conditions. Studies indicated that Gibberellin and Abscisic acid (ABA) hormones as well as hot or cold temperature treatments are effective on breaking dormancy (Tantan, 2019).

Allium species have diferent uses as rock gardens, indoor ornamental plants, outdoor ornamental plants, cut flowers, and dried flowers. Earlier studies show that *Allium neapolitanum*, *Allium oreophilum, Allium unifolium* can be used as potted plants; *Allium aflatunense, Allium sphaerocephalon*, *Allium giganteum, Allium robertianum*, *Allium sandrasicum* as a cut flower; *Allium karataviense*, *Allium moly* as rock garden plant; and *Allium cristophii* as dried flower (Davies, 1992; Bijl, 1994).

It was also reported that species which grow in rocky areas can easily grow in rock gardens and are suitable for Alpine climatic conditions such as *Allium szovitsii, Allium subhirsutum*, *Allium kunthianum*, and *Allium aucheri* (Sadabadi et al., 2016).

Some other species have been used as a dried flower for decoration purposes on New Year's Eve. Some others have both aesthetic and consumption purposes but not used commercially (Celik, 2017). They include *Allium vineale, Allium akaka, Allium giganteum*, *Allium porrum, Allium sativum* and *Allium ampeloprasum* species.

Although almost all *Allium* species have the potential to be used as cut flowers, but the stem length is a limiting factor. Five species (*Allium aflatunense, Allium caeruleum, Allium christophii, Allium gignateum* and *Allium sphaerocephelon)* are used commercially as cut flowers worldwide (Shukla et al., 2016).

2. *ALLIUM* SPECIES AS ORNAMENTAL PLANTS

Most of the ornamental plants are used indoors or outdoors and their homogenization is a question in many areas. For this purpose, it is important to use new species. There are more than 170 *Allium* species in our country, Turkey but few of them are considered as ornamental plants. Totally, 63 species are endemic and used in landscaping areas for interior decorations as well as ceremonies (URL-1). Natural habitats, growing regions, altitude, flower color, length, and blooming periods of *Allium* species are summarized in Table 2.

Cultivation of the specific species, farming in a suitable climate and habitats are the most important factors as diversity and economic inputs in the ornamental plants production sector (Koyuncu, 1979; Brullo et al., 2001; Kamenetsky & Fritsch, 2002; Özdemir & Altan, 2011; Behcet et al., 2012; Koyuncu & Bona, 2015; Ekşi et al., 2016; Fırat et al., 2018; URL-1,2,3,4,5. Also, images of some *Allium* species are given in Figures 1, 2 and 3.

Figure 1: Some *Alium* species grown in Van Yüzüncü Yıl University Medicinal Aromatic and Geophyte Garden (Original by Tuncturk, M.)

Table 2: *Allium* species, naturally distributed in the flora of Turkey, used as ornamental plants

Species	Region and Altitude (m)	Flowering period	Habitat	Flower color and Stem length (cm)	Evaluation format
***Allium albidum* Fıscher Ex Bieb. subsp. *caucasicum* (Regel) Stearn**	NEA; 1980-2100	July	Calcareous and granite areas facing South	White; 30	Flowerpot, rock garden
***A. szovitsii* Regel**	E and NEA; 2000-3215	July-September	Volcanic rocks, Alpine meadows, floodplains	Purple; 15-40	Flowerpot, rock garden
***A. scabriscapum* Boiss. Et Kotschy**	SEA; 1850-1900	June	Areas with eroded schist	Yellow; 15-50	Flowerpot, outdoor
***A. hymenorrhizum* Ledeb.**	NEA; 1250	July	Moist, jagged layers of rock	Lilack, pink; 50-105	Outdoor, Cut flower
***A. schoenoprasum* L.**	EA; 2000-3300	June-August	Alpine meadows, pastures, stream and lakeside, calcareous and shady cliffs,	Light purple, Dwarf: 10-20 Long: 25-60lilac;	The short one is flowerpot (10-20), long one outdoor (25-60)
A. subhirsutum	SWA; 0-1800	March-May	Rocky areas *Castanea* sp. and *Cupressus* sp. groves, maquis	White; 7-30	Flowerpot, rock garden
A. trifoliatum	SA; 0-915	March-May	Cultivated stony areas, shady shores,	Pink; 30 cm and above	Outdoor, Cut flower
A. cassium	SA; 1000-2800	June- July	Meadows, bushes, *Pinus* and mixed forests, maquis	White, light pink; 10-25	Flowerpot
A. neapolitanum	WA and SA; 0-1035	March-May	Meadows, maquis, rocky shadows	White; 30-45	Flowerpot, outdoor
A. zebdanense	NA; 1-1000	May- June	Rock crevices, stony terraces,	White; 45	Flowerpot, outdoor
A. roseum	SA, WA, EA and NA; 0-2000	April-May	Maquis, *Pinus* sp. and *Abies* sp. fields, stony areas, meadows, swamps	Light pink, lilac; 35-40	Flowerpot, outdoor
A. isauricum	SA; 1900-2020	June	Calcareous rockys	White; 24-31	Flowerpot, outdoor
A. triquetrum	NA; 850	July	Natural areas	White; 17-60	Flowerpot, outdoor
A. oreophilum	EA; 0-3500	July	Stony regions	Reddish pink; 30-75	Outdoor, Cut flower
A. cupani* subs. *hirtovaginatum	WA, SA; 10-2200	March-May	Calcareous cliffs *Pinus nigra* forests, alpine steppes	Whitish pink; 12-18	Flowerpot, rock garden
A. callidictyon	TA; 400-2800	June-August	Alpine steppes, cereal fields, *Quercus* thickets, calcareous rock areas,	Pinkish purple; 10-30	Flowerpot, rock garden, Outdoor
A. callimischon* subs. *haemostictum	SWA; 450-550	July-October	Stony slopes	White; 10-35	Flowerpot, rock garden
A. anacoleum	EA; 2400-3500	July-August	Grasslands dry rocky slopes,	Lilac, pink; 7-25	Flowerpot, rock garden
A. rubellum	EA; 0-1680	August	Steps	Pink; 25-40	Flowerpot, outdoor
A. moschatum	Thrace; 400-600	September	Dry and rocky slopes	Lilac; 10-30	Flowerpot, rock garden
A. frigidum	SWA; 800-2500	August - September	Calcareous lawns, stony mountain areas,	Pink; 8-22	Flowerpot, rock garden
A. kossoricum	EA;	June	Dry and rocky slopes	Whitish pink; 20	Flowerpot, rock garden
A. paniculatum* subs. *paniculatum	WA, CA and SA; 0-2000	June-August	*Juniperus nana* thickets, *Fagus* and	Light pink; 30-70	Outdoor, Cut flower

			Quercus groves, *Pinus* forests,		
A. paniculatum* subs. *fuscum	NA, CA and SA; 200-1500	July-September	Cultivated fields *Pinus brutia* and *Castanea* forests, dry open slopes,	Reddish brown; 75	Outdoor, Cut flower
A. paniculatum* subs. *villosulum	WA; 100-120	August - September	Vineyards, ruins, cultivated fields, fallow fields	Reddish brown; 30-70	Outdoor, Cut flower
A. chloranthum	SA; -	June-August	Dry slopes	Yellow; 25-35	Flowerpot
A. opacum	SA; 800-1660	May-August	Rocky areas	Yellow; 16-23	Flowerpot, rock garden
A. pallens* subs. *pallens	WA, SA and EA; 0-1560	May-August	Sea cliffs, *Pinus* forests, meadows, dry slopes, riverside	Whitish; 10-30	Flowerpot, rock garden
A. bassitense	SA; 150-1500	July-August	Calcareous slopes *Pinus halepensis* and *Pinus brutia* forests, scrub, meadow, maquis	Reddish purple; 30-50	Flowerpot, rock garden, outdoor
A. rupestre	NA; 760-2000	July-October	Stony and rocky slopes Hazelnut thickets,	Pinkish white; 17-35	Flowerpot, rock garden
A. djimilense	EA; 1700-3000	August	Steep slopes, Subalpine grasslands, rocky slopes	Lilac, pink; 15-22,5	Flowerpot, rock garden
A. kunthianum	NEA; 1700-2200	July-September	Steppes, Alpine openings, stony slopes	Reddish purple; 10-30	Flowerpot, rock garden
A. staticiforme	WA; 5-10	June	sandy areas, prairie	Pink to purple; 20	Flowerpot
A. flavum* subs. *flavum* var. *flavum	WA; 0-600	July	Stony areas, rocky slopes,	Yellow; 30	Flowerpot, rock garden
A. flavum* subs. *tauricum* var. *tauricum	NA, EA; 10-2500	May-August	Dry Stones, *Pinus brutia*, *Abies*, *Cedrus* and *Juniperus* forests, reeds,	Yellow; 30	Flowerpot, rock garden
A. pseudoflavum	TA; 300-2200	June-August	Calcareous areas, mountain steppes cultivated areas, dry and stony slopes, roadsides	Yellow; 20-50	Flowerpot, rock garden, outdoor
A. carinatum* subs. *pulchellum	Thrace; -	June-August	Steps	White; 45	Outdoor
A. stamineum	WA; 80-1600	June-July	Dry rocky slopes, *Pinus* groves, fallow fields, steppes	Purplish pink; 10-35	Flowerpot, rock garden,
A. myrianthum* var. *floribus albidis	WA, SA and CA; 0-1600	June- July	Volcanic and calcareous slopes, maquis, *Pinus brutia* and *Quercus* forests, scrub	Cream and white; 30-150	Outdoor, Cut flower
A. rupicola	SA; 150-2000	May	Cliffs, bushes, dry slopes,	Purple; 30-75	Outdoor, Cut flower
A. sativum	C; -	June-August	Cultivated land	Pink to purple; Up to 100	Outdoor, Cut flower
A. ampeloprasum	TA; 0-1300	May- July	Maquis *Pinus brutia* forests, , olive groves, cliffs, rocky steppes, bushes	White, Lilac, pink and green; 50-180	Outdoor, Cut flower
A. porrum	Thrace, SA; -	June- July	Cultivated land	Cream; Up to 90	Outdoor, Cut flower
A. bourgeaui* subs. *bourgeaui	SWA; 50-800	June-July	Rocky slopes, calcareous cliffs,	Pale green purple; 40-90	Outdoor, Cut flower
A. bourgeaui* subs. *cycladicum	SWA; 30-250	June-August	Rocky slopes, maquis cliffs, terraces	Pale green purple; 45-115	Outdoor, Cut flower

A. commutatum	NA and WA; -	June- July	Cliffs and calcareous regions	Purple, pink; 50-100	Outdoor, Cut flower
A.pseudoampeloprasum	SA; 2400-2500	June- July	Volcanic slopes and dry rocky	Purple, light pink; 40-60	Outdoor, Cut flower
A. atroviolaceum	TA; 5-2000	June- July	Vineyards fallow fields, fields and forest edges, cultivated fields meadows	Dark purple; 50-100	Outdoor, Cut flower
A. pustulosum	EA and CA; 1200-1900	June-August	Calcareous gravel	White; 20-60(-70)	Flowerpot, Outdoor, Cut flower
A. trachycoleum	SA and SEA; 1050-2100	June- July	Meadows, dry stony slopes, *Quercus* forests	Grayish white; 80	Outdoor, Cut flower
A. scorodoprasum* subs. *rotundum	NA and EA; 0-1400	May- June	Destroyed slopes, beaches, lawns fields, calcareous and clayey	Dark pink, lilac; 25-90	Outdoor, Cut flower
A. asperiflorum	EA; 900-1450	June	Meadows, slopes,	Purple; 15-35	Flowerpot
A. sphaerocephalon* subs. *Sphaerocephalon	WA, SA; 0-1550	June-July	Dry rocky slopes, eroded *Pinus halepensis* thickets, beaches, prairies	Maron to pink; 45-60	Outdoor, Cut flower
A. sphaerocephalon* subs. *trachypus	SWA; 280-1500	July	Calcareous cliffs	Maron to pink; 45-60	Outdoor, Cut flower
A. sphaerocephalon* subs. *arvense	SA; -	May-June	Cultivated and abandoned fields forests,	Maron to pink; 45-60	Outdoor, Cut flower
A. curtum	SA; 0-925	April- June	Bushes, prairies, dry stony areas,	Greenish lilac; 15-30	Outdoor, Cut flower
A. fuscoviolaceum	SA; 830-2510	June-V	Roadsides, dry stone slopes,	Dark purplish red; 40-70	Outdoor, Cut flower
A. phanerantherum* subs. *involucratum	SA; 800-2200	June-July	dry hillsides, on limestone and serpentine	Purple, purplish red; 70-100	Outdoor, Cut flower
A. vineale	NA and CA; 25-2650	June-August	Meadows, Alpine, swamps, river beds,	Purplish pink, lilac; 30-70(120	Outdoor, Cut flower
A. amethystinum	NWA, WA, SWA and CA; 10-1585	May- June	Calcareous rocky, *Pinus* forests, *Poterium* maquis, shady hills, prairies slopes,	Reddish purple; 50-100	Outdoor, Cut flower
A. guttatum* subs. *guttatum	NWA, WA and TA; 25-2400	July-August	Gravelly areas *Abies* forests, cliffs, rocky slopes, mountain steppes	Whitish green; 10-60	Flowerpot, rock garden, outdoor
A. guttatum* subs. *sardoum	NWA, WA, SA and EA; 5-2200	July-August	*Quercus* shrub, vineyards Conifer forests, rocky swamp, lawns	Whitish green; 10-60	Flowerpot, rock garden, outdoor
A. affine	SA and EA; 500-2000	June-August	Steppes *Pinus*, *Quercus ithaburensis* and *Quercus libani* forests, dry slopes	Pink; 30-80	Outdoor, Cut flower
A. aucheri	SA; 1800-2550	June-July	Summer pastures, meadows, dry grassy edges, wet areas	Violet, pink, purple; 40-70	Outdoor, Cut flower
A. junceum* subs. *junceum		April-May	Cliffs, rocky slopes, ruins	Purple; 8-25	Flowerpot, rock garden,
A. jubatum	NWA; 200-1000	May-June	Calcareous rocks	Purple; 15-40	Flowerpot, rock garden, outdoor
A. dictyoprasum	EA and SA; 100-3050	June-July	*Pinus halepensis* forest, salty regions, mountain	Dark purple Brownish green; 60-150	Outdoor, Cut flower

			steppes, volcano craters, rocky slopes,		
A. karyeteini	SA; 0-650	June-July	Barren slopes	Reddish; 20-60(-80)	Flowerpot, rock garden, outdoor
A. akaka	EA; 1650-3400	May-June	Steppes, volcanic gravel, volcanic rocks or swollen slopes	Lilac, purple, pink; 15 cm or longer	Flowerpot, rock garden, outdoor
Cristophii	CA; 2135	-	Mountain areas	Metallic violet; 30-45	Flowerpot, rock garden, outdoor
A. nigrum	WA, SWA and SA; 0-950	April-May	Grassy places, rocky slopes, prairie, sandy seaside	Green and white; 45	Rock garden, outdoor
A. atropurpureum	Trakya; -	May	Cultivated fields and field edges,	Dark Purple; 60-90	Outdoor, Cut flower
A. cyrilli	WA; 0-1240	May-June	Vineyards, cultivated fields, roadsides, river banks, clay soils	Purple; 50-60	Outdoor, Cut flower
A. chrysantherum	EA; 800-2150	May-June	*Quercus infectoria* and *Juniperus* area, prairies, grassy areas	Yellow, greenish; 50-80	Outdoor, Cut flower
A. cardiostemon	EA; 900-2800	May-June	Alpine thickets, *Quercus* forests, meadows, volcanic rocky or sandy slopes	Dark purple; 30-60	Outdoor, Cut flower
A. decipiens	EA; 770-2450	May-June	Loose moving cliffs, open lands, stony slopes, field edge	Lilac, Purple; 90	Outdoor, Cut flower
A. orientale	SA, CA and EA; 600-1870	April-May	Vineyards, slopes, calcareous hills, rocky areas, meadows,	Lilac; 10-50	Flowerpot, rock garden, outdoor
A. kharputense	SA and EA; 900-2000	May	Calcareous fields and slopes cultivated fields, grassy slopes	Cream or dirty white; 30-50	Flowerpot, rock garden, outdoor
A. asclepiadeum	SA; 500-2150	May-June	Hills, mountain vegetation	Whitish; 10-20	Flowerpot, rock garden
A. nemrutdaghense	EA; 2100	May	Mountain steppes	White; 12-20	Flowerpot, rock garden
A. aschersonianum	SA; 1500-1800	April	Calcareous areas	Reddish purple; 25-50	Flowerpot, rock garden
A. noeanum	SEA; 550-1150	April-May	Vineyards, calcareous fields, basaltic, rocks, and clayey soils,	Lilac, pink; 20-30	Flowerpot, rock garden
A. lycaonicum	CA and SA; 1000-2000	May-June	*Pinus pallasiana Pinus sylvestris* and *Pinus nigra* groves, meadows	Pinkish purple; 20-30	Flowerpot
A. hirtifolium	SEA; 1580-2600	June	Rocky volcanic slopes, meadows	Pinkish purple;80-100	Outdoor, Cut flower
A. schubertii	SA; 0-0	March - May	Alluvial soils, prairie,	Purple; 45-60	Outdoor, Cut flower
A. giganteum	SEA, EA; 1439-2030	July	Rocky slopes	Pink; 80-200	Outdoor, Cut flower

(NEA: Northeast Anatolia, SEA: Southeast Anatolia, SWA: Southwest Anatolia, EA: Eastern Anatolia, SA: Southern Anatolia, WA: Western Anatolia, NA: Northeast Anatolia, TA: Terrestrial Anatolia, CA: Central Anatolia, C: Common)

Figure 2: *Alium* species that can be used as ornamental plants (a. *A. giganteum,* b. *A. akaka*, c. *A. kharputense,* d. *A. Scorodoprasum*, e. *A. vineale*, f. *A. sintensii*) (Original by Tuncturk, M.)

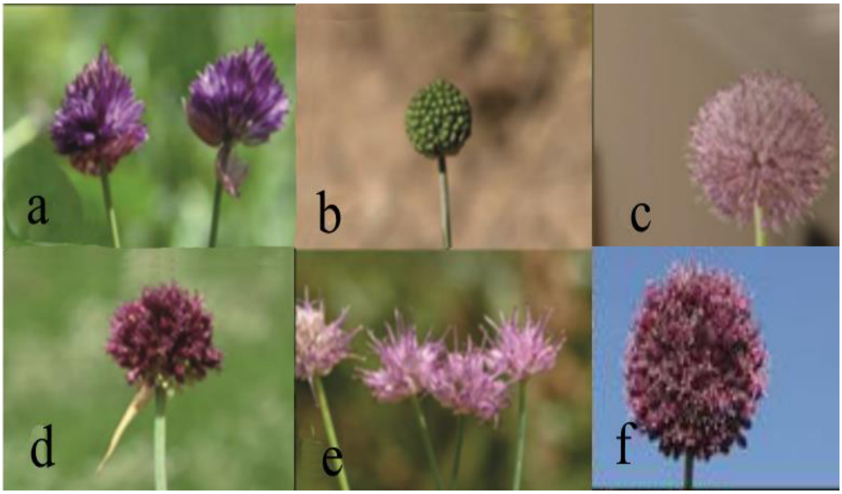

Figure 3: Some species of *Allium* growing naturally (a. *Allium aucheri,* b. *A. dictyoprasum*, c. *A. pseudoampeloprasum*, d. *A. scorodoprasum* subsp. *rotundum,* e. *A. szovitsii,* f. *A. atroviolaceum*) (Fırat, 2015)

CONCLUSION

Despite of high diversity of flora in Turkey for different purposes (food, shelter, ornamental plants, medicine, etc.), however the number of accessible plant species are very limited. One of the most important reason could be the migration process from the villages to the urban areas. Most of the people preferred using of exotic species rather than native species in ornamental plants production sector. Also, most of the studies in this field are focused on cut flowers.

Considering different climatic zones as well as soil characteristics in the regions, it has been observed that the genus Allium with its high diversity can be used as an ornamental plant. There are species that have the potential to be used as ornamental plants in indoor and different open green areas. These species need to be considered for propagation in ornamental plants production sector. Regarding bulbous plants used in open green areas in Turkey, the bulbs of most known species are generally imported from abroad. So, finding new methods for cultivation of Allium species with high varieties will add novel results and innovation to this sector especially decreasing foreign dependency imports. The potential of using naturally grown and non-endemic Allium species in pots, cut flowers, rock gardens, indoor and outdoor areas as well as studies on growing conditions have been investigated and observed that it can be grown in suitable regions of the country based on habitats, flowering dates, and the altitude

REFERENCES

Alp Ş., Koyuncu, M., & Aşur F. (2006). A Study on the usability of three *Allium* species *Allium hirtifolium, Allium kharputense* and *Allium scabriscapum* as decorative plants. III. National Ornamental Plants Congress, 8-10 November 2006, İzmir, 154-160.

Alp, S., Zeybekoglu, E., Salman, A., & Ozzambak, M. E. (2020). The development and cultivation of wild plants and using as ornamental plant. Bursa Uludağ University Journal of Agriculture Faculty, 34(Special issue): 351-357.

Andalib, S. & Yazdi, N. A. (2017). Anti-inflammatory Effect of *Allium akaka* extract on the inflammation induced by carrageenan in rats. Research Journal of Pharmacognosy, 4(Supplement): 22-22.

Atay, S. (1996). Soğanlı Bitkiler, Türkiye'den İhracatı Yapılan Türlerin Tanıtım ve Üretim Rehberi. Doğal Hayatı Koruma Derneği, İstanbul.

Avcı, M. (2005). Diversity and endemism in Turkey's vegetation. Geography Journal, (13): 27-55.

Balge, R., Gill, S., Blessington, T., Ross, D., Rosenkranz, G., & Bosmans, R. (2000). Production of *Allium* as Cut Flowers. Illustrations by Raymond V. Bosmans, Maryland Cooperative Extension Servise, Fact Sheet, p.19.

Behcet, L., Kaval, I., & Rüstemoğlu, M. (2012). Three new records for Turkey: *Allium giganteum* (Liliaceae), *Grammosciadium scabridum*, and *Ferulago angulata* subsp. *carduchorum* (Apiaceae). Turkish Journal of Botany, 36(6): 637-643.

Bijl, J. R. (1994). *Allium*—Flowering onions. Herbertia, 50: 88-94.

Brullo, S., Guglielmo, A., Pavone, P., & Salmeri, C. (2001). Cytotaxonomical notes on some rare endemic species of *Allium* (Alliaceae) from Greece. Caryologia, 54(1): 37-57.

Celik, F. (2017). The ımportance of edible landscape in the cities. Turkish Journal of Agriculture - Food Science and Technology, 5(2): 118-124.

Davies, D. (1992). Alliums. The Ornamental Onions. Timber Press.

Dey, P. & Khaled, K. L. (2015). An Extensive Review on *Allium ampeloprasum*: A magical herb. Int. J. Sci. Res., 4(7): 371-377.

Ekşi, G., Koyuncu, M., & Özkan, A. M. G. (2016). *Allium ekimianum*: A new species (Amaryllidaceae) from Turkey. PhytoKeys, (62): 83.

Erken, K. & Özzambak, M. E. (2018). Cultivation of natural plants from forest to garden, 4th International Non-Wood Forest Products Symposium, 4-6 October, Bursa/Turkey.

Fırat, M. (2015). The ethnobotanical usage of some East Anatolian (Turkey) *Allium* L. species. Manas Journal of Agriculture Veterinary and Life Sciences, 5(1).

Fırat, M., Koyuncu, M., & Ekşi, G. (2018). *Allium pervariensis*, sect. *Allium* (Amaryllidaceae), a new species from Siirt Turkey. Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology, 152(3): 305-310.

Hafeznia, B., Anvar, S. A., Kakoolaki, S., & Choobkar, N. (2018). Antimicrobial efficiency of *Allium atroviolaceum* extract on rainbow trout in different temperature and storage time. Iranian Journal of Aquatic Animal Health, 4(2): 86-94.

Kamenetsky, R. & Fritsch, R. M. (2002). Ornamental *Alliums*. In: *Allium* crop science: Recent Advances, Chapter: 19., Rabinowitch, H. D. & Currah, L. (eds), p. 459.

Kamenetsky R. & Okubo H., (2012). Ornamental Geophytes: From Basic Science to Sustainable Production. CRC Press, 597.

Karagüzel, Ö. (2016). Using as ornamental plants of *Allium* species. Derim, 19(1): 16-19.

Karagüzel, Ö. (2005). Investigation on Propagation and Domestication Possibilities of Thhree Endemic *Allium* Species (*A. junceum* subsp. *tridentatum, A. robertianum, A. sandrasicum*) Native to Antalya as Potential Floricultural Crops. Master Dissertation, Akdeniz University, Antalya.

Karagüzel, O., Korkut, A. B., Özkan, B., Çelikel, F. G., & Titiz, S. (2010). Current situation of ornamental plants production, development possibilities and targets. TMMOB Ziraat Mühendisleri Odası, Ziraat Mühendisliği VII. Teknik Kongresi, Ankara, 539-558.

Koyuncu, M. (1979). Species of *Allium* newly recorded from Turkey I. Sect. *Allium*. Ankara Üniversitesi Eczacılık Fakültesi Dergisi, 9(1):45-53.

Koyuncu, M. & Bona, M. (2015). *Allium phanerantherum* subsp. *involucratum* (Amaryllidaceae), a new subspecies from Turkey. Bangladesh Journal of Plant Taxonomy, 22(2): 143-146.

Ottesen, S. (2014). Ornamental *Alliums*. The American Gardener. www.ash.org.

Özdemir, C. & Altan, Y. (2011). Morphological and anatomical ınvestigations on three *Allium* L.(Liliaceae) species of East Anatolia, Turkey. Bangladesh Journal of Botany, 40(1): 9-15.

Sadabadi, R. F., Zeynalov, Y., Rezaeieh, K. A. P., & Molaei, P. (2016). Ornamental plants of Ararat Mountain flora used in rock gardens. VI Ornamental Plants Congress, 19-23 April 2016, Antalya.

Samani, B. H., Khoshtaghaza, M. H., Lorigooini, Z., Minaei, S., & Zareiforoush, H. (2015). Analysis of the combinative effect of ultrasound and microwave power on saccharomyces cerevisiae in orange juice processing. Innov. Food Sci. Emerg. Technol., 32: 110-115.

Shukla, A., Ramteke, V., Kashyap, S., & Netam, M. (2016). Productıon Of *Alliums* as cut flowers. Innovative Farming, 1(4): 200-204.

Tantan, S, Kasım, R, & Kasım, M. (2019). Dormancy and flowering of *Gladiolus, Freesia* and *Lily* from bulbous ornamental plants. Kocaeli University Journal of Science, 2(2): 83-93.

Titiz, S., Çakıroğlu N., Yıldırım T. B., & Çakmak S. (2015). Developments in Ornamental Plants Production and Trade. Turkey 5. Technical Agricultural Engineering Congress, Ankara.

TUIK (2019). Turkish Statistical Institute (Access date: 20.10.2020)

URL-1. http://194.27.225.161/yasin/tubives/index.php. (Access date: 20.10.2020)

URL-2. https://www.pacificbulbsociety.org/pbswiki/index.php?n=Main.HomePage&action =search&q=allium. (Access date: 20.10.2020)

URL-3. https://www.turkiyebitkileri.com/en/photo-gallery/view-album/6106.html. (Access date: 20.10.2020)

URL-4. http://www.vanherbaryum.yyu.edu.tr/. (Access date: 20.10.2020)

URL-5. https://en.wikipedia.org/wiki/Allium. (Access date: 20.10.2020)

CHAPTER 13

GERBERA(*GERBERA JAMESONII* L.); HISTORY, CLASSIFICATION, VASE LIFE AND POSTHARVEST TREATMENTS

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INTRODUCTION

The ornamental plant is used as in general terms; it is the name given to the plants in which the flower, leaf, branch, fruit, or directly the plant itself comes to the fore visually and is grown for this purpose (Anonymous, 2020a). Flower, which has been used for centuries to meet aesthetic needs and to show love, has become an important sector in the economic development of countries with started to use in the landscape nowadays. In addition to their aesthetic appearance, ornamental plants have also many benefits such as preventing air pollution by holding dust, reducing noise pollution by shielding the sound, and preventing erosion by keeping the soil with root systems (Salman, 2018).

In general, the concept of ornamental plants is examined in four main groups. These are;

i) ***Cut Flowers:*** These are flower branches obtained by cutting from the mother plant, used live in fresh flower bouquets, baskets, garlands or used in their dried or bleached form (Anonymous, 2020b).

ii) ***Indoor (Potted) Ornamental Plants:*** It is the general name given to plants grown for indoor use in pots and similar containers (Anonymous, 2020b).

iii) ***Outdoor (Design) Ornamental Plants:*** It is the general name given to the plants that include trees, shrubs, ground cover, seasonal annual and perennial flowering plants and grown for use in outdoor landscape designs (Anonymous, 2020b).

iv) ***Flower Bulbs (Geophytes):*** It is the general name of plants whose bodies have undergone metamorphosis as tubers, rhizomes, onions or corms and found under the ground (Anonymous, 2020c).

The importance of ornamental plants began to be noticed around the world in the early 20th century. Today, the industry is rapidly changing and developing in the world. According to AIPH Statistical Yearbook 2018 data, cut flower and potted plants production areas in the world: Asia / Pacific 480 000 ha; Europe 60 000 ha; Central / South America 30 200 ha; 18 000 ha in Africa and 6 200 ha in the Middle East, and it shows distribution as 650.000 ha in total (Anonymous, 2020d).

The production of ornamental plants in Turkey shows a wide range of distribution. Among the reasons for this, it can include that Turkey has advantages such as favorable climatic conditions for production, geographical structure, low cost to have production, its proximity to countries that would be done exports or imports (Anonymous, 2020d). The production area of ornamental plants was 51 802 644 m^2 in Turkey in 2018, whereas it increased to 52 477 362 m^2 in 2019, and it was corresponds rising by almost 7%. When the production areas are examined according to the product groups in 2019, it is seen that it is 12 374 109 m^2 for cut flowers, 1 992 021 m^2 for indoor ornamental plants, 37 699 087 m^2 for outdoor ornamental plants, and 412 145 m^2 for flower bulbs (TUIK, 2019).

The gerbera cut flower has an important rank in world trade due to the large number of varieties and the relatively long vase life. Gerbera ranks fifth after rose, chrysanthemum, tulip and lily among the most preferred cut flowers in the World (Figure 1, Royalfloraholland, 2016).

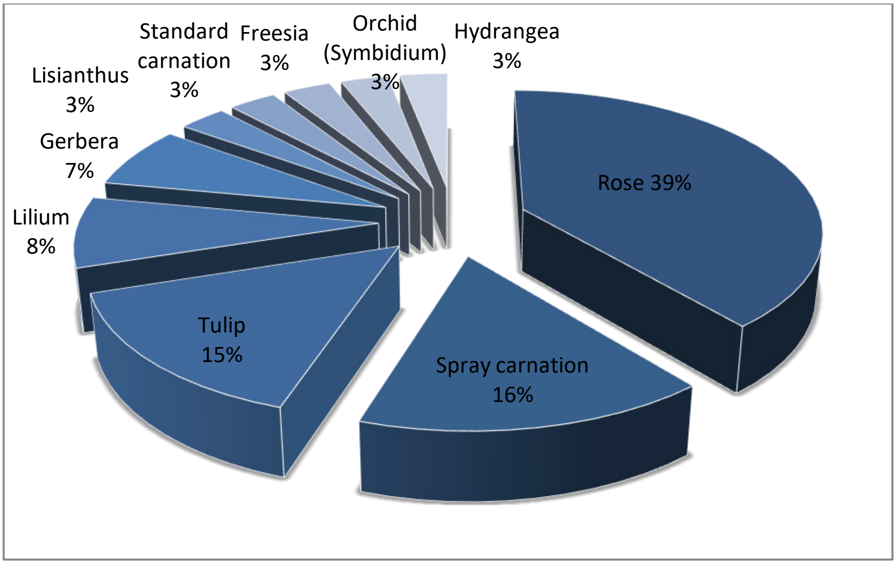

Figure 1: Cut flowers that rank in the top ten in world flower trade (TUIK, 2017)

The total ornamental plant production area of Turkey is 48,438 da, and the share of cut flower in this total production is 11, 949 da. Gerbera cut flower ranks third in terms of production area and second in terms of production amount among 18 different cut flower species produced (Figure 2-3, TUIK, 2017). Although the use of cut flowers in the world is significantly high depending on the quality of life and standards, the value given to the use of cut flowers is also increasing in our country.

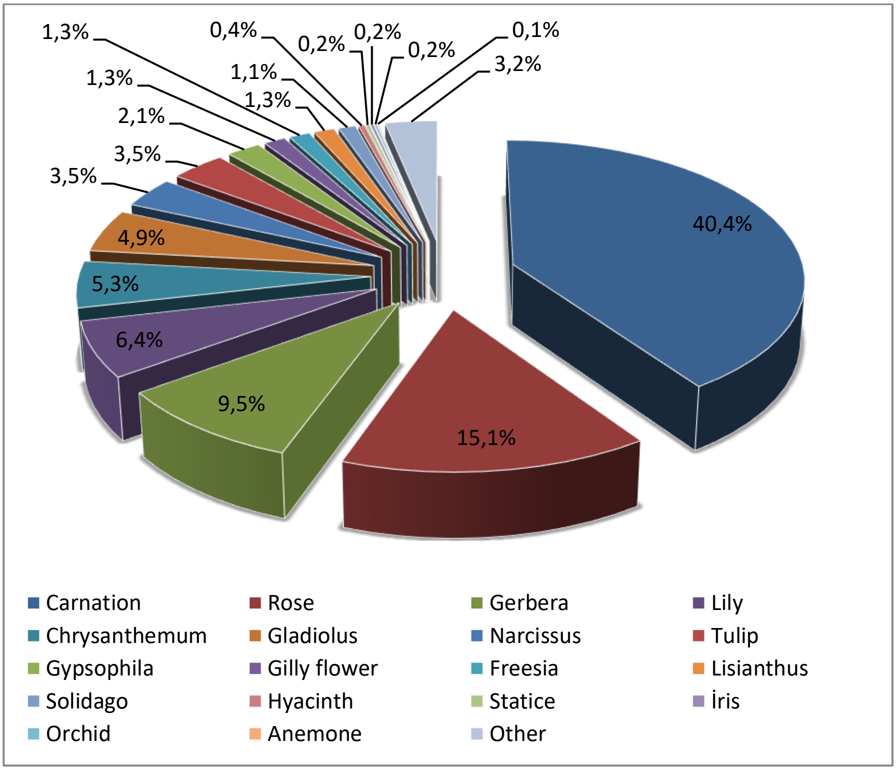

Figure 2: Share of gerbera in cut flower production area of Turkey (TUIK, 2017)

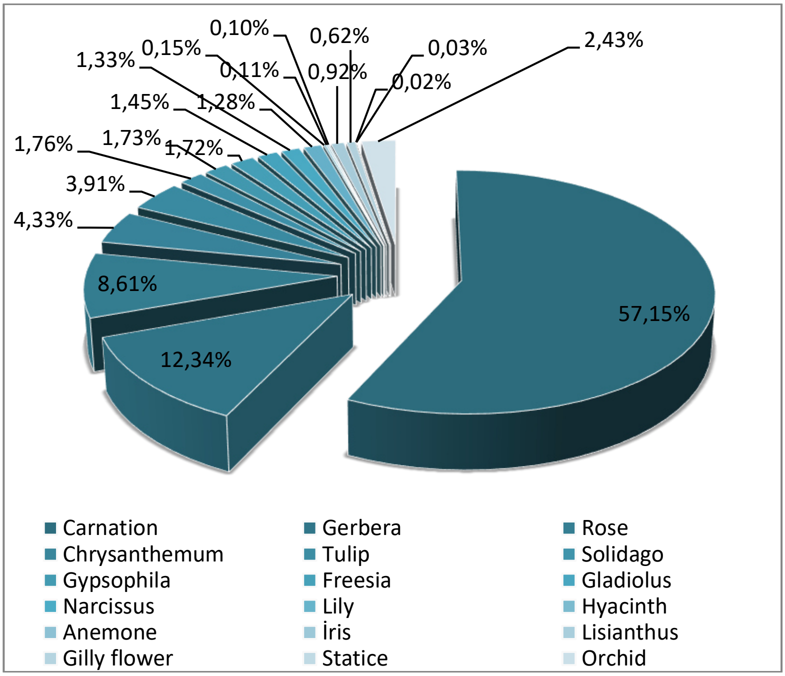

Figure 3: The production amount of gerbera in cut flower production of Turkey (TUIK, 2017)

1. HISTORY

Gerbera, which is commonly known as the Transvaal daisy or Barberton daisy, belongs to the Asteraceae (Compositae) family. Gerbera (*Gerbera jamesonii* H. Bolus ex. Hooker) flower got its genus name from Traugott Gerber who is German botanist and medical doctor (Salunkhe et al., 1990; Ambrosius, 2003; Cardoso & Silva, 2013). The Scottish Captain Robert Jameson first discovered the gerbera flower close to Barberton where in the Transvaal region of South Africa in 1884, and the flower has taken the jamesonii-species name from the captain.

Captain Jameson donated the plants to the Durban Botanical Garden. Later, John Medley Wood, the garden's director, sent the flowers to the Royal Botanic Garden in Kew in England in 1888. He proposed the scientific naming of flowers as *Gerbera jamesonii* and gerbera began to be used as a commercial product in the 1930s (Rogers & Tjia, 1990; Tourjee et al., 1994; Kumar et al., 2010). The first official visual description of *Gerbera jamesonii*, whose natural distribution areas are Africa, Madagascar, tropical Asia and South America, was made by J.D. Hooker (for Curtis Botanical Magazine) (Figure 4).

Figure 4: First color drawing of barberton daisies (a), Botanical Magazine, Plate 7087, 1889 (Gerbera Lab, 2020), Today's commercial gerbera varieties (b)

2. CLASSIFICATION

Gerbera jamesonii species belongs to order of Asterales (Compositae), family of Asteraceae and the genus of gerbera (Table 1).

There are about 40 woody and perennial species include in the Gerbera genus (Jamshidi et al., 2012), and the only species *Gerbera jamesonii* L. has been produced of these (Brickell & Zuk, 1997). The flowers of gerberas, a stunted herbaceous perennial plant, are known as head or capitulum.

Table 1: The classification of gerbera (USDA, 2020)

Kingdom	Plantae	Plants
Subkingdom	Tracheobionta	Vascular plants
Superdivision	Spermatophyta	Seed plants
Division	Magnoliophyta	Flowering plants
Class	Magnoliopsida	Dicotyledons
Subclass	Asteridae	
Order	Asterales	
Family	Asteraceae	Aster family
Genus	Gerbera J.F. Gmel.	Transvaal daisy
Species	*Gerbera jamesonii* sp.	Barberton daisy

The important varieties of gerberas have a large capitulum consisting of yellow, orange, white, pink or red ray flowers (Figure 4b). Gerbera's becoming a popular flower is due to its perfect shape and these colors, which attract the attention of the consumer (Nair et al., 2003; Solgi et al., 2009). In today's flower markets, there are gerbera flowers of different sizes that can meet the preferences of the consumer. The diameter of the gerbera flower starts from 5 cm in the smallest ones and reaches 15 cm in the largest ones. Mini-gerbera flowers with flower diameters of about 7-9 cm covered 70% of the flower markets (Stravers & Van, 2008; Acharyya et al., 2012; Esendam, 2014). Gerbera flowers consist of three different florets, which are ray, trans, and disc floret (Figure 5; Gerbera Lab, 2020).

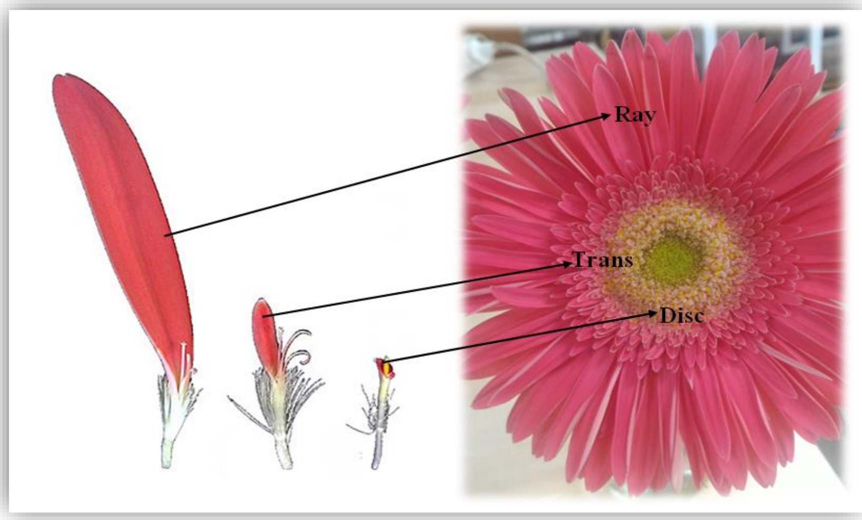

Figure 5: The names of the florets in the gerbera cut flower

Table 2: Classification of gerberas according to flower form

Class	Structure of ray floret	Structure of disc floret
Single	Not overlapped single row	Green centered
Folded/double	Double row overlapped	Green, black or red centered
Crested double	One or several rows of shorter ray flowers with two overlapping rows	Green, black or red centered
Full crested double	Multiple rows of comprising ray florets, which getting smaller and smaller towards the inside of the flower.	Disc flower not prominent
Quilled full crested double	Rows of split ray florets overlapping smoothly with fine-textured appearance.	No disc flower

Also, gerbera can be classified into five groups according to the floret form. These; single, folded or double, crested doubles, full crested double, and quilled full crested doubles (Table 2; Tjia et al., 1991).

3. POSTHARVEST QUALITY OF GERBERA CUT FLOWER

The beauty or quality of the gerbera cut flower is directly related to the freshness of the flower for a long time without losing its aesthetic appearance. However, time of maintain the quality of gerbera flowers after harvest is not long enough to satisfy the consumer. The vase life of a gerbera cut flower is short due to the bending of the flower stalk, which is called "scape bending". Because stem bending causes the flower to age before natural senescence process. Therefore, the post-harvest life of gerbera varies between 1-4 weeks depending on the variety, post-harvest processing method and conditions (Acharyya et al., 2012). However, in a study, the shelf life of gerbera flowers harvested in the optimum period and kept in hot climates and in non-refrigerated conditions was determined as 14 days (Hannweg, 2008).

Since gerbera flowers rapidly lose quality due to water loss after separation from the mother plant (Halevy & Mayak, 1981), it is important to uptake of the lost water firstly. Therefore, it is important to use preservative solutions containing appropriate metabolites together with water as a vase solution. After the flowers are placed in the vase solution, they should be cooled quickly and precautions should be taken to prevent stem bending, especially for gerbera. Postharvest quality of gerbera cut flowers is affected by the factors explained below.

3.1. Harvest

One of the most important issues for preserving the post-harvest quality of gerbera cut flowers is to determine the harvest time correctly. In the studies to determine the harvest time of Gerbera; The opening of bisexual disc florets, which is in 1-3 rows in the gerbera capitulum has been determined as the optimum harvest time (van Meeteren, 1978a; Reid, 2004). Because at this stage, although the flower stalks are not fully mature structurally, the flowers have reached their final size (Steinitz, 1983; Wernett et al., 1996).

Commercial harvest criteria for the majority of Gerbera varieties are defined as the period when the stamens of the florets in the two outer rings on the capitulum mature (Rogers & Tjia, 1990; Hannweg, 2008; Shoub, 2013). It is preferred that the flower stalk be breaken as twisting during the harvest of Gerbera because the cutting leaves old parts on the plant, making the plant vulnerable to disease-causing organisms (Perik et al., 2012). The best way to harvest the flower is to tear off the flower stalk from the lowest node without damaging the plant (Salunkhe et al., 1990; Shoub, 2013).

3.2. Respiration Rate

Cut flowers are alive and breathing after harvest. The higher the increase in respiration rate, the shorter the flower's lifespan. The most effective way to reduce the respiration rate is to lower the temperature of the atmosphere in which the flower is located. It has been determined that the respiration rate of Gerbera (Hook. f. 'Vesuvio' *Gerbera* *jamesonii* H. Bolus) cut flowers increases exponentially with increasing storage temperature. In addition, it was found that the negative gravitropic bending of the flower stalk increased even more while the vase life decreased during transportation after the storage at high temperatures. Besides, it was stated that stem bending and vase life of gerbera after dry storage showed quite distinct negative and positive linear relationships, respectively with the respiration rate during storage. According to these results, it has been revealed that it is important to store the gerbera cut flower at low temperatures during commercial processing and transportation in order to extend the vase life (Çelikel & Reid, 2002).

3.3. Storage Temperature and Relative Humidity

The ideal growing temperature for different gerbera varieties and the ambient temperature during the post-harvest period during the vase life were determined as 24ºC/15ºC the day/night duration (Davarynejad et al., 2008, Esendam, 2014; Reddy, 2016). It has been stated that stalk bending occurs in flowers at temperatures below and above these temperatures, and also this negatively affects the quality of the flower (Davarynejad et al., 2008).

It has been found that the ambient humidity to maintain the quality of the flowers should be below 70% during the day and 85% at night. (Reddy, 2016). Gerbera described as a day-neutral plant in terms of its response to day length. Day length has no significant effect on flower development. Gerbera flowers can bloom for 8-16 hours of light conditions (Yan, 2016).

3.4. Variety

Although the post-harvest life of flowers differs between species, it also varies according to varieties within the same species. The vase life of the varieties determined by applying basic loading (600 ppm HQS, 300 ppm citric acid, and 4% sucrose) in twenty-one different gerbera varieties. The results showed that there are significant differences between ion leakage, stem bending, vase life, and water uptake. As a result of the study, the vase life of Tropik Blend, Cacharel, and Aventura varieties was found to be maximum, whereas Onedin, Ecco, and Entourage varieties were minimum (Javad et al., 2011).

The reason for the difference in vase life between varieties is related to the stem strength. Especially in gerbera flowers, the stem bending after dry storage shows the structural strength of the stem. In general, the stem bending rate of flowers is declined with the rising strength of stems. However, if the appropriate post-harvest treatment that maintains the turgor of the stem made, the importance of the structural strength of the stem decreased (De Jong, 1978).

3.5. Cultivation Season of Varieties

Although Gerbera varieties have different vase life, the growing season also affects this duration. In a previous study, it has been shown that the longest vase life obtained in winter grown varieties with 18.37 days. Also, it stated that it has followed by varieties grown in spring (14.8

days) and autumn (9.57 days) seasons. Also, when considering the interaction of the variety and season, it was determined that the vase life of the Sunway variety, which was grown in the winter period, was the longest meanwhile, the shortest vase life was in the Malibu and Primrose varieties (5.7 and 7.8 days, respectively). In contrast, stem length and flower diameter were highest (57.88 cm and 10.78 cm, respectively) in flowers grown in autumn, whereas stem diameter was highest in those grown in spring with 0.64 cm. It was observed that the water uptake the flowers grown in winter has the highest (34.9 mL) and followed by the spring and autumn (34.7 and 26.14 mL, respectively) seasons (Acharya et al., 2010).

3.6. Stem Bending

Gerbera jamesonii, which is one of the most popular cut flowers, and its flower have different shapes and glamorous colors. However, the vase life is short due to the bending of the flower stalk. Stem bending occurs due to the insufficient development of sclerenchyma cells during the elongation of the flower stalk. So, this phenomenon causes the flower to lose its turgor because of water uptake declining (Perik et al., 2012).

For this reason, increasing the turgor in the flower stalk to prevent stem bending is very important in terms of extending the vase life of flowers. The vase life of gerbera (12.32 days) that placed preservative solution comprising 8-HQS + 20 ppm $AgNO_3$ + 5% sucrose was higher than those of control (4.56 days).The synergistic effect of 8-HQS and

$AgNO_3$ significantly preserved tissue water potential and reduced stem bending. The fact that the total sugar content of the capitulum is higher than that of the flower stem causes the osmotic pressure of the capitulum to increase. Thus, the flowers absorb more water and maintain their turgor. The harmonious combination of 200 ppm 8-HQS + 2 ppm $AgNO_3$ 20 + 5% sucrose resulted in a decrease in sugar, protein, and peroxidase activity, leading to a significant vase life increase of gerbera flowers (Prashanth & Chandrasekar, 2010).

It has been found that stem bending of gerbera is partly due to blockage of the xylem by bacteria, as well as lack of osmotic pressure and loss of firmness. Also, it stated that this caused leading to early loss of turgor. Stem bending can be delayed by pulsing or holding treatments after harvest, which providing the turgor of flower stalk, and preventing bacterial growth. Also, antimicrobial compounds and surface disinfectants, which prevent xylem blockage, together with sugars, inorganic ions, and chemicals that affect cell wall firmness can be used for this purpose. Chlorine and silver-containing antimicrobial compounds have not been effective in preventing stem bending while pH 3.0-3.5 buffer has prevented bacterial growth and delayed bending. Similarly, disinfectants with antimicrobial activity were not effective in preventing bending, but they were delayed bending when used with sugar.

Calcium applications, also maintain the firmness of the cell wall and delay stem bending. Because both calcium ions and H^+ concentration affect cell wall firmness. Vanadate, which preventing H^+ transport in the cell wall, effectively prevented stem bending but caused undesirable discoloration of the petals. Conversely, fusicoccin, which stimulates H^+ transport, significantly accelerated bending. Gerbera flowers were pulsed with calcium chloride (50 mM) + sucrose (25 g/L) + citric acid (pH 3.5), and a chemical mixture with buffered K_2HPO_4 for 24 hours. After that, the flowers were placed in a vase at room temperature after stored dry for 24 hours at 20ºC. This treatment was delayed stem bending of Tamara and the other six varieties during the vase life (Perik et al., 2014).

3.7. Bacterial Blockage

Bacteria that grow in the vase solution block the xylem vessels, preventing water uptake of the gerbera flowers. While bacteria damage the visual quality of the flower, they also cause rapid senescence due to the toxins they secrete (Ajinkya et al., 2018). Bacteria can pass from the hairy surfaces of Gerbera into the vase solution and proliferate there. Xylem vessel blocked and the vase life of flowers shortens as a result of the rapid proliferation of bacteria in vase solution. However, a low correlation had been stated between bending time and the bacteria count. Therefore, it has been thought that the stem bending was likely correlated with toxicity on the stem surface and xylem blockage caused by dead stalk cells (van Doorn & de Witte, 1994; Schouten et al., 2018).

3.8. Water Uptake

In Gerbera flowers, water uptake occurs in two ways, directly from the cut surfaces and indirectly through the gap in the stem. The stalk breakage occurs as a result of preventing direct water uptake due to the high bacteria amount in the vase solution. Therefore, the long stay of cut flowers in the vase solution is directly correlated with the water uptake rate of them. The fresh weight of the gerbera flowers in the vase decreases 3 days before the stem break occurs, which is due to the inability of the flowers to absorb water. Water potential decreased in the petals of gerbera flowers showing stem breakage, while it remained constant in flowers without stem breakage. It is needed that to prevent stem breakage and accelerate the water uptake of the flowers, sodium hypochlorite or silver nitrate pre-treatment should be done, silver nitrate or diclofenac should be added to the vase solution, and also the flower stem should be recutting in water. The stem breakage rate varies significantly depending on the cultivation of gerbera flowers in winter or summer (van Meeteren, 1978b).

The composition of the vase solution is one of the most significant factors affecting the water uptake of flowers. Although the water absorption rate of the flowers is high right after the flower cut, it gradually decreases. Flow resistance of the flower stalk of gerbera increased while the absorption rate, fresh weight, relative petal dry weight, relative petal water content, and the water potential of the petal decreased four days after the silver nitrate solution was introduced. If the pH of the vase solution is kept constant at 3.5, the flow resistance of the stem has decreased. In this case, the fresh weight, dry weight, relative water, and content of petal increase since the absorption rate are higher than the transpiration rate (van Meeteren, 1978b).

Increasing the water uptake rate is prevented stem bending and increases the vase life of gerbera flowers. In a study, it was found that there are significant differences found between vase life (10-18 days) and stem bending percentage (0-100%) with average water uptake. Consequently, this result shows that there is a close relationship between water uptake and vase life and stem bending. Besides, in the study, it was found that the varieties with high water uptake rates had less stem bending and longer vase life (Javad et al., 2012).

The reason for stem bending, which is thought to be due to loss of turgor of Gerbera (*Gerbera jamesonii* cv. Tamara) was examined. It was found that the water loss in flowers during the vase life is caused by the transpiration rate of the flowers higher than the water uptake rate. Also, it was determined that the net water loss was higher in the part where the stem bent (10-15 cm under the capitulum), and the weight loss in this part of the stem was higher than the non-bending part on the 7th day of the vase life. Covering flower stems with thin and flexible polypropylene slivers decreased the transpiration rate and extended stem bending time from 7 days to 14 days. It is thought that although stem bending might also be related to elongation and morphology stem, any relationship did not find between bending and elongation of the stem. The cavity in the middle of the flower stalk had not had any effect on stem bending. However, the count of sclerenchyma ring formed in the flower stalk in summer, and the lignin level of the stem was found to be related to the bending rate. As a result, it was determined that stem bending was mainly caused by net water loss in the part of the bending.

Furthermore, it has been determined that the upper part of the stem has not to include a sclerenchyma cylinder caused decreases the mechanical strength and causes stem bending (Perik et al., 2012).

4. TECHNIQUES USED TO IMPROVE POST-HARVEST QUALITY OF GERBERA CUT FLOWER

4.1. Cold Storage

It has been stated that the gerbera flowers could be stored for 13 days at 4ºC with 95% RH. Also, these conditions have been found the best to maintain the flowers vase life (Ajinkya et al., 2018). In a study, Intenza gerbera variety flowers were stored at four different temperatures, and it was found that the post-harvest life of flowers stored at 4º, 8º, and 12ºC was higher than the control (22ºC). In the study, it was also determined that the flower weight loss stored at 4ºC was less, whereas the total soluble solids content was higher compared to the control group. For this reason, it has been stated that 4ºC stands out for long-term storage and that the flowers stored at this temperature have 15 days vase life (Muniz et al., 2016).

Cut flowers can be stored dry or in water after harvest, and both storage methods have different effects on the vase life of the flower and stem bending. In the study where nine different gerberas (*Gerbera jamesonii* Bolus) varieties were stored in water, it has been found that except for two varieties, the others did not show stems' bending for 14 days. The cultivation of flowers in summer or winter affects the bending rate during vase life after cold storage. It has been determined that dry storage application (4 days at 1°C) does not affect stem bending in most of the varieties grown in summer, but it has increased the bending rate in all varieties studied in winter. However, most of the varieties grown in both summer and winter were showed bending at the end of dry storage, and it has thought that the differences among the varieties are related to water uptake on the first day of vase life (van Doorn & de Witte, 1994).

4.2. Packaging

Storing cut flowers in packages can increase the vase life. Gerbera cut flowers were pulsed with a preservative solution including 20 ppm $AgNO_3$ + 5% sucrose for 24 hours at room temperature. It was then placed in slives with different air permeability and packed in cardboard boxes with including newspaper and tissue paper as filling material. The weight loss of flowers in 60% ventilated packages during 4 days of storage at room temperature decreased, whereas the rate of wilted flowers increased. Also, petal fall rates of flowers placed on unventilated slives are found higher of these. The vase life of the flowers placed in 20% ventilated plastic slives and packed in newspaper or tissue paper filled cardboard boxes increased after storage (2.71 and 2.68, respectively), and the anthocyanin level also preserved. It was stated that the effect achieved was due to the preservation of the water balance with the packaging application (Prashanth & Chandrasekar, 2010).

Gerbera (*Gerbera jamesonii* cv. "Rosalin") flowers were applied with Mycorrhiza, trichoderma, teldor and calcium were before harvest, and 1-MCP (625 ppb) was applied after harvest. Then the flowers were stored at ± 1°C and 80 ± 5% relative humidity (RH) under normal atmosphere (NA) and modified atmosphere package (MAP) conditions. PP and PVC packages used for MAP have given more successful results than PE in maintaining quality. The combination of 1-MCP + 30 µm PP provided the best results in terms of some quality parameters such as weight loss of flowers, petal breaking force, flower stalk Ca content and vase life during 35 days of storage (Akbudak & Murat, 2012).

“Savana Red” gerbera flowers were stored in four different packages as PP (24µ), HDPE (28µ), LDPE (112µ) and at four different storage temperatures of 5°C, 10°C and 15°C for 7 days. The flowers with PP packaging and stored at 5ºC showed insignificant weight loss immediately after storage, while the water uptake rate was the highest (119.33 mL). The combination of PP packaging and cold storage (5ºC) was delayed senescence and prolonged vase life (8.33 days) via increasing the TSS content (10.90 °Brix) and membrane stability index (MSI, 87.48%) in gerbera. Likewise, the visual quality evaluated on the basis of the criteria that flower diameter (10.57 cm), the ratio of opened disk florets (13.33%) and the strenght of the stem in flowers stored at 5ºC in PP package was found to be superior than the other (Patel et al., 2016).

4.3. Calcium Treatments

Membrane integrity is disrupt as a result of the death of cells in tissues due to calcium deficiency in plants. Therefore, there is a problem in the development of the plant in the pre-harvest period and the strength of the plant decreases in the post-harvest period. Therefore, in many plant species, including cut flowers, calcium treatments are made both before and after harvest in order to eliminate this effect. 0 (control), 0.5, 1.0 and 1.5% $CaCl_2$ were applied to Campitano, Dino, Sangria and Testarossa gerbera cultivars by spraying in the pre-harvest period and by dipping or injection in the post-harvest period. Application of 1.0% $CaCl_2$ by spraying or immersion extended significantly the vase life of ‘Campitano’, ‘Dino’, and 'Testarossa' gerbera varieties and decreased the bending rate. Spray application of 1.0-1.5% $CaCl_2$ before harvesting was increased stem length, flower life, and reduced twisting rate of "Sangria" gerbera variety. Calcium applications increased the calcium content of the flower in Campitano, Sangria, and Testarossa varieties. Thus, the stalk bending time was delayed by 3-5 days, while the vase life was also increased by 3-4 days (Gerasopoulos & Chebli, 1999).

The flowers of Ornella and Testarosa gerbera cultivar were fertilized in the pre-harvest period with various organic fertilizers, fermented barn manure, and different leaf fertilizers containing calcium, potassium, and iron. The flowers were placed in vase solutions containing 1% $CaCl_2$ + 1% $Ca(NO_3)$ + 1% KNO_3 + 1% sugar after harvest. When the quality characteristics and vase life of the flowers have been examined, it was determined that the fertilizers applied from the root and the leaf

did not have a significant effect. On the other hand, 1% KNO_3 applied on the leaf and 1% $Ca(NO_3)_2$ added to the vase solution after harvest increased the vase life of both varieties (Zeybekoğlu, 2002).
Rosalin gerbera (*Gerbera jamesonii* cv. Rosalin) flowers sprayed with calcium pre-harvest, then the harvested flowers have immersed in a solution containing 1% $CaCl_2$. The flowers have then stored in a plastic film with different permeability (MA) and under normal atmosphere (NA) conditions at 4 ± 1C temperature and 80 ± 5% RH. Calcium (Ca) application reduced quality losses of flowers stored in both NA and MA. As a result, MA conditions created with Ca + 30µ polypropylene (PP) were recommended as the best practice (Akbudak & Murat, 2012).

Gerbera jamesonii 'Carambole' cut flowers were treated with nanosilver and calcium chloride at different doses and in combination to maintain quality. The addition of NS to the vase solution and $CaCl_2$ spray application after harvest and their combination raised significantly flowers vase life. According to the results, NS (5 mg/L) alone and in combination with 1% $CaCl_2$ application prolong the vase life, while the highest water uptake was measured in NS, and NS together with 2% $CaCl_2$ or 1% $CaCl_2$ treatments. Also, it has been found that applying NS and $CaCl_2$ separately also reduces weight loss (Geshnizjany et al., 2014).

4.4. Silver Treatments

Silver is a commonly used material for extending the cut flowers, vase life. The use of silver, which started as a silver thiosulfate application in ancient years, continues as nanosilver applications today. Various silver compounds are added to the vase solution as antimicrobial agents. The effectiveness of each compound in extending the postharvest life of cut flowers also varies.

Nanosilver particles were added to the vase solution of Gerbera (cv. Ruikou) as an antimicrobial agent. It was found that the vase life of flowers was higher in nanosilver application (pulsing with 5 mg/L NS for 24 hours + holding in water) compared to control treatment (water). Nanosilver application also increased the water uptake of the flower by inhibiting the proliferation of bacteria in the vase solution (Liu et al., 2009).

Dune gerbera (*Gerbera jamesonii* cv. 'Dune') flowers placed in a vase solution including SNP (5 mg/L) + sucrose (6%) has been found to have a higher vase life than 8-HQC (8-hydroxyquinoline citrate) or control applications. SNP application also delayed fresh weight loss. The vase life of gerbera was extended by adding 50 or 100 mg/L carvacrol and 1 or 2 mg/L SNP to the vase solution from 8.3 to 16 days. However, relative fresh weight and solution uptake of flowers were increased by the addition of 100 mg/L essential oil to vase solution containing 1-2 mg/L SNP (Solgi et al., 2009).

In a study investigating the effects of different silver compounds on post-harvest quality, four different doses of silver nitrate (0, 100, 200, and 300 mg/L), and nanosilver at 0, 2, 4, and 6 mg/L doses, and 0, 2, 4 and 6 mM doses of silver thiosulphate were applied. Silver nitrate and nanosilver both slowed the decrease in anthocyanin content, delayed the relative reduction in fresh weight, and significantly increased the amount of TSS of flowers. While silver nitrate has found more effective on the quality of flowers in the study, this application was followed by nano-silver application, and silver thiosulfate did not have an additive effect on vase life (Abadi et al., 2013).

Nanosilver (NS) alone increased the vase life of gerbera flowers after harvest and was more effective when applied in combination with different compounds. In the study investigating the combined effect of nanosilver (NS), calcium sulfate (CS), and gibberellin (GA 4 + 7), flowers were pulsed by deionized water and a solution containing 3 or 9 mg / L of NS for 24 hours. Then the flowers held in preservative solutions containing sucrose + CS +GA (4 + 7). It was concluded that pulsing with 3 and 9 mg/L NS and holding in 20 mM CS solution increased total water uptake, decreased water loss, and extended vase life compared to the control (deionized water loading and holding in sucrose solution) (Hatamzadeh & Shafyii-Masouleh, 2013).

In a similar study, gerbera (*Gerbera jamesonii* cv. 'Balance') flowers were pulsed in a solution including at different doses of silver nanoparticles (SNP) and/or chlorophenol for 24 hours. The flowers have then placed in a preservative solution containing 8-hydroxyquinoline sulfate + sucrose. As a result of the study, it was stated that maximum vase life was found in flowers hold at 10 mg/L SNP alone with 16.33 days. It was also found that SNP (5 mg/L) + two different doses of chlorophenol (5 mM and 10 mM, respectively) inhibited bacterial proliferation in the vase solution. The fresh weight loss (6.48 g) of the flowers in the solution containing 20 mg/L SNP during vase life has found to be minimum (Safa et al., 2015).

4.5. Carbohydrate Pulsing

Water pulsing treatments are made immediately after the flower harvest to increase the post-harvest life of cut flowers. Then vase solutions containing different compounds are prepared to hold the flower. Vase solution generally consists of a nutrient (sucrose), a disinfectant, and a pH reducer (citric acid). In addition to these, the various compound is added in terms of both increasing the water uptake of the flower and preventing the growth of microorganisms in the vase solution. The compounds added in the vase solution increase the carbohydrate content of the flower and prolongs the vase life. The use of sucrose, together with silver nitrate and cobalt nitrate, increased the starch and total soluble carbohydrate content of gerbera flowers. Therefore, the use of sucrose together with mineral salts increases the carbohydrate content of the flowers, delaying their senescence, and consequently the vase life of the flowers increases (Wani et al., 2012).

In a study, flowers of gerbera were hold in a vase solution containing 100 mg/L 8-HQ (8-hydroxyquinoline) +50 mg/l $AgNO_3$ + 60 mg/L sodium benzoate + 40 g/L sugar + 25 mg/L $AlS0_4$ + 5 mg/L kinetin. The vase life of the flowers was found to 11.44 days, and preservative solutions extended the vase life by 3-6 days compared to the control (5.33 days). There was a decrease in the water consumption of all flowers towards the end of the trial (Yılmaz, 1991).

Red Marleen gerbera flowers have been put into a preservative solution containing distilled water + 2.5% sucrose + 150 ppm 8-HQS + 200 ppm KCl. In this application, the electrolyte leakage of the flowers in the outer ring (Ligulae) increased 1.4 times in the distilled water compared to the preservative solution. The preservative solution conductivity decreased on the first day of the vase life, as with distilled water (control), whereas it increased in the following days. The flowers hold in the preservative solution had have a higher respiration rate, fresh weight, and vase life compared to in distilled water. The color of the flowers in the outer ring intensified due to the increase of color pigments of anthocyanin and carotenoid, during the vase life. Color intensity of flowers in water was found to be higher on the 5th day of storage than in preservative solution (Amariutei et al., 1995).

4.6. Hormones

Hormones are used to maintain post-harvest quality in cut flowers, and for this purpose, hormones mostly in the structure of auxin and cytokine are utilized. Auxins are synthesized at the growth points of the plant and are responsible for the growth and development of the plant. However, it increases the vase life of the flowers by reacting with other hormones in the plant. Cytokinins, on the other hand, are transported to other organs of the plant after they are synthesized from plant roots and delay senescence in the plant. Since the roots, which are the source of cytokine in cut flowers, are destroyed by cutting the flower, the addition of this hormone to the vase solution prolongs the life of the vase by delaying the senescence of the flower. The decrease in the semi-permeability of the petal cells in cut gerbera flowers is considered as a sign of senescence. This symptom is detected by electrolyte leakage. It has determined that the combination of cytokinin with the hot treatment of gerbera flowers affects the amount of water and ion leakage (van Meeteren, 1978b).

Gibberellins have been used as well as auxin and cytokinin for preventing flower aging in gerbera flowers. The application of gibberellic acid (GA_3) at doses of 0, 2.5, 5 or 7.5 mg/L to Gerbera (*Gerbera jamesonii* cv. Ida Red) flowers has increase the number of blooming flowers, prevent petal fading and shedding, thus delaying flower senescence. Thus, flower turgority is maintained for fourteen days (Emengor, 2004).

The cut flowers of Gerbera (*G. jamesonii* cv. Good Timing) were cutted when four rows of outer disc flowers openedSubsequently, different doses of GA_3 and BA were applied to the flowers. The flowers were then held in a preservative solution that contains ethanol (2.5%) and sucrose (3%) and at 25°C and about 70% RH. Fresh weight, solution uptake, membrane stability, total soluble solids (TSS) content, and vase life of the flowers were increased by treatments (Danaee et. al., 2011).

Similarly, gerbera flowers pulsed with distilled water or 4% $CaCl_2$ were placed in solutions containing 25 and 50 ppm GA_3, 150 and 250 ppm benzyl adenine (BA) and 100 and 200 ppm 5-sulfoxysalicylic acid. In the study, it was determined that 30 ppm GA_3 application in combination with distilled water pulsing prevented the decrease in flower diameter, and also, 250 ppm BA combination with both pulsing applications effectively prevented fresh weight reduction (Amini et al., 2013).

Combinations of hormones and organic acids can also be used to maintain cut flower quality. The interaction of GA_3 and citric acid had significant effects on the water content, fresh weight, flower diameter, vase life, and TSS, and also the highest effect was obtained from the combination of 150 ppm GA_3 and 100 ppm citric acid (Ranjbar et al., 2015).

4.7. Organic Acids

Recently, various organic acids have been used to prevent the growth of microorganisms in different products. These organic acids have reduced the pH of the environment below six, and thus microorganisms cannot grow under these conditions. These techniques have also been started to use in cut flowers. Three different concentrations of citric, ascorbic, and salicylic acids (50, 100, and 200 mg/L) were applied to increase the vase life of *Gerbera jamesonii*. As a result of the study, it was declared that the citric acid treatment (100 mg/L) extended the vase life (11.31 days) of gerbera compared to the control (5.80 days) (Mehdikhah, 2016).

In a study, five different NS (1, 2, 3, 4, and 5 mg/L) and four acetylsalicylic acid ASA (1, 1.5, 2, 2.5 mM) doses were used to extend of vase life of gerbera. The microorganism growth in the solution was prevented by both applications regardless of the doses. It has also been found that the doses of 2.5 mM ASA and 5 mg/L NS provided the best results for extending the vase life (Kazemi & Ameri, 2012).

In a similar study in which the effects of salicylic acid (SA) on the quality and vase life of gerbera flowers were investigated, four different concentrations of SA performed with three different ways to flowers. All applications increased the vase life of flowers, uptake of vase solution, weight loss, TSS amount, and flower membrane stability, improve stem structure, and reduce stem bending. It was thought that the effect of SA in increasing the flower life originated from the stimulation of the antioxidant effect, the reduction of the transpiration rate, and its antimicrobial effects. The results showed that SA treatments as both vase solution and spray were more effective than pulsing treatments in preserving the vase life of gerbera (Asgari & Moghadam, 2015).

4.8. Essential Oils

Various essential oils with antifungal effects can also be used to increase the vase life of the Gerbera flower. The effects of vase solution that contain different doses of essential oil, and 3% sucrose on the quality of gerbera flowers were investigated. Flowers in vases containing essential oil were placed under fluorescent lamps (15-20 μmol/m^2 sec light) at 24 °C and 70% RH conditions, and a 14-hour photoperiod has applied. The solution uptake and quality of flowers pulsed with 50 mg/L *Thymus vulgaris* and 3% sucrose + 100 mg/L

Cuminium cyminum increased significantly. In addition, these applications increased petal anthocyanin content, the membrane stability index and the TSS amount of the flower stalk (Dareini et al., 2014).

Applying peppermint (*Mentha piperita*) essence (2000 mg/L) and non-alcoholic cola separately or together on the vase life and some physiological properties of gerbera cut flowers were investigated. As a result of the study, it has been stated that all applications significantly increased the vase life of the flowers, solution intake, petal carotenoid amount, flower diameter, relative fresh weight and the TSS content of the petal. Also, it was found that the vase life of the flowers applied with peppermint essence + cola (250 ml/L) was the longest with 20.33 days. Likewise, it was found that the carotenoid amount, relative fresh weight, total water-soluble dry matter amount, and solution uptake rate of these flowers were the highest (Babarabie et al., 2016).

The effects of different doses of essential oils that oregano oil, thymol, carvacrol, lavender oil, linalool, linalyl acetate on vase life of gerbera were investigated. In the study, 8-HQ and sugar were also used as a vase solution, in addition to essential oils. In the study, sugar-containing carvacrol (100 mg/L) (21.25 days) and thymol (150 mg/L) (21.0 days) solutions were provided the longest vase life. It was also determined that 8-HQ with 100, and 150 mg/L doses of thymol and carvacrol in sugar-containing solutions, significantly reduced the number of bacteria in the vase solution (Tuna, 2012).

4.9. 1-Metilcyclopropene (MCP)

1-MCP is used as ethylene inhibitor in cut flowers. In the study investigating the effects of 1-MCP application on the shelf life of Rosalin gerbera variety, flowers harvested at commercial maturity were stored in MAP or normal atmosphere after applying 1-MCP (625 ppb for 4 hours at 4 ± 1°C). 1-MCP significantly reduced post-harvest quality losses of products stored in MAP or normal atmosphere. It has been determined that the application of 1-MCP and 30 µm polyvinyl chloride gives the best result in terms of preserving the quality characteristics of the flowers. Therefore, the combination of 1-MCP and modified atmosphere was recommended as the best practice in terms of extending the life of the vase, preserving visual quality and reducing quality losses (Akbudak & Murat, 2013)

The Gerbera flowers were kept for 10 days in an environment containing 20°C temperature and 60% humidity and receiving 12 hours of daily light, after applying 1-MCP at 200 and 400 mL/L doses for six hours. 1-MCP application generally gave positive results in terms of increasing the vase life of flowers. However, 200 mL/L 1-MCP application was more effective in protecting the proportional weight of the flowers and the amount of leaf chlorophyll. In addition, this treatment also increased the amount of marketable flowers (Sabır et al., 2014).

4.10. UV-C Treatments

Ultraviolet radiation applications are used for surface disinfection in fruit, vegetable and ornamental plants. However, plants activate their defense mechanism in response to UV-C application. Thus, while the microorganisms are destroyed with UV-C, the quality of the flower, therefore, the shelf life is also increased.

The effects of UV-C on both its antiseptic (germicidal) properties and defense mechanism were investigated in Ice Cream and Ecco gerbera varieties. For this purpose, different UV-C doses (0.5-10.0 kJ/m^2) were used. UV-C treatments decreased both the conidial germination rate of Botrytis cinerea ten times and the lesion diameter on flowers by 70%. Besides, treatments have increased the activity of the polyphenol oxidase enzyme via activating the defense mechanism in flowers. Thus, the spotting of the florets has been prevented. Furthermore, 1.0 or 10.0 Kj/m^2 UV-C applications resulted in 1.8 and 2.4 days increase in the vase life of gerbera flowers, 43 and 29% decrease in stem bending rates, and a delay of 3.3 and 1.3 in stem breakage rates (Darras et al., 2012).

4.11. LED Treatments

Light emitting diode (LED) technology was first used to increase photosynthesis in horticultural crops under controlled conditions, tissue culture studies, and greenhouses. Then, the effects of LED lighting on the physiology and productivity of species such as wheat, radish, spinach, lettuce and pepper were investigated (Morrow, 2008). Since light is extremely important in terms of visual quality in ornamental plants and some other plants, studies on the effect of light in plant breeding have accelerated. In these studies, it was found that infrared lights are effective in stimulating flowering in long day plants, whereas blue lights are important for phototropism. Similarly, red LED lights have been found to increase photosynthesis because the wavelength of red light (600-700 nm) is extremely important for plants to absorb pigments (Brown et al., 1995; Goins et al., 2001; Yorio et al., 2001; Massa et al., 2008).

In the study investigating the storage performance and subsequent vase life of gerbera (*Gerbera jamesonii* cv. Maya) flowers stored under red, green, blue and white LED lighting conditions, it was found that the flowers could be stored for 25 days without loss of quality. However, it was determined that the longer the storage period, the shorter the vase life of the flowers. In the research, it was determined that the vase life of flowers stored under blue LED light was higher (14.22) than other applications (Köse, 2018).

4.12. Combined Treatments

Applications described above to improve the quality and vase life of gerbera flowers could be used individually, or their combinations are also applied. For example, the combination of calcium chloride ($CaCl_2$; 1%), lemon juice (0.5%), vinegar (0.6%), and sucrose (2%) was used to reduce stem bending of Gerbera flowers. As a result of the study, it has been stated that the combination of distilled water + 2% sucrose + 0.6% vinegar + 1% $CaCl_2$; gave the best results in terms of capitulum fresh weight (7.3 g), fresh stem weight (4.2 g), stem bending rate (0%) and maximum vase life (16 days) (De Silva et al., 2013). Similarly, applications of 4% sucrose + 400 ppm $AgNO_3$ and 4% sucrose + 400 ppm 8-HQC as a vase solution in Maron Dementine gerbera flowers are found highly effective in extending the vase life of flowers and increasing post-harvest quality (Vaidya & Collis, 2013).

In another study, humic acid together with A solution (Silver nitrate + salicylic acid + sucrose + 8-Hydroxyquinoline citrate (8-HQC) was used separately or in combination as a vase solution in gerbera flowers. In the study, the application of humic acid and A solution in doses of 25 or 50 mL/L separately increased the vase life, opened disc florets number, and the water uptake of the flowers. The combination of 25 or 50 mL/L humic acid and A solution was very successful in extending the vase life of flowers, increasing the diameter (cm), and increasing the percentage of fresh weight of flowers. Also, this practice significantly reduced the stem bending rate (Khenizy et al., 2013; Sharma et al., 2018). Similarly, the vase life of flowers that 8-HQS (200 mg/L) alone applied was 12.9 days, whereas it had 15.6 days in the flowers treated in combination with SA (100 mg/L) + 8-HQS (200 mg/L) (Banaee et al., 2013).

One of the combined applications using increase the quality characteristics of cut flowers and vase life is the use of sucrose and hormones together. In one such study, gerbera (*Gerbera jamesonii* Dune) flowers have been pulsed with 8% sucrose + BA or 8 sucrose + salicylic acid (SA) for 24 h. The flowers have then placed in a solution containing distilled water or 5 mg/L nano-silver. It was found that SA application was more effective than BA in reducing the weight loss of flowers, preserving the amount of TSS, preventing the decrease in anthocyanin level, and slowing down the deterioration in membrane stability. Besides, the use of NS in the vase solution has further increased the effectiveness of the applications. High doses of BA, on the other hand, had a negative effect on flower life, probably because they created suitable conditions for bacterial contamination by increasing the pH (Danaee et al., 2013). In a similar study, the effect of different combinations of malic acid, salicylic acid, and urea on the postharvest performance of gerbera flowers was investigated. Consequently, it was determined that the vase life of flowers in the solution containing salicylic acid (1 mM) + malic acid (2mM) + 0.5 mM urea (17 days) was found to be longer than flowers in distilled water (9.3 days) (Jamshidi et al., 2014).

Various chemicals, hormones, and essential oils are also used in the preservative solution to improve the postharvest quality properties of gerbera flowers. In a study, the effects of hormones (GA_3, BA, and sulfoxysalicylic acid), chemicals (silver thiosulphate, nano-silver particles, aminooxy acetic acid, and 8-HQS), and essential oils (thymus and stevia) combination on flower quality were investigated. In the study, the fresh weight of flowers kept in 250 mg/L BA solution after 24 hours of distilled water pulsing was found to be higher than other applications. However, the 8-HQS application has been the best practice in terms of preventing stem bending, increasing the capitulum diameter, and also extending the life of the vase among all applications (Jafarpour et al., 2015).

In the study, it was examined that the effects of the combination of 50 ppm sugar as a preservative solution and different ingredients for the preservation of postharvest quality of Gerbera flowers. According to this the combination of 50 ppm sugar + 50 ppm silver thiosulfate (STS) reduced freshness loss, delayed stem bending, loss of color of petals, and petal shrinkage. Also, stem diameter (7.2 mm), solution intake (72.7 mL), petal water amount (72.7%), and vase life (13.3 days) of the flowers were the highest in this application. In the study, sugar + silver thiosulfate and sugar + citric acid applications increased the shelf life of cut gerbera flowers by reducing fungal infection and increasing solution and additional carbohydrate intake of flowers (Khan et al., 2015).

Two different gerbera variety flowers were pulsed with nano-silver + thymol + sucrose combination to prevent bacterial growth in the vase solution and thereby to extend the vase life of the flowers. According to the results, it was found that while 6 mg/L nanosilver treatment increased significantly 'Red Explosion' flowers vase life (14 days), the bacteria in the stem end and solution was reduced by all of the applications (Oraee et al., 2011).

Three different doses of ClO_2 were used to determine the antibacterial effect of chlorine dioxide (ClO_2) in extending the vase life of *Gerbera jamesonii* 'Jenny' variety, and there was no bacterial growth in the vase solution 6 days after the application (Lee et al., 2014).

In another study, the effect of the combination of sucrose and isothiazolinone with aluminum sulfate (AS) and abscisic (ABA) was investigated on postharvest life of gerbera flowers before and during transportation. AS + ABA treatment with 2% and 3% sucrose significantly increased the vase life of flowers. Afterward, flowers were kept in 2% and 4% sucrose + AS + ABA solution with or without ABA at 10ºC for 24 hours, then at 15ºC for 48 hours, after that transferred to distilled water, and kept at 23ºC. With this application, the vase life of flowers was increased 4.5 times compared to pure water. ABA did not affect the vase life while increased fresh weight. Sucrose uptake from a solution containing 2% sucrose was higher than 10ºC at 15ºC (Yagi et al., 2014).

REFERENCES

Abadi, M. A. R. H., Moghadam, A. R. L., & Abdossi, V. (2013). The affected postharvest life of gerbera cut flowers by the application of silver nitrate, silver thiosulfate and nano silver. International Research Journal of Applied and Basic Sciences, 4(4): 806-809.

Acharya, A. K., Baral, A. D. R., Gautam, D. M., & Pun, U. K. (2010). Influence of seasons and varieties on vase life of gerbera (*Gerbera jamesonii* Hook.) cut flower. Nepal Journal of Science and Technology, 11: 41-46.

Acharyya, P., Mukherjee, D., Chakraborty, S., & Chakrabort, L. (2012). Effects of flower preservatives on thevase life of gerbera (*Gerbera jamesonii.* H. Bolus) flowers. Acta Horticulturae, 970: 287-292.

Ajinkya, M., Jadhav, P. B., More, D. B., & Pokharkar, K. P. (2018). Effect of cold storage on post storage life of gerbera (*Gerbera jamesonii*) cut flowers at ambient conditions. International Journal of Current Microbiology and Applied Sciences, 7(10): 2382-2387.

Akbudak, B. & Murat, S. (2012). Effects of preharvest and postharvest calcium and modified atmosphere treatments on vase life of gerbera. Journal of Food, Agriculture and Environment (JFAE), 10(3&4): 968-971.

Akbudak B. & Murat S. (2013). 1-MCP, low O_2 and high CO_2 reduce disorders and extend vase life of “Rosalin” gerberas during storage. Acta Agriculturae Scandinavica, Section B- Soil Plant Science, 63(2): 176-183.

Amariutei, A., Alexe, C., Burzo, I., Fjeld, T., & Stromme, E. (1995). Physiological and biochemical changes of cut gerbera inflorescences during vase life. Acta Horticulturae, 405: 372-80.

Ambrosius, P. (2003). How the barberton daisy got its name. Veld & Flora, 89(1): 30.

Amini, S., Jafarpour, M., & Golparvar, A. (2013). Effect of pulsing treatments (calcium chloride + sucrose and distilled water) with fixed hormonal treatments on postharvest quality of cut gerbera flowers. Technical Journal of Engineering and Applied Sciences, (3)13: 1120-1123.

Anonymous (2020a). Süs bitkileri üretiminin bugünkü durumu, geliştirilme olanakları ve hedefleri. http://www.zmo.org.tr/resimler/ekler/e915db6326b6fb6_ek.pdf,

(Access date: 26.05.2020)

Anonymous (2020b). Dünyada, AB'de ve Türkiye'de süs bitkileri sektöründeki gelişmeler ile bu alandaki uluslararası fuarlar, AB Uzmanlık Tezi. https://www.tarimorman.gov.tr/ABDGM/Belgeler/İDARİ%20İŞLER/Uzmanlik%20 Tez%20mayıs%202015/Beste%20Gulcur.pdf (Access date: 26.05.2020)

Anonymous (2020c). Geofitler. https://arastirma.tarimorman.gov.tr/beykozbbgam/Belgeler/Teknik%20Bilgi/Geofitler.pdf (Access date: 27.05.2020)

Anonymous (2020d). Süs bitkileri ve mamulleri sektör raporu 2020. http://www.susbitkileri.org.tr/images/d/library/354b3de7-2257-4c30-b60d998ecc546d7b.pdf (Access date: 27.05.2020)

Asgari, M. & Moghadam, A. (2015). Comparison of different salicylic acid application ways as a preservative on postharvest life of gerbera cut flowers. Agricultural Communications, 3(4): 1-8.

Babarabie, M., Zarei, H., & Varasteh, F. (2016). Physiological response of *Gerbera jamesonii* L. cut flowers to the cola and peppermint essence. Iranian Journal of Plant Physiology, 6(3): 1729-1736.

Banaee, S., Hadavi, E., & Moradi, P. (2013). Interaction effect of sucrose, salicylic acid and 8-hydroxyquinoline sulfate on vase life of cut gerbera flowers. Current Agriculture Research Journal, 1(1): 39-43.

Brickell, C. & Zuk, J.D. (1997). A-Z Encyclopedia of Garden Plants. The American Horticultural Society, DK Publishing Inc., New York.

Brown, C. S., Schuerger, A. C., & Sager, J. C. (1995). Growth and photomorphogenesis fo pepper plants grown under red light emitting diodes supplemented with blue or far-red illumination. Journal of the American Society for Horticultural Science, 120: 808-813.

Cardoso, J. C. & Silva T. J. A. (2013). Gerbera micropropagation. Biotechnoogyl Advances, 31(8): 1344-1357.

Çelikel, F. G., & Reid M. S. (2002). Storage temperature affects the quality of cut flowers from the asteraceae. HortScience, 37(1): 148-150.

Danaee, E., Mostofi, Y., & Pezham, M. (2011). Effect of GA_3 and BA on postharvest quality and vase life of gerbera (*Gerbera jamesonii* cv. Good Timing) cut flowers. Horticulture, Environment, and Biotechnology, 52(2): 140-144.

Danaee, E., Naderi, R., Kalatejari, S., & Moghadam, A. R. L. (2013). Evaluation the effect of nanosilver with salicylic acid and benzyladenine on longevity of gerbera flowers. Journal of Basic and Applied Scientific Research, 3(8): 682-690.

Dareini, H., Abdos, V., & Danaee, E. (2014). Effect of some essential oils on postharvest quality and vase life of gerbera cut flowers (*Gerbera jamesonii* cv. Sorbet). Europan Journal of Experimental Biology, 4(3): 276-280.

Darras, A. I., Demopoulos, V., & Tiniakou, C. (2012). UV-C Irradiation induces defence response sand improves vase life of cut gerbera flowers. Postharvest Biology and Technology, 64(1): 168-174.

Davarynejad, E., Tehranifar, A., Ghayoor, Z., & Davarynejad, G. H. (2008). Effect of different pre-harvest conditions on the postharvest keeping quality of cut gerbera. Acta Horticulturae, 804:205-208.

De Jong, J. (1978). Dry Storage and subsequent recovery of cut gerbera flowers as an aid in selection for longevity. Scientia Horticulturae, 9(4): 389-397.

De Silva, W. A. N. T., Kirthisinghe, J. P., & Alwis L. M. H. R. (2013). Extending the vase life of gerbera (*Gerbera hybrida*) cut flowers using chemical preservative solutions. Tropical Agricultural Research Vol., 24(4): 375-379.

Emengor, V. E. (2004). Effects of gibberalic acid on postharvest quality and vase life of gerbera cut flowers (*Gerberia jamesoni*). Journal of Agronomy, 3(3): 191-195.

Esendam, H. (2014). Commercially usage of geothermal energy for growing *Gerberaja mesoni.* in Rotorua©, *ISHS Acta Horticulturae, DOI:10.17660/ActaHortic.*1055.

Gerasopoulos, D. & Chebli, B. (1999). Effects of pre- and postharvest calcium applications on the vase life of cut gerberas. The Journal of Horticultural Science and Biotechnology, 74(1): 78-81.

Gerbera Lab (2020). History of gerbera. http://www.helsinki.fi/gerberalab/research_ history of gerbera.html (Access date: 29.10.2020)

Geshnizjany, N., Ramezanian, A., & Khosh-Khui, M. (2014). Postharvest life of cut gerbera (*Gerbera jamesonii*) as affected by nano-silver particles and calcium chloride. International Journal of Horticultural Science and Technology, 1(2): 171-180.

Goins, G. D., Ruffe, L. M., Cranston, N. A., Yorio, N. C., Wheeler, R. M., & Sager, J. C. (2001). Salad crop production under different wavelenghts of red light emitting diodes. SAE Technical Paper Series Paper No. 2001-01-2422.

Halevy, A. H. & Mayak. S. (1981). Senescence and postharvest physiology of cut flowers. Part 2. Horticultural Reviews, 3(1): 59-143.

Hannweg, K. F. (2008). Harvest and postharvest treatment of gerbera cut flowers ensures optimum vase life under hot conditions for farmers with limited resources. Acta Horticulturae, 768: 437-443.

Hatamzadeh, A. & Shafyii-Masouleh, S. (2013). Nano silver pulsing and calcium sulfate improve water relations on cut gerbera flowers. South Western Journal of Horticulture, Biology and Environment, 4(1): 1-11.

Jafarpour, M., Golparvar, A. R., Askarikhorasgani, O., & Amini, S. (2015). Improving postharvest vase life and quality of cut gerbera flowers using natural and chemical preservatives. Journal of Central European Agriculture, 16(2): 199-211.

Jamshidi, M., Hadavi, E., & Naderi, R. (2012). Effects of salicylic acid and malic acid on vase life and bacterial and yeast populations of preservative solution in cut gerbera. International Journal of AgriScience, 288: 671-674.

Jamshidi, M., Hadavi, E., & Naderi, R. (2014). Combination of salicylic acid, malic acid and urea enhances the vase life of cut gerbera flowers on par with selected treatments. International Journal of Postharvest Technology and Innovation, 4(2/3/4): 235-250.

Javad, N. D. M., Ahmad, K., Mostafa, A., & Roya, K. (2011). Postharvest evaluation of vase life, stem bending and screening of cultivars of cut gerbera (*Gerbera jamesonii* Bolus ex. Hook f.) flowers. African Journal of Biotechnology, 10(4): 560-566.

Javad, N. D. M., Mahmood, P. Y., Roya, K., & Hamideh, J. H. (2012). Effect of cultivar on water relations and postharvest quality of gerbera (*Gerbera jamesonii* Bolus ex. Hook f.) cut flower. World Applied Sciences Journal, 18(5): 698-703.

Kazemi, M. & Ameri, A. (2012). Postharvest life of cut gerbera flowers as affected by nano-silver and acetylsalicylic acid. Asian Journal of Biochemistry, 7: 106-111.

Khan, P., Mehraj, H., Taufique, T., Shiam, I. H., & Jamal Uddin, A. F. M. (2015). Chemical preservatives for increasing shelf life of gerbera. Journal of Bioscience and Agriculture Research, 05(01): 30-36.

Khenizy, S. A. M., Zaky, A. A., & El-Shewaikh, Y. M. E. (2013). Effect on humic acid on vase life of gerbera flowers after cutting. Journal of Horticultural Science & Ornamental Plants, 5(2): 127-136.

Köse, C. (2018). Gerbera (*Gerbera jamesonii* cv. Maya) Çiçeklerinde Hasat Sonrası Farklı LED Aydınlatma Uygulamalarının Vazo Ömrüne Etkisi. *Master Thesis,* Kocaeli University, Graduate School of Natural and Applied Science, Horticulture Sciences.

Kumar, P., Lavania, P., Bhatulkar, S. R., & Chonkar, D. S. (2010). Effect of chemical preservatives on vase life of gerbera cut flower (*Gerbera jamesonii*). The Journal of Ruraland Agricultural Research, 10(2): 37-39.

Lee, Y. M., Park, S. K., & Kim, W. S. (2014). Antibacterial effect of chlorine dioxide on extending the vase life of cut gerbera 'Jenny'. Flower Research Journal, 22(3): 161-166.

Liu, J., He, S., Zhang, Z., Cao, J., L. P., He, S, Cheng, G., & Joyce, C. D. (2009). Nano-silver pulse treatments inhibit stem-end bacteria on cut gerbera cv. Ruikou flowers. Postharvest Biology and Technology, 54(1): 59-62.

Massa, G. D., Kim, H. H., Wheeler, R. M., & Mitchell, C.A. (2008). Plant productivity in response to LED lighting. HortScience, 43: 1951-1956.

Mehdikhah, M., Onsinejad, R., & Hashemabadi, D. (2016). Postharvest life of cut gerbera (*Gerbera jamesonii*), flowers as affected by salicylic acid, citric acid and ascorbic acid. Journal of Agricultural and Biological Science, 11(5): 170-174.

Morrow, R. C. (2008). LED lighting in horticulture. HortScience, 43(7): 1947-1951.

Muniz, A. C. C., Galati, V. C., Marques M. K., Mattiuz, C. F. M., & Mattiuz, B. H. (2016). Postharvest quality of red gerberas depending on the storage temperature. Ciência Rural, 46(11): 1945-1951.

Nair, S. A., Singh, V., & Sharma, T. V. R. S. (2003). Effect of chemical preservatives on enhancing vase life of gerbera flowers. Journal of Tropical Agriculture, 41: 56-58.

Oraee, T., Zadeh, A. A., Kiani, M., & Oraee A. (2011). The role of preservative compounds on number of bacteria on the end of stems and vase solutions of cut gerbera. Journal of Ornamental and Horticultural Plants, 1(3): 161-165.

Patel, T., Singh, A., Ahlawat, T. R., & Kapadiya, D. B. (2016). Effect of different polyfilms and storage temperatures on postharvest quality of gerbera (*Gerbera jamesonii* cv.) 'Svana Red'. The Bioscan, 11(1): 197-199.

Perik, R. R. J., Razé, D., Ferrante, A., & van Doorn W. G. (2014). Stem bending in cut *Gerbera jamesonii* flowers, effects of a pulse treatment with sucrose and calcium ions. Postharvest Biology and Technology, 98: 7-1.

Perik, R. R. J., Razé, D., Harkema, H., Zhong, Y., & van Doorn, W. G. (2012). Bending in cut *Gerbera jamesonii* flowers relates to adverse water relations and lack of stem sclerenchyma development, not to expansion of the stem central cavity or stem elongation. Postharvest Biology and Technology, 74: 11-18.

Prashanth, P. & Chandrasekar, R. (2010). Influence of pulsing and packaging materials on the postharvest quality of cut gerbera cv. Yanara. Indian Journal of Agricultural Research, 44(1): 66-69.

Ranjbar, A., Paz, S. K., & Rahimi, J. A. (2015). The effects of the combination of gibberelic acid with citric acid on postharvest life of gerbera flowers. Research Journal of Fisheries and Hydrobiology, 10(10): 740-744.

Reddy, P. P. (2016). Gerbera In Sustainable Crop Protection under Protected Cultivation, Springer, p. 355-362.

Reid, M. S. (2004). Gerbera, transvaal daisy, recommendations for maintaining postharvest quality. http://postharvest.ucdavis.edu /Commodity_Resources

/Fact_Sheets/Datastores/Ornamentals_ English/?uid=17&ds=801 (Access date: 19.10.2020)

Rogers, M. N. & Tjia B. O. (1990). Gerbera Production for Cut Flowers and Pot Plants, Timber Press.

Royalfloraholland (2016). Gerbera. http://annualreport.Royalflora holland.com (Access date: 30.12.2016)

Sabır, A., Sabır, F. K., Yazar, K., & Kara, Z. (2014). Hasat sonrası 1-methylcyclopropene uygulamalarının gerberada vazo ömrü ve çiçek kalitesine etkileri. VI. Bahçe Ürünlerinde Muhafaza ve Pazarlama Sempozyumu, 22-25 Eylül 2014, Bursa.

Safa, Z., Hashemabadi, D., Kaviani, B., Nikchi, N., & Zarchini, M. (2015). Studies on quality and vase life of cut *Gerbera jamesonii* cv. 'Balance' flowers by silver nanoparticles and chlorophenol. Journal of Environmental Biology, 36: 425-431.

Salman, Ö. (2018). Depolanan Lale, Sümbül ve Nergis Soğanlarında *Penicillium* spp. Enfeksiyonlarının Değerlendirilmesi ve *Penicillium* spp.'ye Karşı Bazı Fungisidlerin *in vitro* Etkililiğinin Belirlenmesi. *Master Thesis,* Selçuk University, Graduate School of Natural and Applied Science, Horticulture Sciences.

Salunkhe, D. K., Bhat, N. R., & Desai B. B. (1990). Postharvest Biotechnology of Flowers and Ornamental Plants, Sprenger Verlag, Berlin; New York, 1990.

Schouten, R. E., Verdonk, J. C., & van Meeteren, U. (2018). Re-evaluating the role of bacteria in gerbera vase life. Postharvest Biology and Technology, 143: 1-12.

Sharma, V., Kamra, G., Thakur, R., & Kaur, R. (2018). Extanding post harvest life and keeping quality of gerbera (*Gerbera jamesonii*) using 8-HQS and calcium chloride with sucrose. International Journal of Innovative Pharmaceutical Sciences and Research (IJIPSR), 6(4): 21-29.

Shoub, Y. (2013). High quality stems pay back. Floral News, 3: 16-18.

Solgi, M., Kafi, M., Taghavi, T. S., & Naderi, R. (2009). Essential oils and silver nanoparticles (SNP) as novel agents to extend vase life of gerbera (*Gerbera* *jamesonii* cv. 'Dune') flowers. Postharvest Biology and Technology, 53(3): 55-158.

Steinitz, B. (1983). The influence of sucrose and silver ions on dry weight, fiber and lignin contents and stability of cut gerbera flower stalks. Gartenbauwissenschaft, 48(2): 67-71.

Stravers, L. J. M. & Van O. D. P. M. (2008). U. S. Patent No. 12/217,530. U.Patent and Trademark Office.

Tjia, B. O. S., Black, R. J., & Park-Brown, S. (1991). Gerberas for Florida. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida.

Tourjee, K. R., Harding, J., & Byrne T. G. (1994). Early development of gerbera as a floricultural crop. Hort Technology, 4(1): 34-40.

TUIK (2017). Gerbera üretim verileri. http://www.tuik.gov.tr/Pre Tablo.do?alt_id=1001 (Access date: 14.09.2017)

TUIK (2019). Süs bitkileri. http://www.tuik.gov.tr/PreTablo. do?alt_id=1001, (Access date: 28.05.2020)

Tuna, S. (2012). Kesme Gül ve Gerbera Çiçeklerinin Vazo Ömrünü Arttırmak İçin Bazı Uçucu Yağlar ve Ana Bileşenlerinin Kullanım Olanakları. *Master Thesis,* Süleyman Demirel University, Graduate School of Natural and Applied Science, Horticulture Sciences.

USDA (2020). United States Department of Agriculture, Natural Resources Conservation Servise. https://plants.usda.gov/core/profile?symbol=GEJA (Access date: 10.05.2020)

Vaidya, P. & Collis, J. P. (2013). Effect of biocides and sucrose on vase life and quality of cut gerbera (*Gerbera jamesonii*) cv. Maron Dementine. HortFlora Research Spectrum, 2(3): 239-243.

Van Doorn, W. G. & de Witte, Y. (1994). Effect of bacteria onscape bending in cut *Gerbera jamesonii* flowers. Journal of American Society of Horticultural Science, 119: 568–571.

Van Meeteren, U. (1978a). Water relations and keeping-quality of cut gerbera flowers. I. The cause of stem break. Scientia Horticulturae, 8: 65–74.

Van Meeteren, U. (1978b). Water relation sand keeping quality of cut gerbera flowers, II. water balance of ageing flowers, Scientia Horticulturae, 9(2): 189-197.

Wani, M., Saha, S., Bidwai, J., & Khetmalas, M. D. Y. (2012). Changes in carbohydrate levels and associated enzyme activities during post harvest vase life of *Gerbera jamesonii* cv. Danalin flowers as ınfluenced by mineral salts. Journal of Horticulture Letters, 2(1): 8-11.

Wernett, H. C., Sheehan, T. J., Wilfret, G. J., Marousky, F. J., Lyrene, P. M., & Knauft, D. A. (1996). Postharvest longevity of cut flower gerbera. Journal American Society for Horticultural Science, 121(2): 216-221.

Yagi, M. I., Elgemaby, M. N. A., & Ismael, M. I. A., & Mohammed Almubarak A. A. (2014). Prolonging of the vase life of *Gerbera jamesonii* treatment with sucrose before and, during simulated transport. International Journal of Sciences: Basic and Applied Research (IJSBAR), 18(1): 254-262.

Yan, Y. (2016). Effects of Some Preservative Solutions on Vase Life in *Gerbera jamesonii.* Master Thesis of AgriScience (Unpublished).

Yılmaz, H. (1991). Değişik Kimyasal Madde Uygulamalarının Kesme Çiçek Olarak Kullanılan Gül, Karanfil, Gerbera ve Bahar Yıldızının Vazoda Dayanma Sürelerine Etkileri. *Master Thesis,* Atatürk University, Graduate School of Natural and Applied Science, Horticulture Sciences.

Yorio, N. C., Goins, G. D., Kagie, H. R., Wheeler, R. M., & Sager, J. C. (2001). Improving spinach radish and lettuce growth under red light emitting diodes (LEDs) with blue light supplementation. HortScience, 36: 380-383.

Zeybekoğlu, E. (2002). Gerbera Yetiştiriciliğinde Hasat Öncesi ve Sonrası Yapılan Bazı Uygulamaların Verim Kalite ve Vazo Ömrü Üzerine Etkileri. Master Thesis. Ege University, Graduate School of Natural and Applied Science, Horticulture Sciences, İzmir, p. 71.

CHAPTER 14

TULIP (*TULIPA GESNERIANA* L.), POSTHARVEST TREATMENTS USING TO PROLONG VASE LIFE

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INTRODUCTION

Post-harvest quality of cut flowers varies depending on the physiological structure of the flower. The post-harvest life span of cut flowers depends on the availability of water and the plant's capacity to take this water. Therefore, the continuity of water intake of the flowers should be ensured. They contain cut flowers, sepal, petal, stamen, pistil, stem and mostly leaves. These organs of the flower affect the water uptake and thus determine the quality of the flower. Cut flowers are harvested at different stages according to the flower species and variety. For this reason, the buds turn into flowers in the flowers harvested at the bud stage. Those that are harvested in full opening ripen, age and wither. With flower aging, the petal's carbohydrate, protein and nucleic acid amount decreases. For this reason, it is important to provide a nutrient source after harvest in order to delay maturation and aging in cut flowers (Khan et al., 2007a).

The postharvest vase life of a cut flower is affected by various factors, including low storage temperatures and high relative humidity, water uptake of flower, microorganism growth in vase solution, and ethylene in the environment (Çelikel & Reid, 2002; Reid & Jiang, 2012). For this reason, different treatments are applied after harvest to increase water intake, prevent microorganism growth in the vase solution, reduce the effect of ethylene and stimulate flowering (Çelikel et al., 2002; Eason, 2002; Han, 2003; Serek et al., 2006; Macnish et al., 2008; Asrar, 2012).

The tulip (*Tulipa gesneriana* L.) grown for different use such as bulb production, cut flower, potted plant and landscaping is a monocotyledonous plant in the Liliaceae family (Bukhari, 2005; van Tuyl & van Creij, 2007). The current commercial cut-flowers still produced mainly of cultivars from *T. gesneriana* L., which have attractive colors and delicious. It was stated by Okubo & Sochaki (2013) that the number of tulip varieties traded is about 8000. Also, the tulip is placed in the third position after rose and chrysanthemum among the top ten cut flowers in the World floriculture trade (Jhon & Neelofar, 2006). Furhermore, the tulip bulb export value was just over 215 million euros, in 2019 (Anonymous, 2020).

The long vase life of the cut flowers is significant for their trade. Therefore, the quality of flowers must be maintained for prolonged vase life. The vase life of cut-tulip is short due to tepal senescence, stem bending, and xylem blockage. When the cut tulips are properly cared for, it can stay fresh for 7-10 days in a vase solution. Tulip is not sensitive to ethylene but increasing endogenous ethylene causes tepal senescence, and its shortens vase life. For this reason, different methods are applied to prolong the vase life of cut-tulip. In this chapter, the techniques used to extend the postharvest vase life of tulip summarized.

1. TREATMENTS USING TO EXTENT VASE LIFE

1.1. Pre-harvest Treatments

The preharvest nutrition treatments can be effective to extend the postharvest vase life of tulip. Generally, fertilizers including nitrogen, phosphorus, and potassium used for this purpose. But, it has been found that humic acid fertilization has a significant role in overall plant development, and to maintain postharvest quality of fruit, vegetables, and cut flowers, recently. In a study which was conducted by Ali et al. (2014), it found that 75 mL/L humic acid + 10 g/L NPK treatment has a significant effect on extending the vase life of tulip up 18.70 days.

Similarly, a study evaluated the nutrition of N:K and the different storage methods on flower quality and vase life of cut-tulip. According to this 14.3:3.9 meq/L N:K treatment improved flowering, and increased internode diameter. Furthermore, nutrition with 0.7:3.9 meq/L N:K, 12.1/5.1 meq/L N:K, and 14.3/3.9 meq/L N:K treatments delayed flowering and maintained quality in combination with the postharvest sealing application (Lee et al., 2005).

Gibberellic acid (GA_3) could be used as a pre-harvest application to improve the vase life of the cut flower. When the GA_3 applied at different doses to both bulb dip and foliar spray on the 'Cassini' cut tulip variety, the 100 ppm GA_3 gave the best results. This treatment improved water uptake and inhibited fresh weight loss. Also, flower diameter, scape length, and vase life of the flower in this treatment were high (Khan et al., 2007b).

1.2. Postharvest Treatments

1.2.1. Floral Preservative

When the flower is detached from the mother plants, the water loss occurs quickly (Bhaskar et al., 1999). Therefore, the water pulsing should be done after harvest to inhibit water loss to flowers. But the water alone is not enough to meet the nutrient requirement of flowers. Thus the floral preservatives (FP) are used to provide both water and nutrient for cut flowers. The FP, which are composed of sugars, biocides, and acidifiers, are generally used to maintain turgor and water balance, and to extend the vase life of the cut flower. Also, Since FP reduces microbial proliferation in vase solution, not only is the vascular blockage prevented due to this treatment but also water uptake of flower increased (Patil, 2009). Consequently, exogenous sucrose supply should be provided to meet carbohydrate requirements and also prolong vase life (van Doorn, 2004).

It has found that the sugar holding has caused bud opening and also delayed senescence in cut flowers. Among the sugars, trehalose, a nonreducing disaccharide was improved vase life and viability of petal of gladiolus by suppressing water loss (Otsubo & Iwaya-Inoue, 2000; Watanabe et al., 2013). The cut-tulip flowers are sensitive to high temperature, and therefore the tepals of ‘Ile de France’ cut tulip variety severely wilted seven days after flower opening at 20ºC. So, the effects of trehalose and chloramphenicol (CAP) to prevent this was studied. In the study, 50 mM trehalose in combination with 50µM CAP has been delayed petal abscission by four days. Also, it has declared by only 4% of treated flowers was showed tepal abscission compared to distilled water (82%) and CAP (60%). The authors concluded that trehalose + CAP treatment is effective in extending vase life without abscission, water loss, or elongation of cells in the tulip, but slight wilting occurs in leaves (Iwaya-Inoue &Takata, 2001).

Different floral preservatives are used to prolong the postharvest vase life of tulip. For example, different doses of sugar, aluminum sulphate, and 8-HQS were investigated to determine their effect on increasing water uptake, and vase life of the Yellow Purissima tulip variety. The vase life and water uptake have been increased by all doses of 8-HQS, but the best results were detected in 8-HQS 300 ppm dose with 10.5 g/scape water uptake and 10.1 days vase life. Also, the 8-HQS 300 ppm treatment resulted in the maximum fresh weight change of 105.13%. Aluminum sulfate 300 ppm treatment was also affected the water uptake and fresh weight change. So, it concluded that the floral preservative delayed aging due to increasing water uptake, and also extend vase life (Kumar et al., 2012).

In a study, 'Apeldoorn' tulip variety, harvested at the color break stage, and placed vase solution comprised of 2-4% sucrose, 200-300 ppm aluminum sulfate, and 1000-2000 ppm citric acid. The flowers were kept at room temperature (20 ± 2°C) and 70 ± 5% RH under the cool light of 2000 lux (12 h). It has been concluded in the study that the tulip flowers in Sucrose 4% + 200 ppm aluminum sulfate solution had higher fresh weight (30.22%), leaf chlorophyll content (0.41 mg/g FW), petal and leaf relative water content (58.7% and 64.5%, respectively), petal membrane stability index (53.7%), petal and leaf sugar content (38.3 and 29.5 mg/g DW), and protein. Also, the highest scape length (29.8

cm), tepal diameter (8.996 cm), and vase life (11.6 days) were achieved by this treatment (Khan et al., 2007a).

Preservative solutions not only supply energy to flowers but also reduce the growth of microorganisms due to acidifying of vase solution, therefore inhibit xylem blockage. Organic acids could be used to acidifying the medium (Sun et al., 2001). Besides these, minerals such as aluminum, cobalt, and lanthanum show also beneficial effects on the vase life of cut flowers (Hatami et al., 2010; Abri et al., 2013; Azizi et al., 2015; Gómez-Merino & Trejo-Téllez, 2018). Among these, lanthanum is widely used in medicine, and industry, although found on the earth rarely. It has been shown the lanthanum has positive effects on plant physiology and yield at low concentrations (Hu et al., 2004). These effects are defined as hormesis, which means low dose stimulation, high dose inhibition (Agathokleous et al., 2016). When $LaCl_3$ and $La(NO_3)_3 \times 6H_2O$ at a concentration of 40 μM applied as lanthanum sources to fifteen different cut tulip varieties, the longest vase life was recorded in the Laura Fygi variety. In the study, it also detected that La-treated flowers have higher total soluble sugars in petals and also high total soluble proteins in leaves. Also, $La(NO_3)_3 \times 6H_2O$ treatment was found that increased stem fresh weight and extended vase life. Moreover, this treatment provided the highest chlorophyll content of leaves (Gómez-Merino et al., 2020).

1.2.2. Hormones

Increasing respiratory rate accelerates aging, in all living organisms. The petal and pistil respiration rates firstly increase and then gradually decrease during senescence, after that rise at the later of the vase life of tulip. The respiration change of tulip has been liken to respiratory climacteric in fruit ripening. Also soluble protein has been decreased during senescence, whereas it increase at the end of the vase life. As a result, it has been suggested that the benzyladenine could be used to slow down of respiration and inhibit respiratory climacteric risen and therefore delayed senescence (Baoliang et al., 1999).

The main reasons for the short vase life of tulip cut flowers are tepal abscission and also leaf yellowing. However, these phenomenons are little affected by exogenous ethylene, and the effect of the other hormones on senescence of tepal and the time of tepal abscission was unknown. But, cytokinin or gibberellin treatments have delay leaf yellowing (Woltering & van Doorn, 1988; Pisulewski et al., 1989; Lukaszewska, 1995; Sexton et al., 2000). Also, the stem bending of the cut tulip occurs due to stem elongation. The stem bending is prevented by ethylene or ethephon treatment, however, this application harms the flower opening in Apeldoorn and Frappant tulip varieties (Figure 1). Therefore, these negative effects can overcome by using the GA_3 application, which delayed leaf yellowing. But, since tepal abscission did not inhibit by GA_3, benzyl adenine (BA), which is a synthetic has been used to delaying leaf yellowing and tepal senescence (van Doorn et al., 2011).

Figure 1: The effect of ethephon, GA_3, BA, and calcium ions treatments on Apeldoorn (A) and Frappant (C) cut tulip varieties (van Doorn et al., 2011)

Thidiazuron (TDZ) has used to prevent leaf yellowing some cut flowers such as alstroemeria and lilies since induce cytokinin-like responses. Similarly, cut-tulip flowers were treated with 10, 50, and 100 mM TDZ for 24 hours, and was shown that the TDZ has been successful preventing leaf yellowing (Ferrante et al., 2003).

If the use hormones in combination with a preservative solution, the quality and the vase life of the cut flower could be more improved than preservatives alone. It has been expressed that the preservative solution comprising 8HQC + 4% sucrose alone has no positive effect on the longevity of the Apeldoorn cut tulip variety. However, it has been stated that when GA_3 has added to the holding solution including 8HQC + 4% sucrose, the pistil growth was increased significantly. But the ethephon alone adversely affects stem elongation, pistil growth, and petal length whereas, in combination with GA_3 has improved quality tulip (Lukaszewska, 1995).

1.2.3. Silver Compounds

Silver compounds such as silver thiosulphate and silver nitrate were used as antibacterial agents, in the vase solution of cut flowers for years, since these effectively prevent microorganism growth in the vase solution. However, because they are highly toxic to human health and also the environment, the alternative compounds of them are under investigation. For these reasons, silver nanoparticles are started to use as an alternative of them in vase solution recently (Carrillo-Lopéz et al., 2016). More studies have been done to determine the effects of silver nanoparticles to extend the vase life of cut flowers. In these studies, it had been found that silver nanoparticles prolonged vase life due to prevent microorganism development both in the vase solution and also the cut surface of the stem (Liu et al., 2009; Solgi et al., 2009; Lu et al., 2010; Nemati et al., 2013; Nazemi Rafi & Ramezanian, 2013, Safa et al., 2015; Li et al., 2017).

When 'White Parrot' tulip variety was treated with 10, 20, and 40 mg/L NS, all doses of NS were effective in prolonge vase life of flowers. However, among the treatments, the 10 mg/L NS treatment has resulted in the longest vase life whereas the 10 and 20 mg/L NS were caused a higher fresh weight. Also, it was determined that the leaves treated with 20 or 40 mg/L showed less yellowing. So it could be said that the NS applications have effective for extending vase life, maintaining fresh weight, and decreasing yellowing (Byczyńska, 2017).

1.2.4. Biocontrol Agents and Bacteriocides

Tulip is a moderately ethylene sensitive cut flower however, endogenous ethylene production is the main factor that causes tepal senescence, which is shortening vase life. The endogenous ethylene production accelerates tepal aging even at low concentrations. Plant growth-promoting bacteria (PGB), have capable of delaying senescence of cut flower as an anti-aging. Because these bacteria delay the yellowing of leaf and senescence by reducing ethylene production, thus improve the quality of the flower. Also, there are some bacterial strains as evaluated biocontrol agents that prevent microbial proliferation in vase solution (Nayani et al., 1998; Hunter et al., 2004). Therefore, the PGB are used to delaying ethylene production and preventing the growth of microorganism in the cut flower industry as an alternative of chemicals, which is potentially harmful and expensive (Khan et al., 2006).

Colonized endophytic bacteria can be taken up by the plants, and ACC deaminase-containing bacteria inhibits the accumulation of harmful ethylene concentration by cleave ACC. In this way, the aging of cut flowers is prevented. Therefore these bacteria are used in vase solution for cut flower (Ali et al., 2012). In a study, the effects of four bacterial strains, such as *Burkholderia phytofirmans* (PsJN), *Caulobacter* sp (FA-13), *Enterobacter* sp (MN-17), and *Bacillus* sp (MN-54) tested to prolong the vase life of cut tulip flowers. It found that the (PsJN) in concentration form was given the best results and extended vase life up to 11.2 days, as a result of the study. Also, this treatment delayed leaf yellowing, improved water uptake, slowed down stem elongation, prolonged the flower bud open time, and increased flower diameter. On the other hand (MN-17) in concentration form caused an increase in fresh and dry mass ratio whereas reducing stem bending (Bashir et al., 2019).

Uniconazole is a plant growth retardant and uses as gibberellin inhibitors. Moreover, it can be used as fungicide and herbicide and is effective at little doses. S3307 (uniconazole) has a bacteriostatic effect, thus it can be used to prevent the proliferation of microorganisms in a vase solution of cut flower. When the effect of S3307 on quality and vase life was tested, it was found that it could significantly reduce bacteria count in vase solution, so prolonged vase life of cut-tulip (Li et al., 2008).

1.2.5. Modified Atmosphere Packaging (MAP)

The vase life of cut flowers shortens due to abiotic and biotic factors hastened aging of the organs. On the other hand, the postharvest life of the cut flowers is also affected by various factors such as genotype, cultivation system, storage, and transportation conditions. As for the tulip cut flower, tepal abscission is the most significant senescence symptom that shortened vase life. Premature leaf yellowing is the other important symptom of aging as well as tepal abscission (Iwaya-Inoue & Takata, 2001; Iwaya-Inoue & Nonami, 2003; Ferrante et al., 2003; van Doorn & Han, 2011; Reid & Jiang, 2012).

Modified atmosphere packaging (MAP) can be used to prevent both tepal abscission and premature leaf yellowing. Decreasing the oxygen (O_2) and increasing the carbon dioxide (CO_2) is reduced both the metabolic activity and ethylene production thus delayed the senescence of cut flowers (Rennie & Tavoularis, 2009; Sandhya, 2010). In a study that active and passive MAP has been applied to the tulip, it found that both MAP treatment maintains the quality of flowers. Furthermore, the authors concluded that the weight loss of tulips stored in active and passive MAP reduced by up to 0.3%, and the vase life extended by 5.7 and 6 days for active and passive MAP, respectively compared to the 18-21% weight loss and 3.3 day vase life of traditionally stored cut tulips (Aros et al., 2017).

1.2.6. Fumigation Treatments

The main problem of flower exporters is the rejection of flower consignment from the foreign markets due to the presence of insects. Phosphine (PH_3) is a widely used fumigant to control insects in stored grain, but the disinfection effectiveness depends on concentrations and exposure times. When the different doses of PH_3 (100-8000 µL/L) for 2, 4, and 6 hours applied on tulip (*T. gesneriana* 'Apeldoorn'), the higher dose (8000 µL/L) and application time (6h) were reduced the vase life of tulip was found. Therefore the PH_3 has been stated that at the 4000 µL/L dose for 6 h has potential as an insect disinfestation fumigant for tulip, without affecting vase life or causing damage (Karunaratne et al., 1997).

CONCLUSION

The tulip is a more important bulbous plant in Turkey, and also World trade. But the short vase life of tulip has limited its postharvest use as cut-flower. Therefore, the effect of various techniques on extending the vase life of cut-tulip was studied. These researches mostly focused on preventing stem bending, inhibiting xylem blockage, slowing down tepal senescence and leaf yellowing, and preventing the proliferation of microorganisms. According to the review of the literature, it was determined that although different techniques were used to increase the vase life of tulip flowers, the vase life could be extended up to 7 days. Therefore, it has been concluded that more studies are needed to reduce flower aging.

REFERENCES

Abri, F., Ghasemnezhad, M., Hasansajedi, R., & Bakhshi, D. (2013). Effect of ascorbic acid on vase life and petal senescence in cut rose flowers (*Rosa hybrida*) cv. 'Royal Class'. American-Eurasian Journal of Agricultural & Environmental Sciences, 13(1): 38-43.

Agathokleous, E., Kitao, M., & Calebrese, E. J. (2016). Environmental hormesis and its fundamental biological basis: Rewriting the history of toxicology. Environmental Research, 165: 274-278.

Ali, S., Charles, T. C., & Glick, B. R. (2012). Delay of flower senescence by bacterial endophytes expressing 1-aminocyclopropane-1-carboxylate deaminase. Journal of Applied Microbiology, 113: 1139-1144.

Ali, A., Rehman, S., Hussain, R., Raza, S., Sarwar, M., Bashir, A., & Khan, M. A. (2014). Enhancing the vase life ou tulip (*Tulipa gesneriana*, L.) using various pulsing solutions of humic acid and NPK. International Journal of Plant, Animal and Environmental Sciences, 4(2): 193-200.

Anonymous 2020. Value of the import and export of tulip bulbs in the Netherlands from 2008 to 2019. https://www.statista.com/statistics/581482/value-of-the-import-and-export-of-tulip-bulbs-in-the-netherlands/. (Accesss date: 10.11.2020)

Aros, D., Orellana, K., & Escalona, V. H. (2017). Modified atmosphere packaging as a method to extend postharvest life of tulip flower. New Zealand Journal of Crop and Horticultural Science, 45(2): 1-14.

Asrar, A. W. (2012). Effects of some preservative solutions on vase life and keeping quality of snapdragon (*Antirrhinum majus* L.) cut flowers. Journal of the Saudi Society of Agricultural Sciences, 11: 29-35.

Azizi, S., Onsinejad, R., & Kaviani, B. (2015). Effect of ascorbic acid on post-harvest vase life of cut lisianthus (*Eustoma grandiflorum* L.) flowers. ARPN Journal of Agricultural and Biological Science, 10(11): 417-420.

Baoliang, D., Wei, S., Yiwei, T., & Yimin, S. (1999). Studies on senescence physiology of tulip flowers during vase life. Journal of Shanghai Agricultural College, 1999-04.

Bashir, M., Asif, M., Naveed, M., Qadri, R. W. K., Faried, N., & Anjum, F. (2019). Postharvest exogenous application of varios bacterial strains improves the longevity of cut 'Royal Virgin' tulip flowers. Pakistan Journal of Agricultural Sciences, 56(1): 71-76.

Bhaskar, V. V., Rao, P. V., & Reddy, Y. N. (1999). Effect of minerals on post harvest vase life of cut tuberose (*Polianthes tuberosa* L.) cv. Double. Indian Journal of Horticulture, 56(4): 368-374.

Bukhari, R. A. S. (2005). Development of sustainable commercial floriculture in Pakistan. In The National Seminar on Streamlining: Production and Export of Cut-Flowers and House Plants, 2-4 March 2005, Islamabad, Pakistan.

Byczyńska, A. (2017). Improvement of postharvest quality of cut tulip 'White Parrot' by nano silver. World Scientific News, 83: 224-228.

Carrillo-Lopéz, L. M., Mordago-González, A., & Mordago-González, A. (2016). Biosynthesized silver nanoparticles used in preservative solutions for *Chrysanthemum* cv. Puma. Journal of Nanomaterials, 1-10.

Çelikel, F. G., Dodge, L. L., & Reid, M. S. (2002). Efficacy of 1-MCP (1-methylcyclopropene) and promalin for extending the post-harvest life of Oriental lilies (*Lilium* x 'Mona Lisa' and 'Stargazer'). Scientia Horticulturae, 93(2): 149-155.

Çelikel, F. G. & Reid, M. S. (2002). Storage temperature affects the quality of cut flowers from the Asteraceae. HortScience, 37(1): 148-150.

Eason, J. R. (2002). *Sandersonia aurantiaca*: an evaluation of postharvest pulsing solutions to maximise cut flower quality. New Zealand Journal of Crop and Horticultural Science, 30(4): 273-279.

Ferrante, A., Tognoni, F., Mensuali-Sodi, A., & Serra, G. (2003). Treatment with thidiazuron for preventing leaf yellowing in cut *Tulip*s and *Chrysanthemum.* Acta Horticulturae, 624: 357-363.

Gómez-Merino, F. C., Ramirez-Martínez, M., Castillo-González, A. M., & Trejo-Téllez, L. I. (2020). Lanthanum prolongs vase life of cut tulip flowers by increasing water consumpiton and concentrations of sugars, proteins and chlorophylls. Scientific Reports, 10: 4209.

Gómez-Merino, F. C. & Trejo-Téllez, L. I. (2018). The role of beneficial elements in triggering adaptive responses to environmental stressors and improving plant performance. In Biotic and Abiotic Stress Tolerance in Plants (ed. Vats, S.), Springer, Singapore, p. 137-172.

Han, S. S. (2003). Role of sugar in the vase solution on postharvest flower and leaf quality of oriental lily 'Stargazer'. HortScience, 38(3): 412-416.

Hatami, M., Ghasemnezhad, M., Hatamzadeh, A., & Omran S. G. (2010). Effect of ascorbic acid on antioxidant capacity during flower development in 'Royal Class' rose cut flowers. Acta Horticulturae, 877: 1329-1332.

Hu, Z., Richter, H., Sparovek, G., & Schnug, E. (2004). Physiological and biochemical effects of rare earth elements on plants and their agricultural significance: A review. Journal of Plant Nutrition, 27(1): 183-220.

Hunter, M., Xu, X., & Ried, T. (2004). Role of ethylene in perianth senescence of daffodil (*Narcissus pseudonarcissus* L. 'Dutch Master'). Postharvest Biology and Technology, 32: 269-280.

Iwaya-Inoue, M. & Nonami, H. (2003). Effects of trehalose on flower senescence from the view point of physical states of water. Environment Control in Biology, 41: 3-15.

Iwaya-Inoue, M. & Takata, M. (2001). Trehalose plus chloramphenicol prolong the vase life of tulip flowers. HortScience, 36: 946-950.

Jhon, A. Q. & Neelofar. (2006). Tulip. In *Bulbous Ornamental And Aquatic Plants: Advances In Ornamental Horticulture* (ed: S.K. Bhattacharjee), Pointers Publishers, Jaipur, India. p. 31-72.

Karunaratne, C., Moore, G. A., Jones, R. B., & Ryan, R. F. (1997). Vase life of some cut flowers following fumigation with phospine. HortScience, 32(5): 900-902.

Khan, F. U., Jhon, A. Q., Khan, F. A., & Mir, M. M. (2006). Effect of NPK and Zn on growth, flowering and bulb production in tulip under poly-house conditions in Kashmir. Journal of Horticultural Sciences, 1: 129-134.

Khan, F. U., Khan, F. A., Hayat, N., & Bhat, S. A. (2007a). Influence of certain chemicals on vase life of cut tulip. Indian Journal of Plant Physiology, 12(2): 127-132.

Khan, F. U., Malik, F. A., & Khan, F. A. (2007b). Effect of pre-harvest application of GA_3 and PP333 as bulb dip and foliar spray on quality and vase life of cut tulip cv. Cassini. Journal of Horticultural Sciences, 2(2): 156-158.

Kumar, R., Ahmed, N., Singh, D. B., & Sharma, O. C. (2012). Enhancing water relations and vase life of cut tulip (*Tulipa gesneriana* L.) using floral preservatives. Journal of Applied Horticulturae, 14(2): 152-156.

Lee, W. H., Kim, J. H., Lee, A. K., Suh, J. K., & Yang, Y. J. (2005). Effects of nutrient solution managemenet and methods of storage and distribution on flowering and quality of cut iris, tulip and lily. Acta Horticulturae, 673: 513-518.

Li, H., Li, H., Liu, J., Luo, Z., Joyce, D., & He, S. (2017). Nano-silver treatments reduced bacterial colonization and biofilm formation at the stem-ends of cut *Gladiolus* 'Eerde' spikes. Postharvest Biology and Technology, 123: 102-111.

Li, N., Qu, S., Zhang, S., Han, X., & Yu, D. (2008). Effect of S3307 on the fresh-keeping of cut flower of tulip. Journal of Shenyang Agricultural University, 3: 293-296.

Liu, J., He, S., Zhang, Z., Cao, J., Lv, P., He, S., Cheng, G., & Joyce, D. C., (2009). Nano-silver pulse treatments inhibit stem-end bacteria on cut gerbera cv. Ruikou flowers. Postharvest Biology and Technology, 54: 59-62.

Lu, P., Cao, J., He, S., Liu, J., Li, H., Cheng, G., Ding, Y., & Joyce, D. C. (2010). Nano-silver pulse treatments improve water relations of cut rose cv. Movie Star flowers. Postharvest Biology and Technology 57: 196-202.

Lukaszewska, A. J. (1995). Distribution of sugars in tulip flower parts as affected by ethrel and GA_3 in the holding solution. Acta Horticulturae, 405: 351-355.

Macnish, A., Leonard, R., & Nell, T. (2008). Treatment with chlorine dioxide extends the vase life of selected cut flowers. Postharvest Biology and Technology, 50: 197-207.

Nayani, S., Mayak, S., & Glick, B. R. (1998). Effect of plant growth-promoting rhizobacteria on senescence of flower petals. Indian Journal of Experimental Biology, 36: 836-839.

Nazemi Rafi, Z. & Ramezanian, A. (2013). Vase life of cut rose cultivars 'Avalanche' and 'Fiesta' as affected by silver and s-carvone treatments. South African Journal of Botany, 86: 68-72.

Nemati, S. H., Tehranifar, A., Esfandiari, B., & Rezaei, A. (2013). Improvement of vase life and postharvest factors of *Lilium orientalis* 'Bouquet' by silver nano particles. Notulae Scientia Biologicae, 5(4): 490-493.

Okubo, H., & Sochacki, D. (2013). Botanical and Horticultural Aspects of Major Ornamental Geophytes. In Ornamental Geophytes: From Basic Science to Sustainable Production (ed: R. Kamenetsky, H. Okubo). CRC Press Taylor and Francis Group LLC, Boca Raton, p. 77-117.

Otsubo, M. & Iwaya-Inoue, M. (2000). Trehalose delays senescence in cut *Gladiolus* spikes. HortScience, 35: 1107-1110.

Patil, V. S. (2009). Effect of chemical preservatives on vase life of daisy (*Aster amellus* L.) flowers. Journal Ornamental Horticulture, 12(1): 54-58.

Pisulewski, T. R., Goszczynska, D. M., & Rudnicki, R. M. (1989). The influence of giberellic acid and ethrel on cut tulips. Acta Horticulturae, 251: 115-118.

Reid, M. & Jiang, C. (2012). Postharvest biology and technology of cut flowers and potted plants. Horticultural Reviews, *40*: 1-54.

Rennie, T. J. & Tavoularis, S. (2009). Perforation-mediated modified atmosphere packaging: Part I. Development of a mathematical model. Postharvest Biology and Technology, 51(1): 1-9.

Safa, Z., Hashemabadi, D., Kaviani, B., Nikchi, N., & Zarchini, M. (2015). Studies on quality and vase life of cut *Gerbera jamesonii* cv. 'Balance' flowers by silver nanoparticles and chlorophenol. Journal of Environmental Biology, 36(2): 425-431.

Sandhya (2010). Modified atmosphere packaging of fresh produce: Current status and future needs. LWT-Food Science and Technology, 43(3): 381-392.

Serek, M., Woltering, E. J., Sisler, E. C., Frello, S., & Sriskandarajah, S. (2006). Controlling ethylene responses in flowers at the receptor level. Biotechnology Advances, 24(4): 368-381.

Sexton, R., Laird, G., & van Doorn, W. G. (2000). Lack of ethylene involvement in tulip tepal abscission. Physiologia Plantarum, 108: 321-329.

Solgi, M., Kafi, M., Taghavi, T. S., & Naderi, R. (2009). Essential oils and silver nanoparticles (SNP) as novel agents to extend vase-life of gerbera (*Gerbera jamesonii* cv.'Dune') flowers, Postharvest Biology and Technology, 53(3): 155-158.

Sun, J., Jameson, P. E., & Clemens, J. (2001). Water relations and stamen abscission in cut flowers of selected Myrtaceae. Acta Horticulturae, 543: 185-189.

van Doorn, W. G. (2004). Is petal senescence due to sugar starvation? Plant Physiology, 134: 35-42.

van Doorn, W. & Han, S. S. (2011). Postharvest quality of cut lily flowers. Postharvest Biology and Technology, 62: 1-6.

van Doorn, W. G., Perik, R. R. J., Abadie, P., & Harkema, H. (2011). A treatment to improve the vase life of cut tulips: Effect on tepal senescence, tepal abscission, leaf yellowing and stem elongation. Postharvest Biology and Technology, 61(1): 56-63.

van Tuyl, J. M., van Creij, M. G. M. (2007). Tulip. In Flower Breeding and Genetics (ed: N.O. Anderson). Springer, Dordrecht, p. 623-645.

Watanabe, Y., Miyajima, K., Nomizu, T., Nakano, M., & Ichimura, K. (2013). Effect of sugar treatments on the vase life of cut tulip (*Tulipa gesneriana* L.) flowers. Postharvest Physiology and Technology, 12(2): 201-207.

Woltering, E. J. & van Doorn, W. G. (1988). Role of ethylene in senescence of petals-morphological and taxonomical relationships. Journal of Experimental Botany, 39: 1705-1616.

CHAPTER 15

CYCLAMEN CULTIVATION

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INTRODUCTION

Cyclamen (*Cyclamen persicum* Mill.) is among the most popular species in the world as both indoor and outdoor flowering ornamental plant. Cyclamen cultivars of the indoor and outdoor growing demand for use as an ornamental plant in Turkey is met by domestic production and imports. In Turkey, although there are growing cyclamen, it has many problems adversely affecting growing. Lack of knowledge of the growing method, lack of knowledge on basic breeding, foreign dependency in varieties and seeds, diseases and pests, insufficient communication and cooperation between segments related to cyclamen have been identified in the field investigations and interviews with the sector. Depending on these factors, difficulties are encountered in growing healthy and quality plants.

Cyclamen, originating from Near-East, shows wide geography from east to south. Countries where it spreads; France, Switzerland, Italy, Austria, Croatia, Bosnia, Serbia, Albania, Greece, Bulgaria, Turkey, Georgia, Caucasus, Iraq, Iran, Syria, Lebanon, Israel, North Africa's different regions (Tunisia, Algeria and Libya) North Somalia and many Mediterranean Islands (Balearic Islands, Corsica, Sardinia, Malta, Sicily, Cyprus, Greek Islands, Saronic Islands, Sporades, Cyclades, Aegean Islands, Crete and Twelve Islands) (Anonymous, 2016). There are 23 species of cyclamen plant, which is from the Myrsinaceae family (Grey-Wilson, 2002). In Turkey, 12 species of the plant, which generally spread in the coastal regions, grow naturally and 6 species are endemic (Ekim et al., 1991; Gündogan, 2003).

The plant grows in the shade of trees or shrubs in its natural environment. Cyclamen, a tuber plant, is resistant to all seasons and is used both indoors and outdoors. Commercial varieties are generally developed from *Cyclamen persicum* species because this type creates larger and taller flowers. Cyclamen grows between 5-20 cm in height and blooms from autumn to late spring. One plant develops approximately 20-30 flower stalks. Depending on the variety, it forms between 20 and 70 seeds in the fruit capsules formed after flowering (Figure 1). The plant can be produced by seed as well as by dividing the tubers (Cuisance, 1971; Rissel, 1988; Bonduel, 1990). However, in commercial cyclamen cultivation, seed production is preferred because it is more economical. Its heart or kidney-shaped leaves are its most distinctive feature. Five-piece flowers; It is white, pink, dark pink, red and it is possible to see very different colours (Figure 2) and forms in new varieties obtained by breeding (Salman, 2014).

Schoneveld Breeding (Netherlands), Syngenta (China) and Morel (France) are the major companies in the world that carry out breeding and cultivation studies on cyclamen plants. Besides, breeders are working locally all over the world, especially in Japan. Companies compete with each other to get a bigger share from the market by offering new varieties, each more beautiful than the other, developed every year. Cyclamen production in Turkey has been dominantly carried out in Yalova yet in recent years the propagation has spread to other cities with suitable climates and conditions. As in the rest of the world, the use of the plant both indoors and outdoors is increasing every year in our country (Salman et al., 2016).

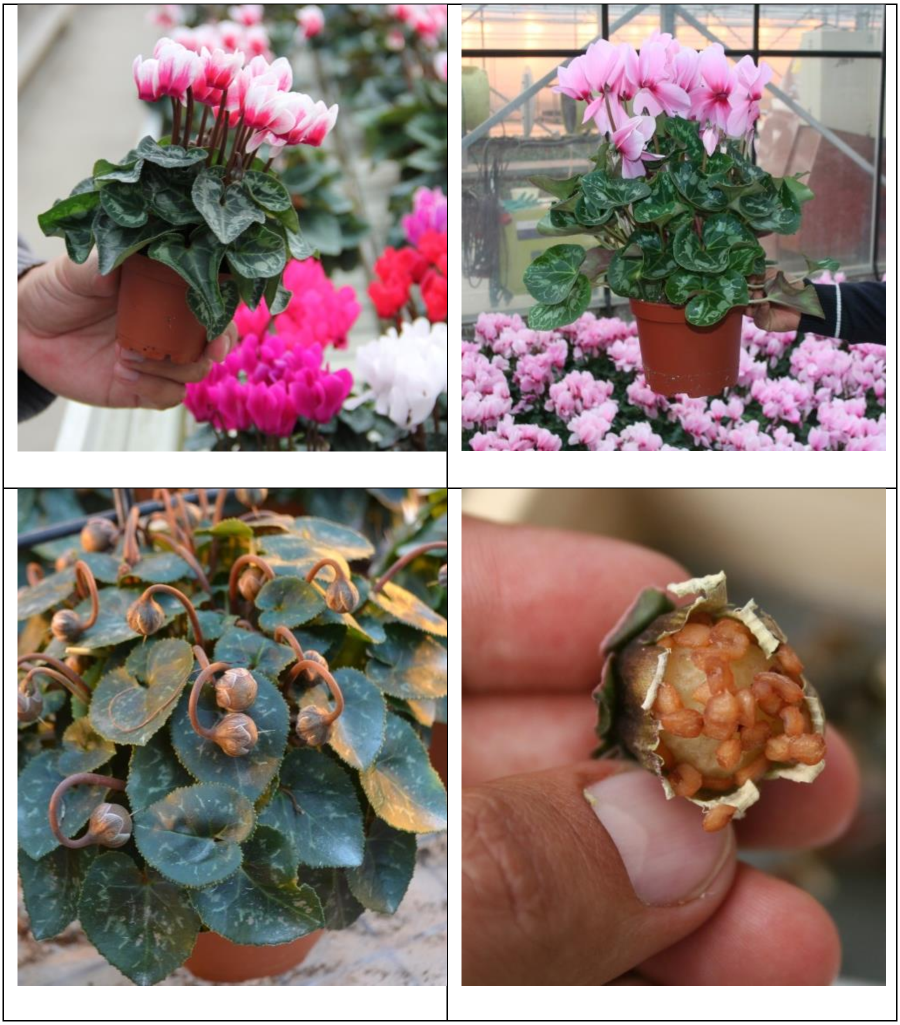

Figure 1: Different pot sizes, fruit capsules and seeds of cyclamen (Original by Salman)

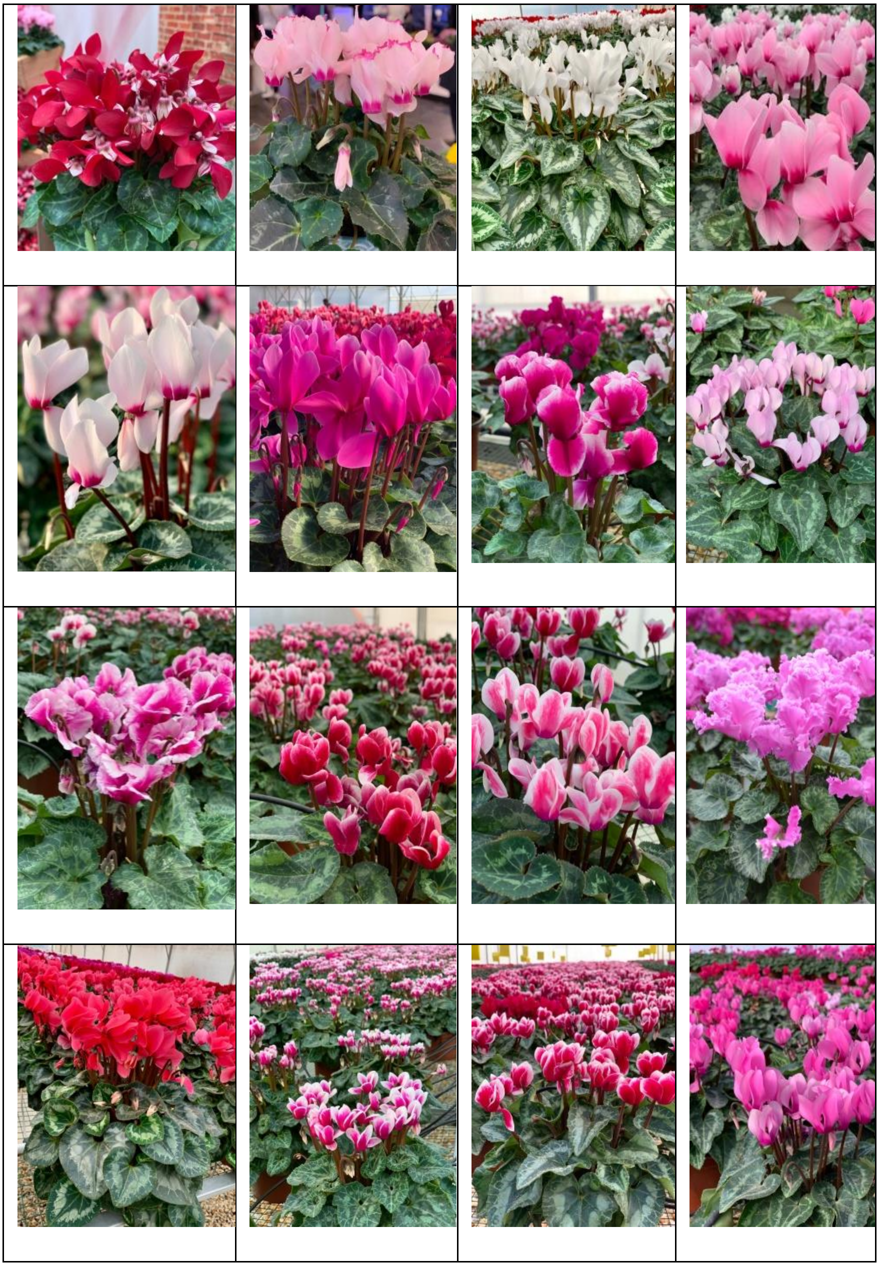

Figure 2: The color range of cyclamen varieties (Original by Salman)

1. CYCLAMEN PLANT STATUS IN THE WORLD

Although the exact figures are not known, according to the data obtained as a result of the meetings held with Schoneveld Breeding (Netherlands) company officials in 2020, the annual seed production of cyclamen is approximately 250 million units. If this total value is distributed according to continents, 150 million of it is grown in Europe, 60 million in Asia, 25 million in the United States, 5 million in South America, 10 million in Australia and 0.5 million in Africa. When the seedling and flower production capacity is examined, the highest production potential in Europe is realized in the Netherlands with 40 million pieces, followed by Italy with 20 million pieces and Germany with 20 million pieces. France 15 million, England 10 million, Eastern Europe 10 million, Poland 5 million, Spain / Portugal 10 million and other countries total around 10 million. In Asian countries, the most cyclamen cultivation is in Japan with 35 million, followed by China with 10 million. Korea, Turkey and the rest of the countries carry about 5 million cyclamen plant production (Salman, 2020).

2. PLANT QUALITY AND MARKET DEMANDS

Production quality, quantity and market demands of the cyclamen plant vary according to continents. In Europe, where production is the most intense, it is seen that producers produce very large quantities (0.5 - 9 million pieces/producer) and under modern greenhouse conditions, due to the high price pressure. The marketing of the plants produced is done by auction or wholesale. Quality production is a must in Europe, where production exceeds the demand.

Unlike the varieties found in Europe, more mini cyclamen varieties are grown in the Asian market. Here, plants are sold at high prices. It is seen that the quality is high in Japan, where the production is most intensive and lower in China. In the Asian market, producers produce in lower quantities (0.01-0.5 million units/manufacturer) and market their products as auction and wholesale.

Colour and plant size plays an important role in preference in the United State. Although the quality of the plants grown here is low, the producers are medium-sized (0.05-1.5 million units/producer) and the marketing is carried out by auction.

In Turkey, the market focusing more on price than quality; growers producing small scale (0.05-0.5 million units/manufacturer), locally unsuitable climate and the lack of professional knowledge remain as the main problems.

Marketing of plants is carried out to garden markets, supermarkets and, in recent years, municipalities. Standard varieties are preferred in product variety.

The companies that come to the fore in the world of cyclamen seedling cultivation; Beekenkamp, Florensis, Vollebregt, Schneider Young Plant, Floripro Services in the Netherlands, Sentier in Italy, Padana, Lazzeri, Bigi Seeds, Domina, Planta, Graines Voltz in France, Young Plants in England, Early Ornamentals, in Germany Sprunken, Volmary is Ball Century in China. In Japan, more producers grow their own seedlings. In Turkey, Tasaco in Yalova, with Ege Plantek and Baycikoop in the Aegean region raise their own seedlings. Small producers, on the other hand, produce seedlings with their own means (Salman et al., 2016).

3. SEEDLING (SEED SOWING, GERMINATION AND TRANSPLANTING)

Since seedling cultivation in cyclamen is a very sensitive process that requires knowledge, experience and a long time, seedling production is carried out by seedling companies specialized in this field and growers meet their seedling demands from these companies. In order to have the desired quality plant production, it is extremely important to fulfil all the conditions from seed planting to the marketing stage. Seed sowing constitutes the first stage of the production period. Cyclamen seeds, which are healthy and have high vitality, are sowed on trays and then moistened by covering them with vermiculite. Sowed trays are placed on top of each other and tightly closed with stretch film to protect their moisture. Since the seeds germinate in the dark environment, the trays placed on the pallet are covered with a black cover in a way that is not translucent to light (Figure 3). Germination takes place between 20-23 days, depending on the variety, in a dark environment with 18 ^{o}C and 95% humidity. Keeping this period longer causes the seedlings to grow excessively, which is undesirable. After the germination process, the trays are taken to the greenhouse and covered with a fleece tent for 14 days (Figure 4). In this way, both the preservation of moisture and excessive growth of the seedlings are prevented, homogeneous development is provided. Care should be taken to keep the trays moist so that the first leaflets can develop in a quality manner after germination. After the trays taken into the greenhouse environment are irrigated with clean water for the first two weeks, irrigation is started in accordance with the fertilization program.

Figure 3: Seed sowing, covering with vermiculite and tightly closed with stretch film (Original by Salman)

Figure 4: Germination stage and covering with a fleece tent (Original by Salman)

4. TRANSPLANTING SEEDLINGS INTO POTS

The seedlings' arrival at the stage of planting in pots varies according to the variety characteristics. The most important indicator here is the leaflet number of the seedlings. When the seedlings formed 2-3 leaves in varieties with a pot diameter of less than 10 cm, and when the seedlings formed 5-6 leaves in varieties with a pot diameter of more than 10 cm, it was understood that the stage of planting in the pot was reached (Figure 5).

There are two important points to be considered during the planting phase of the seedlings that reach the desired size. The drainage holes of the pot should remain 3-5 mm above the surface of the table (Figure 6). In this way, excess water can be removed from the environment.

mini	large

Figure 5: Transplanting stage of mini and large varieties of cyclamen seedlings (Original by Salman)

The peat to be used for quality plant production must be well aerated, its pH value is in the range of 5.8-6.0 and EC value is in the range of 0.5-0.7. In addition, 80% peat, 10% cocos fibre and 10% perlite are recommended as a suitable mixture in the preparation of the potting substrate (Figure 6). Care should be taken not to reuse previously used substrates and pots in terms of hygiene. At the stage of filling the pot with the substrate, the substrate should not be overfilled either too much or too little. It is recommended to fill slightly above the pot level (Figure 7). In the case of filling below the pot level, the problem in obtaining the desired compact form in the development of the plant leaves can be experienced. Another important point to be considered during the planting of seedlings is that in mini varieties (pot diameter less than 10 cm), the seedling tuber remains above the soil level, in large varieties (pot diameter greater than 10 cm), it is the planting process so that half of the tuber remains in the soil (Figure 8). For the seedlings to adapt to the environment and provide root development, they should be watered with clean (without fertilizer) water for two weeks after planting in pots. The quality values of the irrigation water to be used should be in the range of EC 0.0-0.5 and pH 5.0-6.0. If necessary, irrigation water should be disinfected with sodium hypochlorite. It should be paid attention to irrigation in the early hours of the morning and overhead irrigation should be avoided. Otherwise, a suitable environment will be provided for the development of *Botrytis, Fusarium* and *Erwinia* diseases.

Figure 6: Pot and growing medium used in cyclamen production (Original by Salman)

Figure 7: Filling pot level with substrate (Original by Salman)

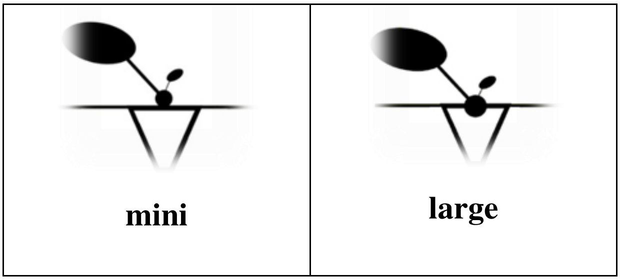

Figure 8: Planting process of mini and large cyclamen varieties (Shoneveld Breeding, 2016)

5. ENVIRONMENTAL CONDITIONS

Cyclamen can be grown in controlled greenhouses where the air humidity is 60-80%, the daytime temperature is 16 °C and the night temperature is 14 °C. The greenhouse temperature should be kept below 25 °C to prevent the formation of coarse and large leaves. Although cyclamen is a light-loving plant, shading must be done when the light intensity in the environment where it is grown reaches 30.000 lux and above, as it will be damaged by sunburn. The ambient temperature should be kept at 17-18 °C in the period after the seedlings are taken into pots and 14-16 °C after the potting process. The environment should be constantly ventilated.

Depending on the type of plant to be grown, it takes 25 to 34 weeks for it to become marketable (Figure 9, 10). In case the suitable growing conditions are not provided, this period may be longer.

Varieties		Growing Period		Pot Size
Micro	→	22 weeks	→	6-7 cm
Mini	→	24 weeks	→	9-10.5 cm
Large	→	28-30 weeks	→	12-13 cm
X Large	→	32-34 weeks	→	14-20 cm

Figure 9: Growth period and pot sizes in different cyclamen varieties

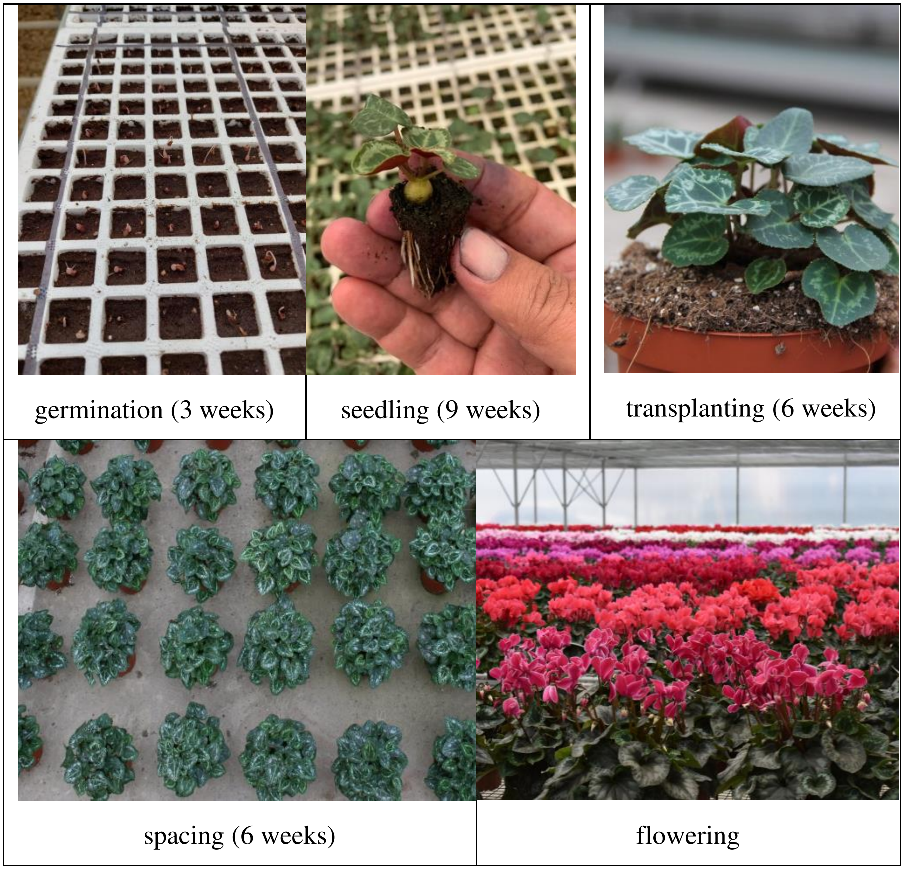

Figure 10: Production stages of cyclamen (Original by Salman)

6. FERTILIZATION

In the first two weeks after the seedlings are planted in pots, irrigation is carried out with clean water (without fertilizers). In the phase after two weeks, fertilized water with a N:K ratio of 1:1 should be applied in the range of 5.5-6.0 pH and 0.5-1.0 EC. While setting the EC value, the quality characteristics of the water used should also be taken into consideration. At this stage, 15:15:15 or 20:20:20 compound fertilizers should be prepared with microelements. The stage where the leaves of the plants in the pots placed close to each other in the production greenhouse come into contact with each other indicates that it is time for spacing. After the pot spacing is done, the N:K ratio should be increased to 1:2 ratio and EC 1.0-1.5 values. At the beginning of the first flowering or when rapid development is desired, the N: K ratio should be increased to 1:3-1:4 and the EC value should be applied between 1.2-1.8.

Growers producing especially in warm regions should give importance to strong vegetative development at the beginning. Entering the hot period with the desired strong plant structure will allow more successful plants to be obtained in the next stages. Otherwise, the plant growth will slow down during the hot period and the plant will enter the dormant period in very hot weather. Since salinity will increase in the growing medium (potting substrate) during this period, it will be appropriate to decrease the EC values. Phosphorus is an important nutrient element for cyclamen. Growers should be especially careful about the phosphorus content. In the absence of phosphorus, the plant will not be able to form enough roots, causing a slowdown in plant growth, and an insufficient vegetative component will occur.

7. IRRIGATION

Cyclamen should be watered neither too much nor too little. The best indication of this is that the pot should be neither too light nor too heavy when handling. For root development to be smooth, the potting soil must have enough moisture. Since plant root development will not be good in pots with very moist and heavy soil, growth disorders will be seen in cyclamen grown. Watering should be done early in the day and adjusted according to the weather temperature. Irrigations made in the form of overhead sprinkling may cause staining on the leaves depending on the quality of the irrigation water and the formation of diseases in hot weather, and thus product loss. In developed countries, irrigation is done on tables or concrete surfaces by inflating (ebb and flow) or drip irrigation (Figure 11). Drip irrigation method should be preferred especially in case of cultivation in hot regions.

8. DISEASE AND PESTS

As in all other crop production, it is extremely important to ensure hygiene in the production area. The spread of diseases can be prevented by paying attention to hygiene conditions. The pest population should be controlled in the production area by regular counting, and the traps for the pests should be hung inappropriate places. If diseases and pests are detected, it is important to start the struggle in time for success.

Another issue to be considered here is that chemicals in the same group are not used consecutively. Otherwise, pests will gain durability. The most common pests in cyclamen cultivation are *Duponchelia fovealis*, caterpillars, aphids, thrips, mytes and *Sciara* (Fungus Gnats). The most common fungal diseases are; *Botrytis, Anthracnose, Fusarium* and *Erwinia.* Timely implementation of appropriate control programs at every stage of production will ensure success in quality cyclamen production.

ebb and flow irrigation

drip irrigation

Figure 11: Ebb and flow irrigation and drip irrigation in cyclamen production (Original by Salman)

REFERENCES

Anonymous (2016). http://www.cyclamen.org/ indexCS.html

Bonduel, P. (1990). Les Plantes Bulbeuses. 17, rue du Montparnasse, 75298 PARIS CEDEX 06. ISBN 2 03 515113-9.

Cuisance, P. (1971). Les Plantes D'Appartement Larousse. Librarie Larousse, 17, rue du Montparnasse, 75006 PARIS. ISBN 2 03 0747 06 8.

Ekim, T., Koyuncu, M., Guner, A., Erik, S., Yıldız, B., & Vural, M. (1991). Türkiye'nin Ekonomik Değer Taşıyan Geofitleri Üzerinde Taksonomik Ve Ekolojik Araştırmalar. T.C. Tarım Orman ve Köyişleri Bakanlığı Orman Genel Müdürlüğü, İşletme ve Pazarlama Daire Başkanlığı, O. E. M. Eğitim Dairesi Başkanlığı Yayın ve Tanıtma Şube Müdürlüğü Matbaası, Ankara.

Grey-Wilson, C. (2002). Cyclamen. A Guide for Gardeners, Horticulturists and Botanists. New Edition. Batsford, London.

Gündoğan, M. T. (2003). *Cyclamen mirabile* Hildebr. ve *Cyclamen trochopteranthum* O. Schwarz Türleri Üzerinde Bazı Fitokimyasal Araştırmalar. Doktora Tezi. Muğla Üniversitesi. Fen Bilimleri Enstitüsü, Muğla.

Rissel, P. (1988). Les Plantes D'Intérieur. Larousse. Librarie Larousse, 17, rue du Montparnasse, 75298 Parıs Cedex 06. ISBN 2 03 515118-X.

Salman, A. (2014). Sağlıklı siklamen yetiştiriciliği. Plant Peyzaj ve Süs Bitkiciliği Dergisi, 4(12): 146-149.

Salman, A. (2020). Oral interview with Huub van Oorspronk, Schoneveld Breeding Regional Manager for Asia and Middle East.

Salman, A., Alp, Ş., Özzambak, M. E., Akça, M., & Koers, T. (2016). Türkiye'de ticari siklamen yetiştiriciliğinin önemi, sorunları ve çözüm önerileri. VI. Süs Bitkileri Kongresi, 19-22 Nisan 2016 Antalya, Turkey. s: 111-116.

Schoneveld Breeding (2020). https://schoneveld-breeding.com/en/growing-tips-for-transplanting-cyclamen-may-2020/ (Acces date: 15.11.2020)

CHAPTER 16

IMPORTANT MEDICINAL AND AROMATIC PLANTS USED AS ORNAMENTAL PLANTS

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INTRODUCTION

Medicinal and aromatic plants have different important values as food supply, medicines, cosmetics and spices from ancient times. While some of these plant species are collected from nature, some others have been adapted to be cultured However, most of the herbs used for therapeutic purposes are collected from nature (Acıbuca & Budak, 2018). The most studies on properties of medicinal and aromatic plants are focused on their therapeutic properties and uses. Medicinal and aromatic plants and their products including essences and drugs are widely considered in Turkey like all over the world and there are several studies on developing resistance against various abiotic and biotic stresses (Sener, 2010; Faydaoglu & Surucuoglu, 2011). The first record on using herbal therapy back to 5000 B.C. in Mesopotamian civilization which showed that 250 herbal drugs were used (Demirezer, 2010). Medicinal and aromatic plants used also in ornamental plants sector. Medicinal aromatic plants, also used as ornamental plants, are natural products used in agriculture to combat pesticides (Yogunlu, 2011). With this wide range of usage, medicinal and aromatic plants have a great increasing demand in all of the regions of Turkey (Pouya & Demir, 2017).

Despite of uneven distribution of plants, the high diversity of species obsrved in tropical regions such as northern parts of South America and the Indonesian archipelago and the number of species decrease towards the poles (Anonymous, 2016a). Totally, 422,000 flowering plant species known in the world which 72 000 species used for medical purposes that found with high diversity in China, USA and India, respectively (Schippmann et al., 2006). These plant species are cultivated in approximately 36 million hectares of land worldwide and coffee, cocoa, tea and red pepper have the most production amounts (Kosa & Gural, 2019). Total export value of medicinal and aromatic plants and their products was 204 billion dollars in 2018 with total and its import value of 202 billion dollars (Kırıcı et. al., 2020). The number of popular medicinal plants is around 4000-5000, which 3000 of them are traded and 900 of them are cultivated commercially worlwide (Arslan et al., 2015). Turkey has a wide variety of plant species due to its geographical location as well as climatic conditions.

The total number of species and subspecies in Turkey including foreign source as well as cultivated species is around 11.707 species, which 3 649 species are endemic taxa (31.82%). Most of the endemic species diversity could be observed in Mediterranean, Eastern Anatolia and Central Anatolia Regions (Acıbuca & Budak, 2018). The total export value of medicinal and aromatic plants of Turkey and their products was estimated around 980 million dollars in 2018 with import value of 1.5 billion dollars (Kırıcı et al., 2020). Oregano has the first rank with 25% of total export and Turkey has approximately 70-80% of world oregano trade. Also, coffee constitutes 61% of the total imports in Turkey. The most important essential oils export belongs to rose, oregano, stearopten and orange, respectively. On the other hand, the important essential oils imported in Turkey are mint, orange, lemon, other citrus fruits and lavender oils (Temel et al., 2018).

It is estimated that at least 1 000 of plant species are used for different purposes in Turkey which 400 species are traded worldwide (Arslan, 2014) which most of these species are collected from nature.

1. CLARY SAGE (*Salvia sclarea* L.)

Family	Lamiaceae
Spreading	Europe and Asia
Botanical Features	It is a biennial or perennial species that grows between 100-500 cm (Figure 1)
Flowering Time	June
Propagation Method	Seed and cutting
Used Part of The Plant	Leaves and flowering aboveground part
Essential Oil Content	2.5%
Composition	Tannins, flavones, essential oil (cineol (61.8%), linalyl acetate (14.3%), linalool (17.2%), geraniol (6.5%), geranyl acetate (7.5%), terpinol (15.1%), sclareol (5.2%)).
Medicinal Effect	Hormone regulator, gum ailments, antidepressant, antiseptic, antibacterial, anti-inflammatory, anticlimacteric, antiperspirant, astringent, digestive, antifungal, antiviral, constipation, asthma, pain reliever, expectorant, cold prevention, muscle pain relief, liver problems and antipyretic.
Usage Areas	Ornamental plant and therapeutic, tonic
Method of Use	Medicinal tea, tincture and perfumery

(Ozata, 2009; Tanrıkulu, 2019; Anonymous, 2020a)

Figure 1: Clary sage (Anonymous, 2020b)

2. CONFLOWER (*Echinacea purpurea* (L.) Moench)

Family	Asteraceae
Spreading	USA and Canada
Botanical Features	Perennial that can sized between 60-150 cm (Figure 2)
Flowering Time	July
Propagation Method	Seed
Used Part of The Plant	Flowering aboveground part and roots
Essential Oil Content	Flower (0.1-0.3%), dry leaves and root (0.06%)
Composition	Essential oil (germakren D (50-55%), β-myrcene, α-pinene (2-5%) and β-pinene (2-4%), borneol, caryophyllene (3-6%), limonene (2%) -3) and α-fellandrene (6-10%)), flavanoids, phenylprepanoids, polysaccharides, antioxidant, anti-inflammatory, antiviral, immunostimulator
Medicinal Effect	It is used in the treatment of common cold, cough, bronchitis, flu prophylaxis (preventive) and treatment, in the treatment of urinary system infections, externally in the treatment of wounds and burns.
Usage Areas	Therapeutic, cosmetic and ornamental plant
Method of Use	Medicinal tea and tincture

(Anonymous, 2016b; Tanrıkulu, 2019)

Figure 2: Conflower (Anonymous, 2020b)

3. ENGLISH LAVANDER (*Lavandula angustifolia* Miller)

Family	Lamiaceae
Spreading	Mediterranean countries
Botanical Features	Length between 1-1.5 m, evergreen, perennial, half-bushy (Figure 3)
Flowering Time	June-August
Propagation Method	Seed and cutting
Used Part of The Plant	Flower stem
Essential Oil Content	0.8-1.8 %
Composition	Aromatic oils (pinen, cineol, borneol, camphor, linalool (30-40%), linalil asetat (30-40%), phenolic substances (flavonoids, coumarins, tannins), phytosterols, terpenoids.
Medicinal Effect	Expectorant, antiasthma, antidepressant, antifungal, antimigrene, analgesic, anxiolytic, aperitif, sedative, antiseptic, antispasmotic, carminative, burn treathment, antiacne
Usage Areas	ornamental plant, aromatherapy, cosmetic
Method of Use	Medicinal tea, tincture, bath and aromatic oil

(Anonymous, 2016c; Anonymous, 2020a; Asımgil, 1997; Derwich et al., 2010; Koc, 2005)

Figure 3: English lavander (Anonymous, 2020b)

4. CALENDULA (*Calendula officinalis* L.)

Family	Asteraceae
Spreading	Europe
Botanical Features	50 cm high, annual or biennial, hairy, herbaceous (Figure 4)
Flowering Time	May-November
Propagation Method	Seed
Used Part of The Plant	Flowers, leaves and stem
Essential Oil Content	<1 %
Composition	Aromatic oil (1,8-cineole (29.4%), g-terpenene (11.6%), d-cadinene (9.0%), b-pinene (6.9%) and a-thujene (6.3%)), phytosterols, flavonoids, bitter glycosides, carotenoids, carbohydrates, resins, terpenoids, mucilage, xanthophyll, organic acids
Medicinal Effect	Wound and burn healing, sunscreen, antimicrobial, antiseptic, antispasmotic, antiviral, astringent, detoxifier, antiemetic, anti-inflammatory, immunostimulant, jaundice, antiparasitic, analgesic, antimicrobial, stomach ulcer, anti cancer, antibacterial
Usage Areas	Cosmetic, ornamental plant and health
Method of Use	Medicinal tea, tincture, aromatic water, mouthwash, water bath

Anonymous (2020a); Koc (2005); Shahbaz (2013); Tanrıkulu (2019)

Figure 4: *Calendula* (Anonymous, 2020b)

5. IMMORTELLE (*Helicrysum arenarum* L.)

Family	Asteraceae
Spreading	Europe, South Asia and Anatolia
Botanical Features	Length between 10-70 cm, grayish, dense hairy, upright (Figure 5)
Flowering Time	July
Propagation Method	Seed and cutting
Used Part of The Plant	Flowering stems
Essential Oil Content	<1%
Composition	Aromatic oil (linalool, caryophyllene, eucalyptol (1,8-cineole), limonene, α-humulene, β-farnesene, γ-muurolene, γ-cadinene, δ-cadinene, α-ylangene and α-terpineol) phenolic substances (flavonoids, tannins), Viamin C, coumarin, resin
Medicinal Effect	Antispasmotic, diuretic, hepatoprotective, impotency, jaundice, rheumatism, eczema
Usage Areas	Cosmetic, ornamental plant, therapeutic and repellent
Method of Use	Medicinal tea and medicinal oil

(Asımgil, 1997; Bulbul, 2009; Liu et al. 2019)

Figure 5: Immortelle (Anonymous, 2020b)

6. MARSHMALLOW (*Althea officinalis* L.)

Family	Malvaceae
Spreading	America, Asia and Europe
Botanical Features	150-200 cm high, perennial (Figure 6)
Flowering Time	June
Propagation Method	Seed
Used Part of The Plant	Leaf, flower and root
Essential Oil Content	<1%
Composition	Aromatic oils (palmitic acid (7%), heptacosane (3.3%), nonacosane (7.2%), palmitic acid (6.8%), linoleic acid (omega-6) (18.0%), naphthalene decahydro 2,6-dimethyl (16.4 %), hypolaetin-8-glucoside (1.5%), ısoquercetin (5.4 %),kaempferol (6.1%), caffeic acid (0.8%), p-coumaric acid (1.6%)), phenolic compounds (phenolic acids, flavonoids, coumarins, tannins), phytosterols, starch, mucilages, peçtin, nitrogenous compounds (betaines and amino acids), sesquiterpenes, steroids, lipids and minerals
Medicinal Effect	Antitussive, anti-inflammatory, antiviral, antimicrobial, antifungal, pregnancy and lactation, free radical scavenging, laxative, diuretic, breast softener, preservatively, cough, respiratory irritations, emollient in skin wounds
Usage Areas	Therapeutic, cosmetic and food (vegetable)
Method of Use	Medicinal tea, tincture, syrup (root) and hydrosol

(Ozata, 2009; Kaya et al., 2010; Golshani et. al., 2015)

Figure 6: Marshmallow (Anonymous, 2020b)

7. ROSE GERANIUM (*Pelargonium graveolens* L.)

Family	Geraniaceae
Spreading	South Africa and Middle East
Botanical Features	60 cm high, evergreen, perennial (Figure 7)
Flowering Time	June
Propagation Method	Seed and cuttings
Used Part of The Plant	Leaves
Essential Oil Content	0.2 %
Composition	Aromatic oil (citronellol (33.6%), geraniol (26.8%), linalool (10.5%), citronellyl formate (9.7%) and *p*-menthone (6.0%))
Medicinal Effect	Antimicrobial, beautifies the skin, anti-diarrhea, sore throat, carminative, anemia, cirrhosis, infertility, kidney stones
Usage Areas	Aromatherapy, perfumes, cosmetics, tea and ornamental plant.
Method of Use	Aromatic water and medicinal oil

(Bulut et al., 2008; Bulbul, 2009; Swamy & Rao, 2009)

Figure 7: *Rose geranium* (URL-1)

8. EVENING PRIMROSE (*Oenothera biennis* L.)

Family	Oenotheraceae
Spreading	Europe and North America
Botanical Features	1 m high, annual or biennial, herbaceous (Figure 8)
Flowering Time	July
Propagation Method	Seed
Used Part of The Plant	Root, leaf, seed and seed oil
Composition	Seed oil (Seed oil (linoleic acid (74 %), γ-linolenic acid (9.2 %), oleic acid (7 %), palmitic acid (6.3 %), stearic acid (2 %), phytosterols, tannins, terpenoids
Medicinal Effect	Cough, asthma, rheumatoid arthritis and skin diseases, antioxidant, anti-inflammatory, antiallergic, antitumor, anticoagulant, immunomodulator, antiallergic, antiegzema
Usage Areas	Therapeutic, vegetables (leaves and roots), tea (aboveground parts), seeds (bakery products), ornamental plant
Method of Use	Medicinal tea and seed oil

(Timoszuk et al., 2018, Tanrıkulu, 2019; Anonymous, 2020a)

Figure 8: Evening primrose (Anonymous, 2020b)

9. THYME (*Thymus vulgaris* L.)

Family	Lamiaceae
Spreading	North Africa and Eurasia
Botanical Features	Small leaved, woody handle, perennial (Figure 9)
Flowering Time	June
Propagation Method	Seed and cutting
Used Part of The Plant	Flowering stem ends
Essential Oil Content	1-2.5 %
Composition	Aromatic oil (thymol and carvacrol (64 %), phenolic glycosides, flavonoids, saponins, tannins (7%)
Medicinal Effect	Menstrual disorders, rheumatism, antiseptic, cough suppressant, Antibacterial, antifungal, antihypertensive, antioxidant, antispasmotic, antiviral, digestive, expectorant, bronchitis, antimicrobial
Usage Areas	Food, ornamental plant and therapeutic
Method of Use	Medicinal tea and mouthwash

(Bozdemir, 2019; Anonymous, 2020a; URL-2)

Figure 9: Thyme (URL-3)

10. YARROW (*Achillea millefolium* L.)

Family	Asteraceae
Spreading	Eurasia, North America and North Asia
Botanical Features	60 cm high, perennial, fragrant, hairy and herbaceous (Figure 10)
Flowering Time	May-August
Propagation Method	Seed and root separation
Used Part of The Plant	Flower, aboveground part (fresh or dried), aromatic oil
Essential Oil Content	0.4-1.2 %
Composition	Alkaloids, aromatic substances (β-pinene (14.9–29.2%), sabinene (2.9–17.6%), 1,8-cineole (6.9–18.3%), β-caryophyllene (3.3–6.2%), (E)-nerolidol (0.5–6.4%), guaiol (0.3–11.8%) and chamazulene (0.1–13.3%)), carbohydrates, phenolic substances (flavonoids, coumarins, tannins), glycosides (saponins, sterols), fixed oils, vitamins
Medicinal Effect	Analgesic, antibacterial, antidiarrheal, anti-inflammatory; antihypertensive, anticoagulant, antipyretic /diaphoretic, antipruritic, antispasmotic, aperitif, astringent, digestive, hemostatic, hypotensive, choleretic, cicatrizan, diuretic, carminative, wound healing, menstrual regulator, appetizer
Usage Areas	Food, cosmetics, ornamental plant, therapeutic, insect repellent, fragrance
Method of Use	Medicinal tea, tincture (45%) and sitting bat

(Bayram et al., 2013; Ogretmen, 2014; Anonymous, 2020a)


Figure 10: Yarrow (Anonymous, 2020b)

11. GERMAN CHAMOMILE (*Matricaria chamolilla* L.)

Family	Asteraceae
Spreading	Southern and Eastern Europe, Western Asia, North Africa, Australia
Botanical Features	20-50 cm high, hairless, annual, herbaceous (Figure 11)
Flowering Time	May-July
Propagation Method	Seeds
Used Part of The Plant	Flower
Essential Oil Content	0.2-1 %
Composition	Essential oil (camazulene (1-1.5%), terpenic and sesquiterpenic compounds (such as bisabolol, bisabololoxide), mucilage, phenolic compounds (phenolic acids, flavonoids, coumarins, tannins), carbohydrates, terpenoids, fatacids
Medicinal Effect	Wound healing, eczema, analgesic, anxiolytic, antidiarrheal, anti-inflammatory, antiallergic, antidiabetic, antiphlogistic, antihemorrhoidal, antimicrobial, antipeptic, antispasmodic, antiulcer, antiviral, digestive, diuretic, emmenagogue, hypnotic, carminative, cholagogue, choleretic, musculotropic, sedative, cicatrizan, vulnerary, unaesthetic, diaphoretic, laxative, stomachic
Usage Areas	Therapeutic, ornamental plant, cosmetic (sunscreen etc.)
Method of Use	Medicinal tea, tincture, vapor and bathroom

(Anonymous, 2020a; Shahbaz, 2013; Amiragai & Koc, 2016)

Figure 11: German chamomile (Anonymous, 2020b)

12. ROSEMARY (*Rosmarinus officinalis* L.)

Family	Lamiaceae
Spreading	Mediterranean Countries, USA, Asia and Australia
Botanical Features	50-100 cm high, evergreen, bushy (Figure 12)
Flowering Time	May-June
Propagation Method	Seeds, cutting
Used Part of The Plant	Leaves
Essential Oil Content	1-2.5 %
Composition	Rosmarinic acid, tannins, organic acids, glycosides, aromatic oil 20% bornyl acetate, 5-12% camphor, 15-30% cineol), flavonoids, saponins, terpenoids
Medicinal Effect	Antirheumatic, wound closure, bile drainage, antiacne, antibacterial, anti-inflammatory, antidepressant, anticarcinogen, antimicrobial, antioxidant, antiparasitic, antisephalaic, antiseptic, antispasmotic, diuretic, carminative, lowering blood sugar, analgesic
Usage Areas	Spices, health, perfumery, ornamental plant (especially border plant),cosmetic, aromatherapy, pesticides
Method of Use	Medicinal tea (brewing), tincture (70%), bath, extract, hydrosol

(Asımgil 1997; Yasar, 2005; Ozata, 2009; Anonymous, 2020a; URL-4)

Figure 12: Rosemary (URL-5)

13. BASIL (*Ocimum basilicum* L)

Family	Lamiaceae
Spreading	Africa, Asia, South USA
Botanical Features	20-50 cm high, annual, herbaceous, stem erect (Figure 13)
Flowering Time	July-September
Propagation Method	Seed
Used Part of The Plant	Flowering stem and leaves
Essential Oil Content	0.25-1 %
Composition	Aromatic oil (estragole (87.3%), linalool (5.4%), methyl eugenol (1.5%), karyophyllene (2.4%), α-pinene (1.0%), β-pinene (0.8%), limonene (0.5%) and camphene (% 0.2)), saponins, tannins, cardiac glycoides, minerals
Medicinal Effect	Antiacne, antimicrobial, antidyspepsia, antiviral, antiinflammattory, antibacterial, antioxidant, antipyretic, antispasmotic, antitussive, anthelmintic, digestive, galactogogue, cardioprotective, carminative, sedative, stomachic
Usage Areas	Spice, perfumery, aromatherapy, cosmetics, repellent and ornamental plant
Method of Use	Medicinal tea and mouthwash

(Akgul, 1989; Anonymous, 2020a)

Figure 13: Basil (URL-6)

14. COMMON CENTAURY (*Centaurium erythraea* Rafn.)

Family	Gentianaceae
Spreading	Eurasia and North Africa
Botanical Features	60 cm high, biennial, hairless, upright (Figure 14)
Flowering Time	June- September
Propagation Method	Seed
Used Part of The Plant	Flower, flower stem and root
Essential Oil Content	<1%
Composition	Aromatic oil (neophytadiene (1.4%), thymol (2.6%), carvacrol (6.1%) and hexadecanoic acid (5.7%), bitter substances (terpenic), phenolic substances (acids, flavonoids), glycoside (erytaurin), alkaloid (kensianin (0.6-1.0 %))
Medicinal Effect	Acaricide, antialopecic, antidiabetic, anti-inflammatory, antihyperlipidemic, antimicrobial, antioxidant, antipyretic, aperitif, digestive, diuretic, hepatoprotective, carminative, sedative, soporific, appetizing, strengthening, antihelmintic
Usage Areas	Therapeutic and ornamental plant
Method of Use	Medicinal tea and tincture (70%)

(Koc, 2005; Bayrak Ozbucak et al., 2006; Anonymous, 2020a)

Figure 14: Common centaury (URL-7)

15. HAWTHORN (*Crataegus monogyna* Jacq.)

Family	Rosaceae
Spreading	Europe and North Africa
Botanical Features	2-6 m high, thorny, deciduous a shrub or a small tree (Figure 15)
Flowering Time	May-June
Propagation Method	Cutting
Used Part of The Plant	Flowered, leafy branch tips, unripe fruit and tree bark
Essential Oil Content	0.03-0.08%
Composition	Aromatic oils (benzaldehyde (83%), butyraldehyde (38%), (E)2-hexenal (22%)), phenolic acids, flavonoids, proanthocyanidins, tannins, triterpenic acids, glycosides, vitamins (especially C)
Medicinal Effect	Anxiolytic, antilipemic, antifebrile, antiasthmatic, antidiarrheal, anti-inflammatory, insomnia, antioxidant, diuretic, cardioactive, antihypertensive, sedative, antispasmotic
Usage Areas	Food, alcoholic beverage, ornamental plant, therapeutic
Method of Use	Medicinal tea, tincture (45%) and extract

(Asımgil, 1997; Koc, 2005; Ozderin, 2014)


Figure 15: Hawthorn (URL-8)

16. DOG ROSE (*Rosa canina* L.)

Family	Rosaceae
Spreading	Eurasia and Northwest Africa
Botanical Features	1-5 m tall, thorny shrub, deciduous, erect (Figure 16)
Flowering Time	May-June
Propagation Method	Cutting
Used Part of The Plant	Flowers, leaves, seeds and fruit
Essential Oil Content	0.038%
Composition	Aromatic oils (vitispirane (9.1-22.5%) benzene acetaldehyde (0.8%), nonanol (1.9-2.1%), (Linalool 1.9-2.1%) α-terpineol (0.5%), trans-β-caryophyllene (0.4%)), organic acids (malic acid, citric acid), pectin, proanthocyanidins, rutin, tannins, vitamins (especially A, B2, C)
Medicinal Effect	Astringen, antiarthritic, antioxidant, antidiarrheal, anti-inflammatory, antirheumatic, carminative, laxative, diuretic, gastroprotective, lithotriptic, refrigerant, ophthalmic, tonic, vermifuge
Usage Areas	Food, alcoholic beverage, ornamental plant, therapeutic, and cosmetic
Method of Use	Powders, medicinal tea, capsules, gels and creams

(Onal & Oruc, 2012; Shahbaz, 2013; Anonymous, 2020a; URL-9)

Figure 16: Dog rose (URL-10)

17. COMMON OLEANDER (*Nerium oleander* L.)

Family	Apocynaceae
Spreading	Mediterranean Countries
Botanical Features	2-4 m high, evergreen, perennial, erect shrub (Figure 17)
Flowering Time	April-September
Propagation Method	Cutting
Used Part of The Plant	Leaves, bark and flowers
Essential Oil Content	1.76%
Composition	Aromatic oil (α-thujone, 1.8-cineole, α and β-pinene, neriine, humulene, germacrene-D, limonene), glycosides, polysaccharides, tannins
Medicinal Effect	Anticancer, expectorant, diaphoretic, antimicrobial, diuretic, cardiotonic; against skin parasites (externally)
Usage Areas	Ornamental plant, therapeutic, insecticidal (leaves, bark), cosmetic, medical and food industries.
Method of Use	Medical tea, oil (flower) and extract

(Derwich et al., 2010; Shahbaz, 2013; Anonymous; 2020a)

Figure 17: Common oleander (Anonymous, 2020b)

18. COTTON LAVENDER (*Santolina chamaecyparissus* L.)

Family	Asteraceae
Spreading	Western European Countries
Botanical Features	30-60 cm high, evergreen, densely grayish hairy, perennial (Figure 18)
Flowering Time	May
Propagation Method	Seed and cutting
Used Part of The Plant	Flower stem
Essential Oil Content	< 1%
Composition	Aromatic oil (1.8 cineole (2-18%), artemisia ketone (0.1-28.1%), borneol (1-28%), camphor (trace-43%), copaenol (trace-15%), cubenol (1-17%), alloaromadendrene (19 %) flavonoids, terpenoids
Medicinal Effect	Antifungal, antimicrobial, antispasmodic, emmenagogue, vermifuge, digestive, antiinflammattory, antiseptic
Usage Areas	Ornamental plant and insect repellent (dried leaves)
Method of Use	Medicinal tea

(Demirci et al., 2000; Anonymous, 2020a)

Figure 18: Cotton lavender (Anonymous, 2020b)

19. BAY LAUREL *(Laurus nobilis* L.)

Family	Lauraceae
Spreading	Mediterranean countries
Botanical Features	3-10 m high, evergreen, perennial (Figure 19)
Flowering Time	June-July
Propagation Method	Seed and cutting
Used Part of The Plant	Fruit and leaves
Essential Oil Content	0.5-4%
Composition	Aromatic oils (1.8-cineol (30-50 %), alfa- terpinyl (7-39%), eugenol (2-12%) sabinene, linalool, eugenol acetate, methyleugenol, phellandrene, terponoids), tannin, mucilages, fixed oils (30-50%)
Medicinal Effect	Diaphoretic, stomach, analgesic, antidermatosic, antirheumatic, antiseptic, antitussive, digestive, diuretic, carminative
Usage Areas	Food, alcoholic beverage, ornamental plant, therapeutic, cosmetic and chemistry
Method of Use	Medicinal tea and fixed oil

(Celik & Yılmaz, 1996; Koc, 2005; Nurbas & Bal, 2005; Anonymous, 2016d)

Figure 19: Bay laurel (URL-11)

20. LINDEN (*Tilia tomentosa* Moench.)

Family	Malvaceae
Spreading	Eastern Europe
Botanical Features	40 m high, deciduous, tree (Figure 20)
Flowering Time	June-August
Propagation Method	Seed and cutting
Used Part of The Plant	Flower
Essential Oil Content	0.02-0.1%
Composition	Aromatic oil (α-pinen 5.2%, linalool 5.5% camphor 17.7% verbenon 10.9% borneol 10.9% 1,8-sineol 10.1%), phenolic substances (phenolic acids, flavonoids, tannins), mucilages
Medicinal Effect	Anti-inflammatory, antinociceptive, antispasmotic, astringent, diaphoretic, digestive, emollient, hepatoprotective, hypotensive, sedative, urine enhancer, antipyretic
Usage Areas	Food (honey) and therapeutic
Method of Use	Medicinal tea (brewed, cold or hot) and tincture

(Anonymous, 2019; Karakaş et al., 2019; Anonymous, 2020a)

Figure 20: Linden (URL-12)

CONCLUSION

Turkey is located in the border of two continents with different climatic conditions is the only country in the world with 3 phytogeographical regions (Europe-Siberia; Mediterranean; Iran-Turan) intersects and high plant species diversity. So; it is supposed the origin and differentiation center of many genera and sections with various species and genetic diversity. From ancient times, people collected the plant species from natüre and used them for food, therapeutic purposes (phytopherapy: treatment with medicinal plants), tea, spices, dyes, insecticides animal diseases treatment, resin, gum, essential oils, soft drinks and cosmetics industry. Nowadays, using of medicinal and aromatic plants and their products from natural conditions has been considered due to the high side effects of synthetic drugs as well as resistance of organisms to these drugs.

Medicinal plants contain glycosides, organic acids, tannins, alkaloids, fixed oils, essential oils, resinous compounds, vitamins and antibiotics. Secondary metabolites synthesized as complex compounds in medicinal and aromatic plants serve as antibiotic, antioxidant, pharmaceutical, fragrance and flavors, food and beverage additive, allelochemical, promoter of pollination and fertilization, insecticide and growth regulator.

Almost 600-700 plants are used for medicinal purposes in Turkey. Medicinal and aromatic plants are used also in ornamental plants sector due to their characteristics such as shape, form, color and aesthetic features. The importance of these plant species in medicine and pharmacy has been revealed in Turkey, but unfortunately in landscape designs has not been focused yet.

REFERENCES

Acıbuca, V. & Budak, D. B. (2018). Place and importance of medicinal and aromatic plants in the world and Turkey. Çukurova J. Agric. Food Sci., 33(1), 37-44.

Akgul, A. (1989). Volatile oil composition of sweet basil (*Ocimum basilicum* L.) cultivating in Turkey. Molecular Nutrition & Food Research, 33(1): 87-88.

Amiragai, M. E. & Koc, A. (2016). Effects of sowing date and nitrogen applications on production of essential oil and yield of *Matricaria chamomilla* L. Atatürk Univ., J. of the Agricultural Faculty, 47(1): 31-34.

Anonymous (2016a). Medicinal Aromatic Plant and Good Life, Izmir Commodity Exchange (http://itb.org.tr/dosya/rapordosya/tibbi-aromatik-bitkiler-ve-iyi-yasam.pdf?v=1506816000032 (Access date: 02.03.2017)

Anonymous (2016b). Echinacea. Afyon Kocatepe University, Medical and Aromatic Plants Working Group, TABCAG Handbooks. p: 1-20.

Anonymous (2016c). Lavender. Afyon Kocatepe University, Medical and Aromatic Plants Working Group, TABCAG Handbooks. p: 1-20.

Anonymous (2016d). Bay Laurel. Afyon Kocatepe University, Medical and Aromatic Plants Working Group, Tabcag Handbooks. p. 1-20.

Anonymous (2019). https://www.yeniakit.com.tr/haber/ihlamur-ne-zaman-toplanir-ihlamurun-faydalari-nelerdir-801706.html (Access date: 10.11.2019)

Anonymous (2020a). Zeytinburnu Medicinal Plants Garden. Zeytinburnu Municipality Cultural Publications. Book No: 35.

Anonymous (2020b).Van Yuzuncu Yil University, Medicinal Aromatic Plant Garden.

Arslan, N. (2014). Our endemic medicinal plants. II. Medicinal and Aromatic Plants Symposium, 23-25 September 2014 Yalova, 9-21.

Arslan, N., Baydar, H., Kızıl, S., Karık, U., Sekeroglu, N., & Gumuscu, A. (2015). Changes and new searches in medicinal and aromatic plants production. VII. Turkey Agricultural Engineering Technical Congress, 483-507.

Asımgil, A. (1997). Medicinal Plants. Timas Printing. p. 32-191.

Bayrak Ozbucak, T., Kutbay, H. G., & Özbucak, S. (2006). Flora of Boztepe Picnic Area (Ordu City). Ecology, 15(59): 37-42.

Bayram, E., Sonmez, C., Ekren, S., Tatar, O., Gurel, A., & Hayta, S. (2013). Determination of yield, essential oil and chamazulene content of species belong to *Achillea millefolium* L. group. Ege Univ J. of the Agricultural Faculty, 50(1): 87-96.

Bozdemir, C. (2019). Economic ımportance and usage fields of oregano species growing in Turkey. Yüzüncü Yıl Univ. Journal of Agricultural Sciences, 29(3): 583-594.

Bulbul, E. (2009). From Nature to Us. Inkilap Publishing House. p. 19-98.

Bulut, Y., Atabeyoglu, O., & Kordali, S. (2008). The Effects of *Pistacia terebinthus* leaf extracts and giberellic acid on plant height, inflorescence survival and inflorescence numbers of *Pelargonium* 'Ringo Deep Scarlet'. Journal of the Faculty of Agriculture of Atatürk University, 39(1): 123-126.

Celik, S. & Yılmaz, O. (1996). The fatty acid composition of *Laurus nabilis* L. leaves and fruits. The Journal of Food, 21(3): 165-167.

Demirci, B., Ozek, T., & Baser, K. H. C. (2000). Chemical composition of *Santolina chamaecyparissus* L. Essential Oil. Journal of Essential Oil Research, 12(5): 625-627.

Demirezer, L. O. (2010). Our responsibilities regarding the use of plants in medicine. Herbal Treatment Symposium, 5-6 June 2010 Zeytinburnu / Istanbul, 87-88.

Derwich, E., Benziane, Z., & Boukir, A. (2010). Antibacterial activity and chemical composition of the essential oil from flowers of *Nerium oleander*. Electronic Journal of Environmental, Agricultural & Food Chemistry, 9(6): 1579-4377.

Faydaoglu, E. & Surucuoglu, M. S. (2011). Using medicinal and aromatic plants from past to present and its economic importance. Kastamonu University Journal of Forestry Faculty, 11(1): 52-67.

Golshani, Y., Zarei, M., & Mohammadi, S. (2015). Acute/Chronic Pain Relief: Is *Althaea officinalis* essential oil effective. Avicenna Journal of Neuro Psycho Physiology, 2(4): 100-105.

Karakas, N., Okur, M. E., Oztunc, N., Karadag, A. E., Kultur, S., & Demirci, B. (2019). Investigation of volatile components and various in vitro biological activities of *Tilia tomentosa* Moench flowers. Mersin University Journal of Health Sciences, 12(2): 220-229.

Kaya, G. O., Kucukboyacı, N., Ayaz, F., Hurkul, M. M., Uzunhisarcikli, M. E., & Koroğlu, A. (2010). Evaluation with regard to the European pharmacopoeia of the herbal drugs which sold in the name of "hatmi" in local herb markets in Ankara and Adana. J. Fac. Pharm, Ankara. 39(4): 291-316.

Kırıcı, S., Bayram, E., Tansı, S., Arabacı, O., Baydar, H., Telci, I., Inan, M., Kaya, D. A., & Ozel, A. (2020). Current situation and future in the production of medicinal and aromatic plants. Turkey IX Agricultural Engineering. Technical Congress. 1: 505-528.

Koç, H. (2005). Derman Plants. Akcay Publications, p. 140-409.

Kosa, S. & Gural, S. M. (2019). Medicinal and aromatic plants and their use in landscaping. Peyzaj, 1(1): 41-54.

Liu, X., Jing, X., & Li, G. (2019). A process to acquire essential oil by distillation concatenated liquid-liquid extraction and flavonoids by solid-liquid extraction simultaneously from *Helichrysum arenarium* (L.) Moench ınflorescences under ıonic liquid-microwave mediated. Separation and Purification Technology, 209: 164-174.

Nurbas, M. & Bal, Y. (2005). Recovery of fixed and volatile oils from *Laurus nobilis* L. fruit and leaves by solvent extraction method. Eskisehir Osmangazi University J. of Eng.&Arch.Fac., 18(2): 15-24.

Ogretmen, N. G. (2014). Effect of Different Cultural Practices on Yield and Some Quality of Yarrow (*Achillea asplenifoliaa* and *Achillea collina*) Some Features of Populations. Master Dissertation, Adnan Menderes University, Aydın.

Onal, A. & Oruc, S. (2012). Investigation of dyeing properties of cotton and woollen fabrics with extract obtained from *Rosa canina* fruits. Gaziosmanpaşa Research Journal, 1: 21-26.

Ozata, N. (2009). Phytotherapy and Aromatherapy. Dogan Egmont Publishing, p. 26-63.

Ozderin, S. (2014). Botanical and Chemical Properties of Some Hawthorn (*Crataegus* L. spp.) Taxa Natural Distributed in Western Anatolia. Doctarate Dissertation, Süleyman Demirel University, Isparta.

Pouya, S. & Demir, S. (2017). Using medicinal and aromatic plants in landscape architecture. Journal of International Social Research, 10(54): 1114-1125.

Schippmann, U. W. E., Leaman, D., & Cunningham, A. B. (2006). A comparison of cultivation and wild collection of medicinal and aromatic plants under sustainability aspects. Frontis, 17: 75-95.

Sener, B. (2010). Herbal medicines and herbal medicine legislation, Herbal Treatment Symposium, 5-6 June 2010, Zeytinburnu, Istanbul, 153-171.

Shahbaz, S. E. (2013). Medicinal Plants Of Iraq Book, Serial Number: 90, p. 116-476.

Swamy, K. N. & Rao, S. S. R. (2009). Effect of 24-Epibrassinolide on growth, photosynthesis, and essential oil content of *Pelargonium graveolens* (L.) Herit. Russian Journal of Plant Physiology, 56(5): 616-620.

Tanrıkulu, N. (2019). Guide to Correct Use of Medicinal Plants Book. ISBN: 978605-4325-32-0, p. 65-84.

Temel, M., Tınmaz, A. B, Ozturk, M., & Gunduz, O. (2018) Production and trade of medicinal aromatic plants in the world and Turkey. KSU Journal of Agriculture and Nature, 21(Special Issue): 198-214.

Timoszuk, M., Bielawska, K., & Skrzydlewska, E. (2018). Evening primrose (*Oenothera biennis*) biological activity dependent on chemical composition. Antioxidants, 7(8): 108.

Yasar, S. (2005). Determination of Fixed and Essential Oil Contents and Soil Characteristic of Some Perennial Medical Plants That Grow Naturally in The Campus of Çukurova University. Master Dissertation, Çukurova University, Adana.

Yogunlu, A. (2011). Fırat Development Agency, Tunceli Plants with Economic Value Report. Sectoral Research Series-5, Fırat Development Agency. 1-25.

URL-1. https://www.google.com/search?q=Pelargonium+graveolens&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiIkfbRyv3sAhWOlhQKHUFQAKwQ_AUoAXoECAcQ

Aw&biw=1366&bih=657#imgrc=Ad3cXWR0Cq2yWM&imgdii=O_Pd5E_Tzzdn8M (Access date: 10.11.2020)

URL-2. file:///C:/Users/R%C3%BCveyde/Downloads/AROMAT%C4%B0K%20B%C4%B0LE%C5%9E%C4%B0KLER%202%20(1).pdf) (Access date: 10.11.2020)

URL-3. https://www.google.com/search?q=Thymus+vulgaris&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjF0dD4zf3sAhWE_KQKHZZTChoQ_AUoAXoECAcQAw&biw=1366&bih=657#imgrc=eHdzd_4j-GYMRM&imgdii=Bdzlngmb9Agc0M (Access date: 10.10.2020)

URL-4. http://e-kutuphane.teb.org.tr/pdf/eczaciodasiyayinlari/ila_habr-kas07/7.pdf)

URL-5. https://www.google.com/search?q=rosmarinus+officinalis&rlz=1C1SQJL_trTR908TR908&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjvoITK14LtAhU1C2MBHSlgABgQ_AUoAnoECB0QBA&biw=1366&bih=601#imgrc=7B2nb-3kCyKstM (Access date: 09.10.2020)

URL-6. https://www.google.com/search?q=Ocimum+basilicum&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjTqbrl0v3sAhXmBGMBHXQoA7wQ_AUoAXoECAcQAw&biw=1366&bih=657#imgrc=7X2j9AJvEpRfcM&imgdii=ewMsBUSkSiJYgM (Access date: 10.11.2020)

URL-7. https://www.google.com/search?q=Centaurium+erythraea&source=lnms&tbm=isch&sa=X&ved=2ahUKEwj4upfd0_3sAhVN_aQKHYJvDxQQ_AUoAXoECAYQAw&biw=1366&bih=657#imgrc=dYak3VRNPve64M (Access date: 10.10.2020)

URL-8. https://www.google.com/search?q=Crataegus+monogyna&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjq0v3A1f3sAhUR6aQKHV4ND24Q_AUoAnoECAcQBA&biw=1366&bih=657#imgrc=4b6Q1VC5Hl4-jM&imgdii=ZiuX3tzjukqWXM (Access date: 10.11.2020)

URL-9. https://www.cirsafety.org/sites/default/files/rosaca092016tent.pdf): Safety Assessment of Rosa canina-derived Ingredients as Used in Cosmetics. (Access date: 10.11.2020)

URL-10. https://www.google.com/search?q=Rosa+canina&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiUrpOV1_3sAhVStIsKHeWfAEoQ_AUoAXoECAcQAw&biw=1366&bih=657 (Access date: 10.11.2020)

URL-11. https://www.google.com/search?q=Laurus+nobilis&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiMip3c3f3sAhVXA2MBHT3yBLMQ_AUoAXoECAcQAw&biw=1366&bih=657 (Access date: 10.11.2020)

URL-12. https://www.google.com/search?q=Tilia+tomentosa&source=lnms&tbm=isch&sa=X&ved=2ahUKEwjfs4jx3f3sAhWE3OAKHfTYAcIQ_AUoAXoECAcQAw&biw=1366&bih=657 (Access date: 10.11.2020)

CHAPTER 17

AN INTRODUCTION TO ENGLISH LAVENDER, AN ORNAMENTAL MEDICINAL PLANT

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INTRODUCTION

Lavandula angutifolia, syn. *L. vera*, *L. spica* or *L. officinalis* are the fragrant ornamental plant species high medicinal value. Its inflorescences, is evaluated in fresh and dried forms with multiple uses. Lavender is also extensively used in gardening and park or urban landscape architecture designs. It is also important for extraction of essential oils used in paint, perfumery, pharmacy, and cosmetics industry. Dry flowers are also used as decoration items, and as tinctures, teas, or capsules (Nemes, 2017).

The lavender was first reported in 1098–1179 by physicians Abbess Hildegard followed by Nicolas Culpepper. The medicinal use of lavender has also been mentioned in British Pharmacopoeia and the first English Herbals 250 years past. Lucena et al. (2020) recommends use of lavender instead drugs for to induce sleep in nursing home patients. Lavender essential oil mixed with *Spaghnum* was also used to treat and disinfect wounds in 2nd World War (Lis-Balchin, 2004).

The review presents some distinguished features of lavender in terms of therapeutic, cosmetics, cut flower and landscaping uses .

1. BOTANY

Lavandula belongs to order Lamiales, family Lamiaceae, subfamily Nepetoideae and tribe Ocimeae (Toma, 2009); with ~ 200 genera and 3200 species found both in tropical and temperate regions. Whereas, *L. aungustifolia* is native to the West Mediterranean Region.

Lavender is a, perennial evergreen shrub that grows to ~100 centimeters in length with hemispherical natural contour as a bush. The hybrids are dwarf with height of 40-60 cm and diameter of 80-120 centimeter. It has grey-green or bluish green simple leaves that are tapered, flattened and oblong. They have silver colored hairs containing fragrant oil. Leaves are usually long and narrow with a woody root system and are branched at the bottom. Their roots absorb water that can grow below ground to 3-4 meters deep. The flowers are borne in whorls, aromatic and spiky, violet blue in color, but pink and white cultivars are also found from June to September.

The typical inflorescence of lavender is vertical with pair of cymose floral whorls developing at nodes. Each cyme has 3 flowered dichasium.

Inflorescence, epidermis of stems, and leaves contain glandular hairs, that secrete a scent specific to this species (Omidbaigi, 2000).

2. PROPAGATION AND HARVEST

Lavender propagates easily in a variety of ways, although vegetative propagation (unsexual propagation), such as layering, cuttings and division are best for reproduction because propagation by seeds (sexual propagation) may produce heterozygous plants.

It grows best on gritty and sandy loams, on stony grounds and well-drained soils. Lavender is drought tolerant plant that will thrive in a sunny position on well-drained soils. It is needs very low maintenance, and demands only a short period of watering each year to keep it looking good.

3. LAVENDER AND LANDSCAPE

The planting design using odoriferous foliage lavender can be associated with perennials or with other types of plants (Figure 1). the habit and morphological properties, of other annuals (*Argyranthemum* sp., *Molucella laevis* and *Chrysanthemum coronarium*) or perenniels to appeal human senses like hearing, sight, smell, taste and touch), (Hank, 2013).

Figure 1: Planting of some attractive varieties of lavender in landscaping

The hybrids have height of is 80-100 cm with diameter of 150 cm (Bernáth, 2000).

Regardless of the number of hybrids and cultivars with range of size sizes the original *L. angustifolia* is hard to beat. Popular cultivars include:

3.1. *L. angustifolia* cv. 'Hidcote'

It is a very hard and upright, with l dark purple flowers and keep color when dried. They have blue-green leaves and are bushy and makes good hedges. Its flowers can be harvested in early summer to encourage 2nd flowering.

3.2. *L. angustifolia* cv. 'Munstead'

It is popular for hedging has paler mauve blossoms and are 55-85 cm in height, including spikes.

3.3. *L. angustifolia* cv. 'Thumbelina Leigh'

A small variety with purple and violet flowers. It repeats flowers, on earlier blooms harvest. This cultivar is a nice choice for containers and/or pots.

3.4. Hybrid *Lavandula* × *intermedia* cv. *'Alba'*

The vigorous hybrid is also called white lavender with height of ~ 90 cm tall, including floral stems. It starts flowering from late July or early August.

3.5. *L. angustifolia* cv. 'Lowmar'

This variety has purple flowers, and is variegated with yellow leaves fading to creamy.

3.6. *L. intermedia* cv. 'Alba'

A cultivar with long, erect, spikes white flowers. It grows up to 85 cm in length.

3.7. *L. intermedia* cv. 'Arabian Night'

This cultivar has pointed long spikes with violet flowers and grows to 100 cm.

3.8. *L. angustifolia* cv. 'Beechwood Blue'

A dwarf cultivar and grows up to 30-45 cm, or 45 cm in length with blue flowers and green stems.

3.9. *L. angustifolia* cv. 'Imperial Gem'

It is an early flowering cultivar with plant height of 60 cm and dark purple inflorescence that starts blooming from first or 2nd week of June.

3.10. *L. angustifolia* cv. 'Little Lottie'

The cultivar is very dwarf with a plant height of 25 cm pale pink stems. It is generally grown as border or border edging plant.

3.11. *L. angustifolia* cv. 'Loddon Blue'

The cultivar produces flowers that are deep purple-blue in color and grows up to 20-30 cm height with dark green-grey plant foliage. It is ideal for rock gardens or as low border hedge plant.

3.12. *L. angustifolia* cv. 'Loddon Pink'

A Loddon Pink is a compact bushy shrub up to 65 cm tall. Ideal for small spaces, dishes and terraces, flat boxes. It grows in any soil, even poor, dry, sandy or rocky, and welcomes sun exposure. It produces a large number of fragrant flower branches in June-July. Its foliage is completely green and shiny, is very fragrant and remains decorative throughout the year.

4. SECONDARY METABOLISMS AND PHOTOCHEMISTRY

It has several species with varying chemical characteristics (Cavanagh & Wilkinson, 2002). With 0.5 to 3% essential oils. and over 100 chemical constituents, including alcohols like perillyl alcohol, ketones like camphor, polyphenols like tannins, including terpenes like linalyl acetate, triterpenes, limonene, linalool, but also flavonoids, cineole, coumarins, and in different amounts and percentages, depending on regions, genotypes, cultivars, species, time of harvest and climatic conditions. The major constituents of lavender are, linalool (primary active constituent), and linalyl acetate (greater proportion). Both have pharmacological properties, including sedative and calming effects (Basch et al., 2004).

5. EFFECTS OF LAVENDER ON ANXIETY

Lavender is traditionally, anxiolytic in characteristics. In fact HMPC, (Committee on Herbal Medicinal Products) of the EMA (European Medicines Agency) has recognized essential oil obtained of *L. angustifolia* "traditional" herbal medicine product to treat sleep disturbances and mild symptoms of exhaustion and mental stress, (Donelli et al., 2019). Its main constituents inhibit the serotonin transporter - SERT and antagonize the NMDA-receptor (López et al., 2017).

6. ANTIOXIDANT AND ANTIMICROBIAL ACTIVITIES

Traditional preservation methods, pesticides and antibiotics, are replaced by natural alternatives due to concerns about the use of synthetic chemical products these days.

There is an ever increasing concern of public about artificial additives like benzoates, sulphur dioxide and nitrates are the most common preservatives used in food industry with a growing desire for their replacement with natural alternative options. Lavender essential oil is an accepted option and is popular alternative for food industry with biological properties and attractive aroma. The oil has significant effects against the several microorganisms, including *Candida albicans*, *Staphylococcus aureus* and *Escherichia coli* (Hui et al., 2010). They have antioxidant activities and prevent purification of food as approved by many researchers (Gülçin et al., 2004; Danh et al., 2013).

The antioxidants properties reduce oxidative stress in/on cells and could be usefully used to treat human diseases, like inflammatory & cardiovascular diseases and cancer (Krishnaiah et al., 2011).

7. EFFECT OF LAVENDER ON WOUND HEALING

Lavender essential oil is topically applied for wound healing (Koca Kutlu et al., 2013; Reddy et al., 2013). Lavender oil reduce pain after episiotomy and redness of incision sites in very effective manner (Vakilian et al., 2011; Koca Kutlu et al., 2013). Topical application of lavender oil on aphthous ulceration reduce ulcer size significantly as in both animals' clinical studies (Altaei, 2012). It also promoted differentiation of fibroblasts, collagen synthesis, accompanied by up-regulation of TGF-β suggesting potential of lavender oil to promote wound healing at early phases rapid of granulation tissue formation, collagen induced tissue remodeling and wound contraction through up-regulation of TGF-β.This raise possibility of new complementary approaches in injury treatments (Mori et al., 2016).

8. HUMAN SHORT-TERM MEMORY

Alzheimer's disease in adults and attention deficit hyperactivity disorder in children are very common and are adversely affecting mental health in human beings these days. Some medical specialists prefer to use aroma therapy under these conditions compared to prescribing synthetic drugs. The aromatherapy is considered more trustworthy among many medical professionals. Researchers indicated that the essential oil of lavender has significantly increased the image memory (Filiptsova et al., 2018).

9. VERMICOMPOSTING APPLICATION

An experiment was conducted about the use of organic fertilizer on shoot yield and essential oil content of lavender, at Forest and Rangelands Research Institute, Karaj, Iran, during 2013-14, 0, 5, 10 and 15 ton/ha vermicompost in comparison to 0, 10, 20 and 30 ton/ha cow manure. A randomized complete block design (RCBD) factorial experiment with 3 replications. The experimental results indicated that vermicomposting had more positive effects on number and woody stem yield, lateral stems, small and large canopy perimeter, canopy diameter, leaf yield and main stem diameter compared to cow manuring. The vermicompost fertilizers improve tolerance of plants to drought stress by improving soil fertility and moisture.

More than 80% of agricultural lands in Iran lie in semi-arid and arid regions of Iran and are poor in organic matter. The use of organic matters like human waste, animal manures, yard wastes, food wastes, composts, and sewage sludges is recognized as beneficial in crop plants agriculture and improving soil fertility (Joshi & Pal Vig, 2010).

Chemical fertilizers have many bioenvironmental problems like water contamination, falling of crops quality and reduced soil fertility. Vermicompost is obtained from refuse of earthworm (*Eiseniafoetida*) or tiger worms that improve soil physical properties (Abdel-Mouty et al., 2011). It is a stable fine granular organic matter, and loosen the soil with improved aeration. Vermicompost is hydroscopic that improves water holding and prevents water logging. That helps in provision of increased organic carbon helps in slow release adsorption of nutrients (Kale et al., 1992).

The positive effects of vermicompost and manures have been verified in greenhouse and field studies in many crops including lavender (Chan & Griffiths, 1988; Azizi et al., 2008; Buckerfield & Webster, 1998; Peyvast et al., 2008; Kochakinezhad et al., 2012). Following is recommended (Personal communications with Prof. Dr. K. M. Khawar, Ankara University, Faculty of Agriculture, Department of Field Crops, 2020) for healthy growth of the lavender plants Lavender grows well in well-drained and dry, soils with daily sunshine of at least 6-12 hours. The plant grow as shrub, therefore, leave 30-35 cm space in all directions of a single plant.

Mulching prevents loss of water by evapotranspiration. Therefore, the plants should be mulched exclusively. The plants should be watered regularly soon after planting, once the plants are established and starts growing, they could be watered scarcely. Care should be taken during flower harvest. Flowers must be harvested when 50% of them bloom.

Fertilizer should be applied as per local recommendations down the center of each two plants or rows about 15-20 cm from the plants, followed by watering the soil. Each lavender shrub should be pruned every spring at height of 15-20 cm to allow growth of new branches.

REFERENCES

Abdel-Mouty, M., Mahmoud, A., EL-Desuki, M., & Rizk, F. (2011). Yield and fruit quality of eggplant as affected by organic and mineral fertilizers application. Research Journal of Agriculture and Biological Sciences, 7: 196-202.

Altaei, D. (2012). Topical lavender oil for the treatment of recurrent aphthous ulceration. Am. J. Dent., 25(1): 39-43.

Azizi, M., Rezwanee, F., Hassanzadeh Khayyat, M., & Lackzian, A. (2008). The effect of different levels of vermicompost and irrigation on morphological properties and essential oil content of German chamomile (*Matricaria recutita*) c.v. Goral. Planta Medica, 74(09).

Basch, E., Foppa, I., Liebowitz, R., Nelson, J., Smith, M., Sollars, D., & Ulbricht, C. (2004). Lavender (*Lavandula angustifolia* Miller). Journal of Herbal Pharmacotherapy, 4(2): 63-78.

Bernáth, J. (2000). Gyógy- és aromanövények Mezőgazda Kiadó, Budapest.

Buckerfield, J. & Webster, K. (1998). Worm-worked waste boosts grape yields: Prospects for vermicompost use in vineyards. Australian and New Zealand Wine Industry Journal, 13: 73-76.

Cavanagh, H. M. A., & Wilkinson, J. M. (2002). Biological activities of lavender essential oil. Phytotherapy Research, 16(4): 301-308.

Chan, P. L. S. & Griffiths, D. A. (1988). The vermicomposting of pre-treated pig manure. Biological Wastes, 24(1): 57-69.

Danh, L. T., Han, L. N., Triet, N. D. A., Zhao, J., Mammucari, R., & Foster, N. (2013). Comparison of chemical composition, antioxidant and antimicrobial activity of lavender (*Lavandula angustifolia* L.) essential oils extracted by supercritical CO_2, hexane and hydrodistillation. Food and Bioprocess Technology, 6(12): 3481-3489.

Donelli, D., Antonelli, M., Bellinazzi, C., Gensini, G. F., & Firenzuoli, F. (2019). Effects of lavender on anxiety: A systematic review and meta-analysis. Phytomedicine, 65: 153099.

Filiptsova, O. V., Gazzavi-Rogozina, L. V., Timoshyna, I. A., Naboka, O. I., Dyomina, Y. V., & Ochkur, A. V. (2018). The effect of the essential oils of lavender and rosemary on the human short-term memory. Alexandria Journal of Medicine, 54(1): 41-44.

Gülçin, I., Şat, İ. G., Beydemir, Ş., Elmastaş, M., & Küfrevioğlu, Ö. İ. (2004). Comparison of antioxidant activity of clove (*Eugenia caryophylata* Thunb) buds and lavender (*Lavandula stoechas* L.). Food Chemistry, 87(3): 393-400.

Hank, B. (2013). Gardens For The Senses – Gardening As Therapy. Petals & Pages Press, Rio Rancho, New Mexico.

Hui, L., He, L., Huan, L., Xiaolan, L., & Aiguo, Z. (2010). Chemical composition of lavender essential oil and its antioxidant activity and inhibition against rhinitis rekated bacteria. African Journal of Microbiology Research, 4: 309-313.

Joshi, R. & Pal Vig, A. (2010). Effect of vermicompost on growth, yield and quality of tomato (*Lycopersicum esculentum* L). African Journal of Basic & Applied Sciences, 2: 117-123.

Kale, R. D., Mallesh, B. C., Kubra, B., & Bagyaraj, D. J. (1992). Influence of vermicompost application on the available macronutrients and selected microbial populations in a paddy field. Soil Biology and Biochemistry, 24(12): 1317-1320.

Koca Kutlu, A., Çeçen, D., Gürgen, S. G., Sayın, O., & Çetin, F. (2013). A comparison study of growth factor expression following treatment with transcutaneous electrical nerve stimulation, saline solution, povidone-iodine, and lavender oil in wounds healing. Evidence-Based Complementary and Alternative Medicine, 2013: 1-9.

Kochakinezhad, H., Peyvast, G., Kashi, A., Olfati, J., & Asadii, A. (2012). Comparison of organic and conventional production of tomato. Journal of Geographical Systems, 7: 14-25.

Krishnaiah, D., Sarbatly, R., & Nithyanandam, R. (2011). A review of the antioxidant potential of medicinal plant species. Food and Bioproducts Processing, 89(3): 217-233.

Lis-Balchin, M. (2004). Lavender. In Handbook of Herbs and Spices. CRC Press.

López, V., Nielsen, B., Solas, M., Ramírez, M. J., & Jäger, A. K. (2017). Exploring pharmacological mechanisms of lavender (*Lavandula angustifolia*) essential oil on central nervous system targets. Frontiers in Pharmacology, 8.

Lucena, L. R., Santos-Junior, J. G., Tufik, S., & Hachul, H. (2020). 0498 Effect of lavender essential oil on sleep in postmenopausal women with insomnia: Double-blind randomized controlled trial. Sleep, 43(Supplement-1): A190–A191.

Mori, H.-M., Kawanami, H., Kawahata, H., & Aoki, M. (2016). Wound healing potential of lavender oil by acceleration of granulation and wound contraction through induction of TGF-β in a rat model. BMC Complementary and Alternative Medicine, 16(1): 144.

Nemes, N. (2017). Influența Timpului de Distilare și a Fenofazelor de înflorire Asupra Profilului Chimic și Aromatic al Uleiului Esențial de Lavandă. License Thesis. 33-37.

Omidbaigi, R. (2000). Production and Processing of Medicinal Plants. Fekr-e-roz (In Persian).

Peyvast, G., Olfati, J. A., Madeni, S., Forghani, A., & Samizadeh, H. (2008). Vermicompost as a soil supplement to improve growth and yield of parsley. International Journal of Vegetable Science, 14(1): 82-92.

Reddy, K. K., Grossman, L., & Rogers, G. S. (2013). Common complementary and alternative therapies with potential use in dermatologic surgery: Risks and benefits. Journal of the American Academy of Dermatology, 68(4): e127-e135.

Toma, F. (2009). Floriculture and Floral Art. Ed. MultINVEL, Bucharest.

Vakilian, K., Atarha, M., Bekhradi, R., & Chaman, R. (2011). Healing advantages of lavender essential oil during episiotomy recovery: A clinical trial. Complementary Therapies in Clinical Practice, 17(1): 50-53.

CHAPTER 18

HIBISCUS ROSA-SINENSIS L. BETWEEN ORNAMENTAL AND MEDICINE

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INTRODUCTION

Ornamental plants have an important place within the horticultural industry as they are used in gardening, landscaping, and as cut flowers. For all aspects of floriculture the turnover is estimated to be more than 300 billion USD (García-Caparrós & Lao, 2018). Genus *Hibiscus*, belonging to the Malvaceae family, is found mainly in tropical and sub-tropical areas of northern and southern hemispheres and found to be one of the most appealing ornamental plants (Noman et al., 2017). In recent years many species of genus *Hibiscus* have gained the attention of researchers. Within the genus, most of the domesticated species are grown as ornamentals, and the most widely exploited is *Hibiscus rosa-sinensis* L., which is particularly variable with respect to flower colour and shape (Braglia et al., 2010).

Hibiscus rosa-sinensis L. (Figure 1), known as China rose, is a perennial shrub frequently cultivated in tropical and sub-tropical regions worldwide (Ghodoum Parizipour & Keshavarz-Tohid, 2020). With attractive and colorful flowers, it is widely planted as ornamental and is used in traditional medicine.

Hibiscus rosa-sinensis L., is of great economic importance. It has outstanding ornamental features (Gilman, 1999). In animal production *Hibiscus rosa-sinensis* L. appear to have a higher nutritive value (Xuan Ba & Ngoan, 2003). Furthermore, reports exist that Hibiscus species are effective for metal uptake and can be fitted in long term phytoremediation programs for decontamination of toxicants in industrially polluted environment (Noman et al., 2017). *Hibiscus rosa-sinensis* L., has great feed, cosmetic and medicinal uses as well (Ayanbamiji et al., 2012; Noman et al., 2014).

Various important medicinal properties of *Hibiscus rosa-sinensis* L. have been published. The beneficial effects of all parts of this plant have been reported on the reproductive (Sharawy & Ibrahim, 2014), digestive (Kandhare et al., 2012), respirotory (Meena et al., 2014), urinary (Jena et al., 2013), cardiovascular (Khandelwal et al., 2011), nervous (Shewale et al., 2012) and Immun systems (Mishra et al., 2012). Furthermore, the dermatological (Shen et al., 2017), antiinflammatory (Daud et al., 2016), antidiabetic and hypolipidemic (Al Mamun et al., 2013; Pillai & Mini, 2016), cytotoxic (Arullappan et al., 2013), antioxidant (Divya et al., 2013), antimicrobial (Ruban & Gajalakshmi, 2012), antiparasitic effects (Nath & Yadav, 2016), were also demonstrated. All these properties are explained by the plant content of various natural compound. Phytochemical analysis of *Hibiscus rosa-sinensis* L. showed that the main bioactive compounds responsible for its medicinal effects are namely flavonoids, tannins, terpenoids, saponins, and alkaloids (Kumari et al., 2015).

In the current chapter, the taxonomy, the botanical description and reported phytochemical and pharmacological properties of *Hibiscus rosa-sinensis* L. are highlighted.

1. COMMON NAMES OF *HIBISCUS ROSA-SINENSIS* L.

Arabic: Bent EL-Kunsil, Ward El-Jemal, Khatmah Siniyah, Hab misk Seni, Pooq Seni (Al-Snafi, 2018) and karkade (Ali et al, 2005), Karkadia in Algeria.

French: Hibiscus de Chine, Hibiscus rose de Chine, Rose de Chine (Ross, 2003).

English: China-rose, Chinese hibiscus, Hawaiian hibiscus, hibiscus, rose-of-China (Al-Snafi, 2018).

Turkish : Çin gülü, Japon gülü.

Figure 1: *Hibiscus rosa-sinensis* L. (Original by Messaï)

2. TAXONOMY AND BOTANICAL DESCRIPTION

2.1. Taxonomy

According to (Ayanbamiji et al., 2012), the genus *Hibiscus* exhibits considerable taxonomic complexity. It is so heterogeneous that it is not easy to identify any distinguishing features between some species. Taxonomic discrepancies exist in genus Hibiscus due to its plastic morphology (Abdullah et al., 2020). Recent taxonomy studies and genomic sequencing studies in the genus Hibiscus are trying to clarify some phylogenetic discrepancies, and also to evaluate the genetic diversity and variability of different cultivars (Abdullah et al., 2020).

The current state of knowledge makes it possible to classify *Hibiscus rosa-sinensis* L in the family Malvaceae or Mallow, belonging to order Malvales and consisting of 244 genera and 4225 species (Abdullah et al., 2020). *Hibiscus* is one of the most diverse and widely distributed genera consisting of about 250–350 species (Prasad, 2014; Kim et al., 2019). Table 1 describes the current taxonomy of the plant.

Table 1: Taxonomic classification of *Hibiscus rosa-sinensis* L. (ITIS Standard Report , 2020)

Kingdom :	Plantae
Subkingdom :	Tracheobionta
Superdivision :	Spermatophyta
Division :	Magnoliophyta
Class :	Magnoliopsida
Subclass :	Dilleniidae
Order :	Malvales
Family :	Malvaceae
Sub-Family :	Malvoideae
Genus :	Hibiscus
Species :	*Hibiscus rosa-sinensis*. L.

2.2. Botanical Description

The Hibiscus species are annual or perennial herbs, shrubs or trees (Vasudeva & Sharma, 2008). *Hibiscus rosa-sinensis* Linn. is a glabrous shrub widely cultivated as an ornamental plant and has several forms with varying colours of flowers (Jadhav et al., 2009a). Its is a shrub with long slender branches up to about 6 meters tall (Figure 2). The branches, arranged spirally on the stem, are ovate and have long stalks. They measure up to 15 cm long and 10 cm wide (Ross, 2003).

Hibiscus rosa-sinensis L. plants are propagated by seed, stem cutting, grafting, budding, root grafting, layering and it is propagated by tissue culture as commercial method too (Izadi & Zarei, 2014; Bala & Sala, 2020).

The Roots: Tap root system. Routs are edible but fibrous (Essiett & Iwok, 2014).

The Stem: The stem is cylindrical, woody and branched.

The Leaves: 5 - 7.5 cm X 2.5 - 4 cm (Maaoui, 2014).

The leaves of *Hibiscus rosa-sinensis* L. and its cultivars are simple, alternate and petiolate with a mucilaginous epidermis along with stomata on both sides. In addition, complex, stellate and glandular hairs are also present (Noman et al., 2014). Leaves are glossy dark green and vibrantlycolored, four to eight-inch-wide (Gilman, 1999). Pedicels are axillary, solitary, and longer than the leaves and joined above the middle (Gupta et al., 2009).

Flower : Flowers of *Hibiscus rosa-sinensis* L. var. rosa-sinensis are a typical single flower, blooms are large and showy, ranging from 7.5 to

15 cm in diameter, with five uniform petals that make up the corolla and an exserted column in the center of the flower (MacIntyre & Lacroix, 1996). Flowers are produced continuously in great abundance, making up for the fact that each flower will last only one or two days (Gilman, 1999). Numerous varieties, cultivars, and hybrids of *Hibiscus rosa-sinensis* L. are available, with variable flower colours ; white, yellow, orange, pink, red, salmon, with both single and double sets of petals (Hammad, 2009).

Epicalyx: The epicalix is a ring of modified leaves/ bracts that looks like an extra calyx below or adjacent to the proper calyx, and may resemble a calyx. The number, size, shape, structure and orientation of bracteoles of the epicalyx were found to be useful in the identification of species time (Ayanbamiji et al., 2012). Depending on the variety, the epicalyx is of 5-7 bracteoles about 1 cm long and cupular calyx about 2.5 cm long (MacIntyre & Lacroix, 1996).

Corolla: The corolla of the single flower is pentamerous. It consists of five uniform single-lobed petals (MacIntyre & Lacroix, 1996). The corolla is short-lived of 5 very showy, contorted-overlapping petals. Many varieties exist differing in size and color corolla (Ross, 2003).

Androecium: The floral apex of *Hibiscus rosa-sinensis* L. produces a ring-shaped meristem, or ringwall, from which stamens are initiated. The flower has a staminal tube with 60-70 stamens that surrounds an exserted synstylous gynoecium with five fused stigmas. In the single flower, stamen primordia arise in five distinct and orderly clusters (MacIntyre & Lacroix, 1996). Staminal tube is red. The yellow reniform anthers are transversely attached to the filament. The anthers are numerous, ranging from 60 to 70 (n = 50), and the stamens project laterally from the staminal tube to just below the stigmas (MacIntyre & Lacroix, 1996).

Gynoecium: The ovary pentalocular with 1 or 2 ovules in each locale. The Style is simple, long and passes through the staminal tube (Ross, 2003).

Fruit: The fruit, very rarely formed, is a capsule about 3 cm long (Ross, 2003).

Figure 2: *Hibiscus rosa-sinensis* L. plants cultivated in the university of Biskra landscapes, Algeria (Original by Messaï)

3. ORIGIN AND DISTRIBUTION

The probable origin of *Hibiscus rosa-sinensis* L. was tropical Asia (Ghodoum Parizipour & Keshavarz-Tohid, 2020). The plant is cultivated in southern and eastern Asia and Oceania, and is becoming popular as a potted ornamental in temperate regions in Europe, the USA and other countries (Braglia et al., 2010). In the International Hibiscus Society web site (http://www.internationalhibiscussociety.org), over 9000 *Hibiscus rosa-sinensis* L. cultivars are reported (Braglia et al., 2010).

Due to its tolerance to high temperature and saline soil, it has been widely cultivated as an ornamental plant in tropical areas and warm climate across the globe (Mak et al., 2013; Prasad, 2014).

Figure 3: *Hibiscus rosa-sinensis* L. distribution (URL-1)

A distribution summary Figure 3 is available (https://www.cabi.org/isc/datasheet/27128#REF-DDB-151456), but the list of countries and continents where *Hibiscus rosa-sinensis* L. is reported, must be updated. In Algeria, *Hibiscus rosa-sinensis* L. is well known as an ornamental plant (Maaoui, 2014).

4. CHEMICAL COMPOSITION

Phytochemical analysis showed that *Hibiscus rosa-sinensis* L. contained tannins, flavanoides, phenols, anthraquinones, terpenoids, quinines, alkaloids, saponins, carbohydrates, reducing sugars, protein, amino acids, mucilage, essential oils, steroids (Ghaffar & El-elaimy, 2012; Divya et al., 2013; Kumari et al., 2015) (cyanidin chloride, ascorbic acid, hentriacontane, riboflavin, malvalic acids, taraxeryl acetate, ß-sitosterol, cyclicacids sterculic and thiamine (Jadhav et al., 2009b).

There are many published reports on the constituents of different plant parts of *Hibiscus rosa-sinensis* L. Each part contains a wide range of compounds.

Leaves: Using methanol and ethanol extracts of leaves, the phytochemical analysis revealed the presence of alkaloids, flavonoids, tannins, cardiac glycosides, terpenoids, carbohydrates and quinones (Prasad, 2014).

Flowers: Quantitative analysis of *Hibiscus rosa-sinensis* L. revealed that the amount of flavonoids was 0.171 mg/g, total phenolics 0.092 mg/g, tannins 0.073 mg/g, carbohydrates 0.356 mg/g, protein 0.247

mg/g, thiamine 0.072 mg/g, niacin 0.075 mg/g, ascorbic acid 0.0339 mg/g, riboflavin 0.087 mg/g, calcium 0.0127%, phosphorus 0.4113% and iron 0.771% (Falade et al., 2010; Raduan et al., 2013).

Roots: flavonoids, tannins, protein, sterol (Soni et al., 2011).

5. PHARMACOLOGICAL EFFECTS

Scientific literature suggests that more than 50% of today's clinical medications were of natural product origin (Udo et al., 2016). Plants are a valuable source of a wide range of secondary metabolites, which are used as raw material in the synthesis of many therapeutic agents (Pekamwar et al., 2013). Many of them have played a significant role in pharmacological industry and in developing better therapies for various diseases (Udo et al., 2016). The extensive medicinal activity of *Hibiscus rosa-sinensis* L. has been reported in the scientific community (Adhirajan et al., 2003). Table 2 summarizes the main medicinal properties and effects of the plant.

Table 2: Medicinal properties and effects of *Hibiscus rosa-sinensis* L.

Activity/effect	Used part	Reference
Reproductive system	- Crude extract of flowers - Aqueous/alcoholic extracts of flowers - Ethanolic extract of roots - Ethanol/Chloroform,/Ethyl acetate extract of flowers - Aqueous extract of flowers	(Kholkute, 1977; Tan, 1983;Vasudeva & Sharma, 2008; Sharawy & Ibrahim, 2014; Afiune et al., 2017)
Immunity system	- Aqueous extract of flowers	(Mishra et al., 2012)
Nervous system	- Flowers extract - Crude ethanolic extract of flowers - Aqueous extract of flowers	(Shewale et al., 2012; Khalid et al., 2014; Nazool & Kumar, 2015)

Cardiovascular system	- Driede pulverized flower - Ethanol extract roots/Ethanol extract flower	(Gauthaman et al., 2006; Khandelwal et al., 2011)
Urinary system	- Aqueous leaf extract - Aqueous extract of flowers. - Aqueous extract of the plant	(Kate & Lucky, 2010; Nirmaladevi et al., 2012; Jena et al., 2013)
Digestive system - Effect in colitis - Liver disorder, anti-cholinesterase activity, anti-hypercholesterolemia	**-** Hydroalcoholic extract of leaves - Flower extracts **-** Aqueous extract of flowers	(Kandhare et al., 2012; Biswas et al., 2014; Nazool & Kumar, 2015)
Respiratory system **-** Antitussive effect	**-** Methanolic extract of dried powder of flower	(Karna et al., 2012)
Fibrinolytic system	- Aqueous extract of the plant	(Aruna et al., 2013)
Dermatotological system - Potential on hair growth - Androgenic alopecia - Angiogenic activity	**-** Petroleum ether extract of leaves and flowers - Ethanolic extract of leaves - N-butyl alcohol extract of red flowers	(Adhirajan et al., 2003; Upadhyay et al., 2013; Shen et al., 2017)
Metabolic Effects - Antidiabetic, hypolipidemic effects	**-** Ethyl acetate fraction of petals - Aqueous/Ethanolic extract of aerial part - Ethanolic extract of leaves - Hydroalcoholic extract of flowers	(Pillai & Mini, 2016; Mandade & Sreenivas, 2011; Al Mamun et al., 2013; Pethe et al., 2017)
- Anti-haemolytic	- Flowers extract - Methanolic extract of flowers	(Meena et al., 2014; Ayakkannu et al., 2016)
- Protective action against piroxicam toxicity	-Alcoholic leaf extract	(Sahu, 2016)
- Anti- inflammatory	**-** Ethanol extract of flowers and leaves	(Raduan et al., 2013)
- Antipyretic and analgesic effects	**-** Aqueous extracts	(Daud et al., 2016)
- No genotoxic activity	- Methanolic flower extract	(Meena et al., 2014)
Anticancer effect - Cytotoxic activity: against leukaemic cell line (K-562)	- Crude petroleum ether/Ethyl acetate/Methanol extracts of leaves and stem - Aqueous/Chloroform extracts of flowers	(Arullappan et al., 2013; Ranjit et al., 2015; Goldberg et al., 2017)

- Against MCF-7 cell lines - Skin cancer melanoma	- Aqueous flower extract	
- Antimicrobial effect	**-** Flower extract - Methanol/Chloroform/ N-Hexane / Water extracts - Aqueous/Solvent extract of flowers - Extracts of petals - Extracts of leaves and flowers	(Ruban & Gajalakshmi, 2012; Rathi et al., 2012; Agarwal & Prakash, 2014; Victoria &Arunmozhl, 2014; Al-Alak et al., 2015)
Antiparasitic effect	-Methanol extract of leaves	(Nath & Yadav, 2015)
Antioxidant effect	**-** Methanolic extract of leaves and flowers. - Flowers extract - Extract of Petals - Crude extract - Extracts of stem and leaves - Flower extract	(Falade et al., 2010; Ghaffar & El-Elaimy, 2012; Garg et al., 2012; Divya et al., 2013; Sumathy & Sankaranarayanan, 2013; Purushothaman et al., 2016)

CONCLUSION

Hibiscus rosa-sinensis L. is native to Southeast Asia. Now it is commonly found throughout the tropics, and as a houseplant all over the world. Due to its high content of active principles this plant is multiple pharmaceutical and medicinal uses. In this chapter, the authors summarizes the data concerning *Hibiscus rosa-sinensis* L. species. The reported botanical description, phytochemical and medicinal properties are discussed.

REFERENCES

Abdullah, Mehmood, F., Shahzadi, I., Waseem, S., Mirza, B., Ahmed, I., & Waheed, M. T. (2020). Chloroplast genome of *Hibiscus rosa-sinensis* (Malvaceae): Comparative analyses and identification of mutational hotspots. Genomics, 112(1): 581-91.

Adhirajan, N., Ravi Kumar, T., Shanmugasundaram, N., & Babu, M. (2003). In vivo and in vitro evaluation of hair growth potential of *Hibiscus rosa-sinensis* Linn. Journal of Ethnopharmacology, 88(2–3): 235-239.

Afiune, L. A. F., Moraes-souza, Q., Soares, T. S., Campos, K. E., Damasceno, C., Fujiwara, T., & Herrera, E. (2017). Beneficial effects of *Hibiscus rosa-sinensis* L . Flower aqueous extract in pregnant rats with diabetes. PLoS ONE 12(6): e0179785. 1–13.

Agarwal, S. & Prakash, R. (2014). Evaluation of Antibacterial activity of *Hibiscus rosa-sinensis* flower extract against *E. coli* and *B. subtillis*. Biological Forum – An International Journal, 6(2): 194-196.

Al-Alak, S. K., AL-Oqaili, R. M. S., Mohammed, B. B., &, and Abd-Alkhalik, N. (2015). Antibacterial activity of *Hibiscus rosa- sinensis* extract and synergistic effect with amoxicillin against some human pathogens. American Journal of Phytomedicine and Clinical Therapeutics, 3(1): 20-27.

Al-Mamun, A., Islam, S., Alam, A. K., Rahman, M. A. A., & Rashid, M. (2013). Effects of ethanolic extract of *Hibiscus rosa-sinensis* leaves on alloxan-induced diabetes with Dyslipidemia in rats. Bangladesh Pharmaceutical Journal, 16(1): 27-31.

Al-Snafi, A. E. (2018). Chemical constituents, pharmacological effects and therapeutic importance of *Hibiscus rosa-sinensis*- A review. International Journal of Pharmaceutical Research, 10(3): 451-475.

Ali, B. H., Al Wabel, N. & Blunden, G. (2005). Phytochemical, pharmacological and toxicological aspects of *Hibiscus sabdariffa* L.: A review. Phytotherapy Research, 19(5): 369-375.

Arullappan, S., Muhamad, S., & Zakaria, Z. (2013). Cytotoxic activity of the leaf and stem extracts of *Hibiscus rosa sinensis* (Malvaceae) against leukaemic cell line

(K-562). Tropical Journal of Pharmaceutical Research, 12(5): 743-746.

Aruna, A., Meenakshipriya, P., Parameswari, S. P. T, Meera, R., Devi, P, & Nagarajan, K. (2013). Fibrinolytic activity of *Hibiscus rosa-sinensis*. IJPCBS, 3(3): 530-532.

Ayakkannu, P., Meenatchi, P., Sundaram, R., & Nallappan, S. (2016). Quantification of total phenolic content, HPLC analysis of flavonoids and assessment of antioxidant and anti-haemolytic activities of *Hibiscus rosa-sinensis* L. flowers in vitro. International Journal of Pharma Research and Health Sciences, 4(5): 134-150.

Ayanbamiji, T., Ogundipe, O., & Olowokudejo, J. (2012). Taxonomic significance of the epicalix in the genus *Hibiscus* (Malvaceae). Phytologia Balcanica: International Journal of Balkan Flora and Vegetation, 18(2): 135-140.

Bala, M. & Sala, F. (2020). Management of *Hibiscus rosa siensis* L. propagation by optimizing the growth substrates and biostimulators combination. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 20(1): 53-60.

Biswas, A., D'Souza, U. J. A., Bhat, S., & Damodar, D. (2014). The hepatoprotective effect of *Hibiscus rosa sinensis* flower extract on diet -induced hypercholesterolemia in male albino wistar rats. Int. J. Med. Pharm. Sci., 4(6): 215-217.

Braglia, L., Bruna, S., Lanteri, S., Mercuri, A., & Portis, E. (2010). An AFLP-based assessment of the genetic diversity within *Hibiscus rosa-sinensis* and its place within the Hibiscus genus complex. Scientia Horticulturae, 123(3): 372-378.

Daud, D., Arsad, N. F. M., Ismail, A., & Tawang, A. (2016). Anti-pyretic action of *Caulerpa lentillifera, Hhibiscus rosa-sinensis,* and *Piper sarmentosum aqueous* extract in mice. Asian Journal of Pharmaceutical and Clinical Research, 9(1): 145-147.

Divya, M. J., Sowmia, C., Dhanya, K. P., & Joona, K. (2013). Screening of antioxidant, anticancer activity and phytochemicals in methanolic extract of *Hibiscus rosa-sinensis* leaf extract. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 4(2): 1308-1316.

Essiett, U. & Iwok, S. E. (2014). Floral and leaf anatomy of *Hibiscus* species. American Journal of Medical and Biological Research, 2(5). 101-117.

Falade, O., Aderogba, M., Kehinde, O., Akinpelu, B., Oyedapo, B., & Adewusi, S. (2010). Studies on the chemical constituents, antioxidants and membrane stability activities of *Hibiscus rosa sinensis*. Nigerian Journal of Natural Products and Medicine, 13(1).

García-Caparrós, P. & Lao, M. T. (2018). The effects of salt stress on ornamental plants and integrative cultivation practices. Scientia Horticulturae, *240*(May): 430-439.

Garg, D., Shaikh, A., Muley, A., & Marar, T. (2012). In-vitro antioxidant activity and phytochemical analysis in extracts of *Hibiscus rosa-sinensis* stem and leaves. Free Radicals and Antioxidants, 2(3): 4146.

Gauthaman, K. K., Saleem, M. T. S., Thanislas, P. T., Prabhu, V. V., Krishnamoorthy, K. K., Devaraj, N. S., & Somasundaram, J. S. (2006). Cardioprotective effect of the *Hibiscus rosa sinensis* flowers in an oxidative stress model of myocardial ischemic reperfusion injury in rat. BMC Complementary and Alternative Medicine, 6: 1-8.

Ghaffar, F. R. A. & El-Elaimy, I. A. (2012). In vitro, antioxidant and scavenging activities of *H. rosa sinensis.* Journal of Applied Pharmaceutical Science, 2(1): 51-58.

Ghodoum Parizipour, M. H., & Keshavarz-Tohid, V. (2020). Identification and phylogenetic analysis of a tobamovirus causing hibiscus (*Hibiscus rosa-sinensis* L.) mosaic disease in Iran. Journal of Plant Pathology, 102(3): 813-824.

Gilman, E. F. (1999). *Hibiscus rosa-sinensis* -Tropical Hibiscus. Institute of Food and Agricultural Sciences, 1-3.

Goldberg, K. H., Yin, A. C., Mupparapu, A., Retzbach, E. P., Goldberg, G. S., & Yang, C. F. (2017). Hibiscus rosa-sinensis fl ower extract inhibit in vitro melanoma cell growth. J Tradit Complement Med., 7(1): 45-49.

Gupta, V., Bansal, P., Garg A, & Meena, A. (2009). Pharmacopoeial standardization of *Hibiscus rosa sinensis* Linn. International Journal of Pharmaceutical and

Clinical Research, 1(3): 124-126.

Hammad, I. (2009). Genetic variation among *Hibiscus Rosa-sinensis* (Malvaceae) of different flower colors using ISSR and isozymes. Australian Journal of Basic and Applied Sciences, 3(1): 113-125.

ITIS Standard Report (2020). Insecta. (n.d.). *Hibiscus rosa sinensis.* https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=99208#null.

Izadi, Z. & Zarei, H. (2014). Evaluation of propagation of chinese *Hibiscus rosa-sinensis* through Stenting Method in response to different IBA concentrations and rootstocks. American Journal of Plant Sciences, 5(13): 1836-1841.

Jadhav, V. M.., Thorat, R. M., Kadam, V. J. & Sathe, S. (2009a). Traditional medicinal uses of *Hibiscus rosa-sinensis*. Journal of Pharmacy Research, 2(28): 1220-1222.

Jadhav, V. M., Thorat, R. M., Sathe, N., & Kadam, V. (2009b). *Hibiscus rosa-sinenis*-Et-Santé. Journal of Pharmacy Research, *2*(7):1168-1173.

Jena, M., Mishra, S., & Mishra, S. S. (2013). Effect of aqueous extract of Hi*biscus rosa-sinensis* Linn on urinary volume and electrolyte extraction in albino rats. Int. J. Pharm. Bio. Sci, 4(3): 304-309.

Kandhare, A. D., Raygude, K. S., Ghosh, P., Ghule, A. E., Gosavi, T. P., Badole, S. L., & Bodhankar, S. L. (2012). Effect of hydroalcoholic extract of *Hibiscus rosa sinensis* Linn. leaves in experimental colitis in rats. Asian Pacific Journal of Tropical Biomedicine, 2(5): 337-344.

Karna, J. P., Gandhi Parth, M., Ganatra Tejas, H., Desai Tusharbindu, R., Tirgar, & Pravin, R. (2012). Preclinical investigation of anti-tussive activity of *Hibiscus rosa-sinensis* on guinea pig. International Research Journal of Pharmacy, 3(9): 1013.

Kate, I. E. & Lucky, O. O. (2010). The effects of aqueous extracts of the leaves of *Hibiscus rosa-sinensi*s Linn . on renal function in hypertensive rats. African Journal of Biochemistry Research, 4(February): 43-46.

Khalid**,** L., Rizwani, G. H., Sultana, V., Zahid, H., Khursheed, R., & Shareef, H. (2014). Antidepressant activity of ethanolic extract of Linn. Pak. J. Pharm.

Sci., 27(5): 1327-1331.

Khandelwal, V. K. M., Balaraman, R., & Pancza, D. (2011). *Hemidesmus indicus* and *Hibiscus rosa-sinensis* affect ischemia reperfusion injury in isolated rat hearts. Evidence-Based Complementary and Alternative Medicine.

Kholkute, S. D. (1977). Effect of *Hibiscus rosa sinensis* on spermatogenesis and accessory reproductive organs in rats. Plant Med, 31: 127-130.

Kim, Y., Oh, Y. J., Han, K. Y., Kim, G. H., & Ko, J. (2019). The complete chloroplast genome sequence of Hibicus syriacus L . 'Mamonde' (Malvaceae). Mitochondrial DNA Part B: Resources, 4(01): 558-559.

Kumari, O. S., Rao, N. B., & Reddy, V. K. (2015). Phyto-chemical analysis and anti-microbial activity of *Hibiscus rosa-sinensis.* World Journal of Pharmacy and Pharmaceutical Sciences, 4(05): 766-771.

Maaoui, M. (2014). Atlas des Plantes Ornementales des Zibans. Edition CRSTRA, ISBN: 978-9931-438-02-1. (https://rs.umc.edu.dz/umc/ouvrage/atlas-des-plantes-ornementales-des-ziban.pdf).

MacIntyre, J. P. & Lacroix, C. R. (1996). Comparative development of perianth and androecial primordia of the single flower and the homeotic double-flowered mutant in *Hibiscus rosa- sinensis* (Malvaceae). Canadian Journal of Botany, 74(12): 1871-1882.

Mak, Y. W., Chuah, L. O., Ahmad, R., & Bhat, R. (2013). Antioxidant and antibacterial activities of hibiscus (Hibiscus rosa-sinensis L.) and Cassia *(Senna bicapsularis* L.) flower extracts. Journal of King Saud University - Science, 25(4): 275-282.

Mandade, R. & Sreenivas, S. A. (2011). Anti-diabetic effects of aqueous ethanolic extract of *Hibiscus rosa-sinensis* L. on streptozotocin-induced diabetic rats and the possible morphologic changes in the liver and kidney. International Journal of Pharmacology, 7(3): 363-369.

Meena, A. K., Patidar, D., & Singh, R. K. (2014). Ameliorative effect of *Hibiscus rosa sinensis* on phenylhydrazine induced. Haematotoxicity, 3(2): 8678-8683.

Mishra, N., Tandon, V. L, & Gupta, R. (2012). Immunomodulation by *Hibiscus rosa-sinensis*: Effect on the humoral and cellular immune response of M*us* *musculus*. Pak. J. Biol. Sci., 15(6): 277-283.

Nath, P. & Yadav, A. (2015). Acute and sub-acute oral toxicity assessment of the methanolic extract from leaves of *Hibiscus rosa-sinensis* L. in mice. Journal of Intercultural Ethnopharmacology, 4(1): 70.

Nath, P. & Yadav, A. K. (2016). Anticestodal properties of *Hibiscus rosa-sinensis* L. (Malvaceae): An in vitro and in vivo study against *Hymenolepis diminuta* (Rudolphi, 1819), a zoonotic tapeworm. Journal of Parasitic Diseases, 40(4): 1261-1265.

Nazool, M & Kumar, S. (2015). Dual inhibition of cholinesterase enzyme by an aqueous extract of *Hibiscus rosa sinensis* L. International Journal of Pharma Research & Review, 4(5): 6-10.

Nirmaladevi, R., Kalpana, S., Kavitha, D., & Padma, P. R. (2012). Evaluation of antilithiatic potential of *Hibiscus rosa - sinensis* Linn, in vitro. Journal of Pharmacy Research, 5(8): 4353-4356.

Noman, A., Ali, Q., Hameed, M., Mehmood, T., & Iftikhar, T. (2014). Comparison of leaf anatomical characteristics of *Hibiscus rosa-sinensis* grown in faisalabad region. Pakistan Journal of Botany, 46(1): 199-206.

Noman, A., Aqeel, M., Javed, M. T., Zafar, S., Ali, Q., Islam, W., Irshad, M. K., Buriro, M., Kanwal, H., Khalid, N., & Khan, S. (2017). Histological changes in *Hibiscus rosa-sinensis* endorse acclimation and phytoremediation of industrially polluted sites. Journal of Animal and Plant Sciences, 27(5): 1637-1648.

Pekamwar, S. S., Kalyankar, T. M., & Jadhav, A. C. (2013). *Hibiscus rosa-sinensis*: A review on ornamental plant. World Journal of Pharmacy and Pharmaceutical Sciences, 2(6): 4719-4727.

Pethe, M., Yelwatkar, S., Manchalwar, S., & Gujar, V. (2017). Evaluation of biological effects of hydroalcoholic extract of *Hibiscus rosa sinensis* Flowers on alloxan induced diabetes in rats. Drug Res (Stuttg), 67(08): 485-492.

Pillai, S. S. & Mini, S. (2016). *Hibiscus rosa sinensis* Linn. Petals modulates glycogen metabolism and glucose homeostasis signalling pathway in streptozotocin-induced experimental diabetes. Plant Foods for Human Nutrition, 71(1): 42-

48.

Prasad, M. P. (2014). In vitro Phytochemical Analysis and Antioxidant Studies of *Hibiscus* Species. International Journal of Pure & Applied Bioscience, 2(3): 83-88.

Purushothaman, A., Meenatchi, P., Saravanan, S., Sundaram, R., & Saravanan, N. (2016). Quantification of total phenolic content, HPLC analysis of flavonoids and assessment of antioxidant and anti-haemolytic activities of *Hibiscus rosa-sinensis* L. flowers in vitro. Int. J. Pharma. Res. Health Sci., 4(5): 1342- 1350.

Raduan, S. Z., Abdul Aziz, M. W. H., Roslida, A. H., Zakaria, Z. A., Zuraini, A., & Hakim, M. N. (2013). Anti- inflammatory effects of *Hibiscus rosa-sinensis* L. and H*ibiscus rosa-sinensis* var. alba ethanol extracts. International Journal of Pharmacy and Pharmaceutical Sciences, 5(4): 754-762.

Ranjit, P. M., Nagarani, T., Swathi, V., Pahni Kumar, K., Chowdary, Y. A., Siva Reddy, C. H., & Girijasankar, G. (2015). Evaluation of phytochemical content and in vitro cytotoxic activity of various ornamental plant flower extracts against MCF-7 Cell lines. International Journal of Current Research in Life Sciences, 4(3): 172-176.

Rathi, S.G., Patel Kanu, R., & Bhaskar Vaidhun, H. (2012). Isolation of herbal plants : Antifungal and antibacterial activities. JPSBR, *2*(1): 25-29.

Ross, I. A. (2003). *Hibiscus rosa-sinensis.* In: Medicinal Plants of the World. Humana Press, Totowa, NJ. https://doi.org/10.1007/978-1-59259-365-1_12.

Ruban, P. & Gajalakshmi, K. (2012). In vitro antibacterial activity of *Hibiscus rosa-sinensis* flower extract against human pathogens. Asian Pac. Trop. Biomed., 2(5): 399-403.

Sahu, C. R. (2016). Mechanisms involved in toxicity of liver caused by piroxicam in mice and protective effects of leaf extract of *Hibiscus rosa-sinensis* L. Clinical Medicine Insights: Arthritis and Musculoskeletal Disorders, 9: 9-13.

Sharawy, S. & Ibrahim, S. (2014). The effects of aqueous extract *Hibiscus sabdariffa* on spermatogenesis and sperm parameters of mice. Global Journal of Biology & Health Sciences, 6(10): 51.

Shen, H. M., Chen, C., Jiang, J. Y., Zheng, Y. L., Cai, W. F., Wang, B., Ling, Z., Tang, L., Wang, Y. H., & Shi, G. G. (2017). The N-butyl alcohol extract from *Hibiscus rosa-sinensis* L. flowers enhances healing potential on rat excisional wounds. Journal of Ethnopharmacology, 198: 291-301.

Shewale, P. B., Patil, R. A., & Hiray, Y. A. (2012). Antidepressant-like activity of anthocyanidins from *Hibiscus rosa-sinensis* flowers in tail suspension test and forced swim test. Indian Journal of Pharmacology, 44(4): 454-457.

Soni, D., Gupta, R. A., Solanki, G., & Kumar, J. (2011). Pharmacognostical, phytochemical and physiochemical findings over the root extract of H*ibiscus rosa sinesis* [Malvacae]. J. Nat. Prod. Plant Resour, 1(4): 73-79.

Sumathy, R. & Sankaranarayanan, S. (2013). Evaluation of antioxidant and antimicrobial activity of flavanoid rich fraction of two Indian medicinal plants. International Journal of Ethnomedicine and Pharmacological Research, 1(1): 7-14.

Tan, C. H. (1983). Is *Hibiscus rosa-sinensis* Linn. a potential source of antifertility agents for males? Int J Ferti, 28(4): 247-248.

Udo, I. J., Ben, M. G., Etuk, C. U., & Tiomthy, A. I. (2016). Phytochemical, proximate and antibacterial properties of *Hibiscus rosa-sinensis* L. Leaf. Journal of Medicinal Plants Studies, 4(5):193-195.

Upadhyay, S., Upadhyay, P., Vinode, R., & Dixit, V. K. (2013). Effect of ethanolic fraction of *Hibiscus rosa sinensis* L ., leaves in androgenic alopecia. 9(5): 1-7.

Vasudeva, N. & Sharma, S. K. (2008). Post-coital antifertility activity of *Hibiscus rosa-sinensis* Linn. roots. Evidence-Based Complementary and Alternative Medicine, 5(1):91-94.

Victoria, A. J. & Arunmozhl, V. (2014). Antibacterial activity of *Hibiscus rosa-sinensis* and *Rosa damascene* petals against dental pathogen. International Journal of Integrative Sciences, Innovation and Technology, Sec B, 3(3): 1-6.

Xuan Ba, N. & Ngoan, L. D. (2003) Evaluation of some unconventional trees/plants as ruminant feeds in Central Vietnam. Livestock Research for Rural Development, 15(6).

URL-1. https://www.cabi.org/isc/datasheet/27128#REF-DDB-151456. (Access date: 15.10.2020)

CHAPTER 19

ORNAFRUIT:
FRUIT SPECIES FOR ORNEMANTAL PURPOSES

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INTRODUCTION

The historical importance of fruit species in human life is very important. The role of fruit crops within urbanization and domestication were studied and its determined that perennial fruit crops were found one of contributing factors within these topics in Western Asia and China (Fuller & Stevens, 2019). Fruits have also historically taken important place in human feeding because of their comprehensive vitamin, mineral, phytochemical, antioxidant, phenolic, and dietary fiber contents. Today, the value of fruit species in human nutrition is increasing day by day and total fruit production of world is achieved nearly 868.1 million metric tons (FAO, 2018).

On the other hand, ornamental plants have an undeniable and important role in improving and stabilizing the environmental situation in cities. They compose a natural healing structure that has the functions of phytoncide activity, sanitation, gas, dust, sound and noise absorption. Recently, a great interest has developed in fruit crops that can be used as ornamentals due to their flower colors, leave color, fruit color, tree and shrub structure, relaxation effects on human spirit, ensuring access to high nutrition content without spending money. Additionally, all these features, edible fruit design of the territory is the formation of a decorative complex that creates aesthetic appeal and beneficial psycho emotional effects on the human body.

Fruit crops may be used in edible landscapes as a part of residential landscape, urban green areas or community gardens, and we can reinviting food back into the city and re-connecting people with their food system to promote a healthier lifestyle (Çelik, 2017). These areas can be also take some educational roles for children, and people so they could learn growing and harvesting fruit crops.

Considering previous research, it is seen that many types of fruits are used both as potted and/or cut ornamental plant (Chen, 1996; Yao, 2013; Asgarzadeh et al., 2014; Güler et al., 2017; Suhonen et al., 2017; Ciftcioglu et al., 2019; Sottile et al., 2019; URL-1). Inspired by Sottile et al. (2019), who first use “ornacitrus” term to ornamental *Citrus* spp., we coined and decided to use “ornafruit” term for fruit species that can be used as ornamental purposes.

Although it varies on the basis of countries, most used and studied ornafruit species are given in Table 1. *Citrus* spp., *Fortunella* spp., *Malus* spp., and *Olea europaea* have highest share of commercial production in worldwide. In this context, ornafruit breeding and selection studies for disease resistance, frost tolerance, cold hardiness, and salt tolerance e.g. have been continued all over the world (Mortensen et al., 1994; Santos-Serejo et al., 2012; McNamara & Pellett, 1994; 1995; Richer et al., 2003; Liu & Wang, 2009; Aiello et al., 2014; Yao & Heyduck, 2018; Kaya et al., 2020; Şahin et al., 2020).

In this study, the main important features sought in ornafruit are explained with visuals and the more important ones are detailed in the rest of the study.

Table 1: Commonly used ornafruit

Family	Scientific name	Common name
Adoxaceae	*Sambucus* spp. *Viburnum* spp.	Elderberry Cranberry (Gilaburu)
Bromeliaceae	*Ananas comosus* L.	Pineapple
Cornaceae	*Cornus mas* L.	Cornelian cherry
Ericaceae	*Arbutus unedo* L.	Strawberry tree
Musaceae	*Musa* spp.	Banana
Moraceae	*Morus* spp.	Mulberry
Rhamnaceae	*Ziziphus jujuba* M.	Jujube
Vitaceae	*Vitis* spp.	Vine
Elaeagnaceae	*Elaeagnus angustifolia* L.	Silverberry, Oleaster Russian-olive,
Rutaceae	*Citrus* spp. *Fortunella* spp.	*Citrus* species
Rosaceae	*Eriobotrya japonica* L.	Loquat
Rosaceae	*Malus* spp.	Apple species
Rosaceae	*Pyrus* spp.	Pear species
Rosaceae	*Cydonia oblonga* M.	Quince
Rosaceae	*Prunus* spp.	Almond, cherry, peach, nectarine, plum
Rosaceae	*Rubus* spp.	Rasberry
Rosaceae	*Sorbus aucuparia* L.	Rowanberry
Oleaceae	*Olea europaea* L.	Olive

1. *Eriobotrya japonica* L.

Eriobotrya japonica is an every green and perennial tree that has been grown as an ornamental with sweet, edible fruits. Loquat fruit has an attractive yellow color, flavor, and high economic and medicinal value (Figure 1). Loquat blooms in autumn, develops its fruit through winter and ripens in early spring. Because of its unusual phenology, it is an important nectar source for bees and food source for animals and mankind. Additionally, this unusual phenology makes this fruit species more fascinating in landscape areas and provides an attractive contrast to the ornamental textures and shapes (Figure 1).

Figure 1: Tree, flower, leaf and fruit structure of *Eriobotrya japonica* (URL-2,3)

2. *Vitis* spp.

Vitis species, which have been at the forefront throughout human history, also are an important species in terms of use as an ornamental purpose. Some ornamental grape cultivars prized for scarlet-red fall foliage and some of interspecific vine hybrids can be use in home gardens, on arbors patios and as borders on fences (Figure 2), due to its unique leaf shape appearance (Mortensen et al., 1994; Dangl et al., 2010). In our country, it is widely used in landscaping areas and home gardens as a gazebo (Figure 2).

Figure 2: Leaf and fruit variation with different usage of ornamental *Vitis* species (URL-2,4,5,6)

3. *Elaeagnus angustifolia* L.

Elaeagnus angustifolia, known as Silverberry or Russian-olive, has saline-alkali tolerance (Liu et al., 2014), fast-growing and nitrogen-fixing ability (Shah et al., 2010) that encouraged for planting in windbreaks and riparian ecosystems (Katz & Shafroth, 2003). Thanks to its silver leaves, twigs, fragrant-yellow flowers, and delicate fruits (Figure 3), as well as its distinct ability to drought stress and cold, it is used as an excellent landscape tree (Asgarzadeh et al., 2014). It can be grown even in inappropriate soil and climatic conditions in our country without any cultivation techniques being applied presents a great advantage (Özdemir & Kalyoncu, 2011).

Figure 3: General view of silver leaves, yellow flowers, fruits and tree structure of *Elaeagnus angustifolia* (URL-2,7,8)

4. *Arbutus unedo* L.

Arbutus unedo L. that is known as strawberry tree, is an evergreen fruit species. It is one of the natural species of Mediterranean Region with an important potential in terms of landscape design with its attractive red fruits, pinkish-white flowers, and stem properties (Figure 4) (Celikel et al., 2008; Güler et al., 2017). It has an important ornamental usage due to long blooming period and having flower and mature fruits on the same time (Figure 4). In addition to outdoor usage, some *Arbutus* species are suitable for bonsai (Figure 4).

Figure 4: General view *Arbutus unedo* and usage as a bonsai (URL-2,9,10)

5. *Sorbus aucuparia* L.

Rowanberry fruits are an important source of vitamin C and are used as fresh or as jam, syrup, compote, tea, and marmalade (Olszewska, 2011; Yılmaz, 2010; Karadeniz, 2004). Also it is a suitable ornamental tree for roadside landscaping and urbanization areas, with benefits birds and frugivorous wildlife (Suhonen et al., 2017). In addition to these, it is also of great ornamental importance with its aesthetic crown structure, attractive white flowers, bright red colored mature fruits, leaves that turn red in autumn (Figure 5).

Figure 5: Tree, flower, leaf and fruit structure of *Sorbus aucuparia* (URL-2,11)

6. *Olea europaea* L.

Olive has an important role in human civilization and feeding, in addition it is used for ornamental purposes because evergreen structure, different tree forms and textures (Figure 6), drought and salt tolerance (Cantini et al., 1999; Leva & Petruccelli, 2011). Usage of olive as an ornamental has been documented since ancient times (Tsalikidis et al., 1997) and recently, dwarf olive trees support this type of usage due to ecological, growth-habit and aesthetic characteristics (Leva & Petruccelli, 2011). In addition to outdoor usage, it is suitable as bonsai for indoor areas too (Figure 6).

Figure 6: General view of olive tree, flower and leaf. Usage as a bonsai indoor areas and tree form outdoor areas (URL-2,12)

7. *Citrus* spp. and *Fortunella* spp.

Rutaceae family have the most important types of fruit used as ornamental plants and the term of “ornacitrus” has been developed for this scope (Sottile et al., 2019). Ornacitrus production focuses especially different cultivars of *Citrus* spp. and *Fortunella* spp. (Figure 7). The production of ornacitrus is an essential industry in Spain, Greece, Portugal, Italy (Sottile et al., 2019) and recently, interest on ornacitrus has increased different parts of the world (Dos Santos et al., 2015; Uzun et al., 2015; Budiarto et al., 2017). Additionally, these species are also used both indoors (e.g. bonsai, potted and mini fruit plants) and outdoors (e.g. hedges, potted plants) ornamental in Turkey (Figure 7) (Uzun et al., 2015).

Figure 7: Different ornacitrus species and some usage (URL-2,13,14)

8. *Ziziphus jujuba* M.

Jujube fruits have high levels of vitamin C, minerals (especially high iron and potassium), cyclic adenosine monophosphate, antioxidants, dietary fiber, and phenolic compounds (Cyong & Hanabusa, 1980; Li et al., 2007; Xue et al., 2009; Zhao et al., 2009; Višnjevec et al., 2019). Some cultivars are well known as an ornamental with unique fruit color, fruit shape (e.g. teapot, donut and mushroom), tree shape (e.g. zigzag growth, twisted branches) (Liu & Wang, 2009; Guo & Shan, 2010; Yao & Heyduck, 2018) (Figure 8). Breeding studies are ongoing for development new ornamental jujube cultivars not only good fruit quality and yield but also different fruit shape and tree growth parameters.

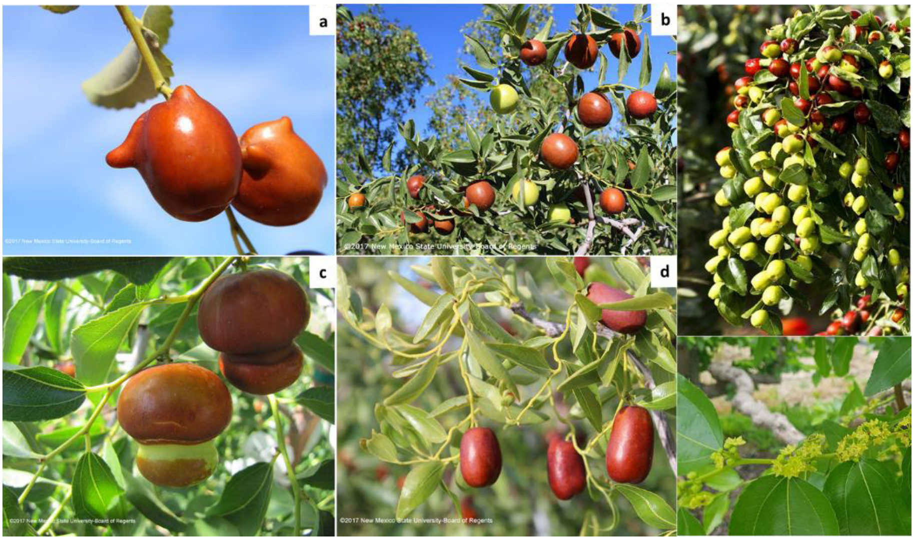

Figure 8: Important ornamental jujube cultivars (a; cv. Teapot, b; cv. So, c; cv. Mushroom, d; cv. Dragon), leaf and fruit features (URL-2,15)

9. *Malus* spp.

Apple is one of the most economically important temperate fruit crops and some *Malus* species especially crabapples, commonly used as an ornamental. Additionally, these are also used as bonsai, espalier, potted mini fruit plants, residential street tree and hedges (Figure 9). Also they are used as pollinizer cultivars in commercial orchards because of producing more flowers, more pollen, and long flowering process (Kendall & Smith, 1975). Size and shape of crabapples vary and can provide interest with single, double, semi-double flowers in white to red or pink to purple, different fruit colors and sizes. Crabapples have been successfully grown in urban areas that have compacted soil, pollution, drought, and poor drainage (Gilman & Watson, 2007).

Figure 9: Variation and usage of crabapples (URL-16,17,18,19)

10. *Sambucus* spp.

Elderberry is a deciduous shrub with white to pink small flowers in large corymbs (Figure 10), and starts flowering in early summer. It used for medicine, source of dietary supplements, beverage, and food flavorings, and ornamental purposes (Dawidowicz et al., 2006; Christensen et al., 2007; Lee & Finn, 2007). There are varieties used as ornamental and flavonoid content have been found different than others (Vrchotová et al., 2017). In addition to usage in edible landscape areas, it is also used indoors as cut flowers and cut fruits (Figure 10).

Figure 10: *Sambucus* spp., variation and some usages (URL-20,21)

11. *Viburnum* spp.

Viburnum species has important ornamental value with its strong shade-tolerance and ecological functions that can be extensively used in urban afforestation in arid areas (Yan et al., 2005). They are also important source of polyphenols, carotenoids, essential oils, steroids, polyphenols, saponins, pectins, and proteins (Konarska & Domaciuk, 2018). Fruit clusters are dark red which is larger than the leaves (Figure 11) (Vodičková, 1999).

Figure 11: Leaf and fruit characteristics of *Viburnum* spp. (URL-2)

12. *Cornus mas* L.

Cornelian cherry is an edible fruit that can be process to jam, wine, stewed fruit, yoghurt, cosmetics, liquor, syrup and also uses ornamental and medicinal purposes. It has red, pink or yellow fruits with oval, pear or bottle shaped (Figure 12). Researches were revealed that fruits have a high percentage of organic acids, vitamin C, anthocyanins, monoterpenes, and antioxidants (De Biaggi et al., 2018). Since it is not host to most diseases and pests, it is cultivated with the least use of pesticides (Klimenko, 1990; 2004; Da Ronch et al., 2016). It is compatible to drought and winter-hardy weather, so does not need much care (Klimenko, 2004).

Figure 12: General view of cornelian cherry (URL-2,22)

13. *Musa* spp.

Musaceae family presents large genetic variability and therefore provides a range of consumption such as fiber, food, pharmaceutical products, dyes, crafts, and ornamental (Whistler, 2000; Uma et al., 2006; Santos-Serejo et al., 2007; Wallace et al., 2007; Kennedy, 2009; Santos-Serejo et al., 2012). Ornamental bananas can be use as cut flower, potted plant, minifruits, male inflorescence, and landscape plants (De Souza et al., 2012; Santos-Serejo et al., 2012) (Figure 13). In landscape areas it provides a charming tropical atmosphere with vigorous growth (Fonsah et al., 2008). In this regard, production quantities of ornamental banana species and breeding studies are increasing day by day.

Figure 13: General view of *Musa* spp. and some usage (URL-2,23)

14. *Morus* spp.

Morus spp. are a fast-growing perennial tree that cultivated in horticultural, pharmaceutical, industrial, and ornamental purposes. Especially mulberries which have weeping canopy is commonly used in landscape areas (Figure 14). Mulberry adapts well to various environmental conditions such as biotic and abiotic stress (Jian et al., 2013; Sasmita et al., 2019). Some species are shade resistant and usually grows in coastal areas (Sasmita et al., 2019).

Figure 14: Weeping canopy of *Morus* spp. and variation of fruit shape and color (URL-2)

CONCLUSION

Fruit species are not only important in terms of fruit production and medicinal purposes but also ornamental usage. Ornafruits include a large number of genera, species, sub-species, and cultivars. Their main remarkable features are attractive flower color, flower structure, flowering time and length of blooming period, leaf forms and attractive color, fruit shape, color, taste, and beneficial health effects. In addition, successful landscape planning and using with different plant species will turn the decoration area into a visual feast. With increasing urbanization, people's need for landscape areas is increasing day by day, and the use of ornafruits in these areas will appeal to both eyes and palate of people. Edible landscape areas will be important in terms of getting some basic nutritional needs, providing access to fresh and natural fruit from the branch and contributing to the family economy, as well as spiritual relaxation.

REFERENCES

Aiello, A. S., Rothleutner, J., McNamara, S., & Hokanson, S. C. (2014). Mid-winter cold hardiness of *Corylus fargesii* germplasm as determined in laboratory freezing tests. Hortscience, 48: S339.

Asgarzadeh, M., Vahdati, K., Lotfi, M., Arab, M., Babaei, A., Naderi, F., & Rouhani, G. (2014). Plant selection method for urban landscapes of semi-arid cities (A case study of Tehran). Urban Forestry & Urban Greening, 13(3): 450-458.

Budiarto, R., Poerwanto, R., Santosa, E., & Efendi, D. (2017). The potentials of limau (*Citrus amblycarpa* Hassk Ochse) as a functional food and ornamental mini tree based on metabolomic and morphological approaches. J. Trop. Crop Sci., 4(2): 49-57.

Cantini, C., Cimato, A., & Soni, G. (1999). Morphological evaluation of olive germplasm present in Tuscany Region. Euphytica, 109: 173-181.

Celikel, G., Demirsoy, L., & Demirsoy, H. (2008). The strawberry tree (*Arbutus unedo* L.) selection in Turkey. Scientia Horticulturae, 118(2): 115-119.

Chen, J. Y. (1996). Chinese Mei Flowers. Hainan Publishing House, Haikou, China. p. 14-58.

Christensen, L. P., Kaack, K., & Fretté, X. C. (2008). Selection of elderberry (*Sambucus nigra* L.) genotypes best suited for the preparation of elderflower extracts rich in flavonoids and phenolic acids. European Food Research and Technology, 227(1): 293-305.

Ciftcioglu, G. C., Ebedi, S., & Abak, K. (2019). Evaluation of the relationship between ornamental plants–based ecosystem services and human wellbeing: A case study from Lefke Region of North Cyprus. Ecological Indicators, 102: 278-288.

Cyong, J. C. & Hanabusa, K. (1980). Cyclic adenosine monophosphate in fruits of *Zizyphus jujuba*. Phytochemistry, 19(12): 2747-2748.

Çelik, F. (2017). The importance of edible landscape in the cities. Turkish Journal of Agriculture-Food Science and Technology, 5(2): 118-124.

Da Ronch, F., Caudullo, G., Houston Durrant, T., & De Rigo, D. (2016). *Cornus mas* in Europe: Distribution, Habitat, Usage and Threats. European Atlas of Forest

Tree Species. Publication Office of the European Union, Luxembourg, p. 82-83.

Dangl, G. S., Raiche, R., Sim, S., Yang, J., & Golino, D. A. (2010). Genetic composition of the ornamental grape Roger’s Red. American Journal of Enology and Viticulture, 61(2): 266-271.

Dawidowicz, A. L., Wianowska, D., & Baraniak, B. (2006). The antioxidant properties of alcoholic extracts from *Sambucus nigra* L. (antioxidant properties of extracts). LWT-Food Science and Technology, 39(3): 308-315.

De Biaggi, M., Donno, D., & Mellano, M. G. (2018). *Cornus mas* (L.) Fruit as a potential source of natural health-promoting compounds: Physico-chemical characterization of bioactive components. Plant Foods Hum Nutr., 73: 89-94.

De Souza, E. H., de Carvalho Costa, M. A. P., Souza, F. V. D., Junior, D. S. C., Amorim, E. P., e Silva, S. D. O., & dos Santos-Serejo, J. A. (2012). Genetic variability of banana with ornamental potential. Euphytica, 184(3): 355-367.

Dos Santos, A. R. A., De Souza, E. H., Souza, F. V. D., Fadini, M., Girardi, E. A., & Soares Filho, W. (2015). Genetic variation of *Citrus* and related genera with ornamental potential. Euphytica, 205(2): 503-520.

FAO (2018). http://www.fao.org/faostat

Fonsah, E. G., Wallace, R., & Krewer, G. (2008). Why are there seeds in my banana? A look at ornamental bananas. Journal of Food Distribution Research, 39(1): 67-71.

Fuller, D. Q. & Stevens, C. J. (2019). Between domestication and civilization: The role of agriculture and arboriculture in the emergence of the first urban societies. Veget. Hist. Archaeobot., 28: 263-282.

Gilman, E. F. & Watson, D. G. (2007). *Malus* spp. Crabapple. [Online] cited at http://hort. ufl. edu/trees/MALSPPA. pdf.

Güler, S., Bozdoğan, E., & Burğut, A. (2017). Peyzaj tasarımında alternatif bir meyve ağacı: *Arbutus unedo* L. V. Uluslararası Katılımlı Üzümsü Meyveler ~~Sempozyumu. Bahçe, 46(1): 215–222.~~

Guo, Y. & Shan, G. (2010). The Chinese Jujube. Shanghai Scientific Technical Publ., Shanghai, China.

Jian, Q., He, N., Wang, Y., & Xian, Z. (2013). Ecological issues of mulberry and sustainable development. J. Res. Ecol., 2: 330-339.

Karadeniz, T. (2004). Şifalı Meyveler (Meyvelerle Beslenme ve Tedavi Şekilleri. ISBN 975288867-4.

Katz, G. L. & Shafroth, P. B. (2003). Biology, ecology and management of *Elaeagnus angustifolia* L. (Russian olive) in western North America. Wetlands, 23: 763-777.

Kaya, O., Kose, C., Donderalp, V., Gecim, T., & Taskın, S. (2020). Last updates on cell death point, bud death time and exothermic characteristics of flower buds for deciduous fruit species by using differential thermal analysis. Scientia Horticulturae, 270: 109403.

Kendall, D. A. & Smith, B. D. (1975). The foraging behavior of honeybees on ornamental *Malus* spp. used as pollinizers in apple orchards. Journal of Applied Ecology, 465-471.

Kennedy, J. (2009). Bananas and people in the homeland of genus *Musa*: Not just pretty fruit. Ethnobot. Res. Appl., 7:179-197.

Klimenko S. V. (1990). Kizil na Ukraine. Nauk. dumka, Kiev, p. 174.

Klimenko, S. V. (2004). The cornelian cherry (*Cornus mas* L.): Collection, preservation, and utilization of genetic resources. J. Fruit Ornam. Plant Res., 12: 93-98.

Konarska, A. & Domaciuk, M. (2018). Differences in the fruit structure and the location and content of bioactive substances in *Viburnum opulus* and *Viburnum lantana* fruits. Protoplasma, 255(1): 25-41.

Lee, J. & Finn, C. E. (2007). Anthocyanins and other polyphenolics in American elderberry (*Sambucus canadensis*) and European elderberry (*S. nigra*) cultivars. Journal of the Science of Food and Agriculture, 87(14): 2665-2675.

Leva, A. R. & Petruccelli, R. (2011). Dwarf olive trees for ornamental use: A morphological evaluation. The Journal of Horticultural Science and Biotechnology, 86(3): 217-220.

Li, J. W., Fan, L. P., Ding, S. D., & Ding, X. L. (2007). Nutritional composition of five cultivars of Chinese jujube. Food chemistry, 103(2): 454-460.

Liu, M. & Wang, M. (2009). Germplasm Resources of Chinese Jujube. China Forestry Publ. House, Beijing, China.

Liu, Z. X., Zhang, H. X., Yang, X. Y., Liu, T., & Di, W. B. (2014). Growth, and cationic absorption, transportation and allocation of *Elaeagnus angustifolia* seedlings under NaCl stress. Acta Ecologica Sinica, 34(2): 326-336.

McNamara, S. & Pellett, H. (1994). Cold hardiness of landscape pear taxa. J. Environ. Hort., 12: 227-230.

McNamara, S. & Pellett, H. (1995). Cold hardiness of flowering crabapple cultivars. J. Environ. Hort., 14: 111-114.

Mortensen, J. A., Harris, J. W., Hopkins, D. L., & Andersen, P. C. (1994). Southern Home: An interspecific hybrid grape with ornamental value. HortScience, 29(11): 1371-1372.

Olszewska, M. A. (2011). Variation in the phenolic content and in vitro antioxidant activity of *Sorbus aucuparia* leaf extracts during vegetation. Acta Poloniae Pharmaceutica-Drug Research, 68: 937-944.

Özdemir, G. & Kalyoncu, I. H. (2011). A selection study on oleaster (*Elaeagnus angustifolia* L.) grown in the campus area of Selcuk University in Konya, Turkey. African Journal of Biotechnology, 10(77): 17726-17736.

Richer, C., Rioux J. A., Lamy, M. P. (2003). Winter damage and growth evaluation of seven ornamental crab apple cultivars in the diverse weather conditions of the Canadian north-east. Canadian J. of. Plant Science, 83: 835-849.

Şahin, M., Mısırlı, A., Gökkür, S., Aksoy, D., & Özaktan, H. (2020). Application of hybridization breeding technique for fire blight resistance on *Cydonia oblonga*: A base study on susceptibility, heterosis, and heterobeltiosis parameters. International Journal of Fruit Science, 1-12. https://doi.org/10.1080/15538362.2020.1804515

Santos-Serejo, J. A., Souza, E. H., Costa, M. A., Costa Junior, D. S., Amorim, E. P., Silva, S. O., & Souza, F. V. (2012). Selection and use recommendation in hybrids of ornamental banana. Crop science, 52(2):560-567.

Santos-Serejo, J. A., Souza, E. H., Souza F. V. D., Soares, T. L., & Silva, S. O. (2007). Morphological characterization of ornamental banana. Magistra, 19: 326-332.

Sasmita, N., Purba, J. H., & Yuniti, I. G. A. D. (2019). Adaptation of *Morus alba* and *Morus cathayana* plants in a different climate and environment conditions in Indonesia. Biodiversitas Journal of Biological Diversity, 20(2): 544-554.

Shah, J. F., Harner, M. J., & Tibbets, T. M. (2010). *Elaeagnus angustifolia* elevates soil inorganic nitrogen pools in riparian ecosystems. Ecosystems, 13(1): 46-61.

Sottile, F., Del Signore, M. B., & Barone, E. (2019). Ornacitrus: Citrus plants (*Citrus* spp.) as ornamentals. Folia Horticulturae, 31(2): 239-251.

Suhonen, J., Jokimäki, J., Lassila, R., Kaisanlahti-Jokimäki, M. L., & Carbó-Ramírez, P. (2017). Effects of roads on fruit crop and removal rate from rowanberry trees (*Sorbus aucuparia*) by birds in urban areas of Finland. Urban Forestry & Urban Greening, 27: 148-154.

Tsalikidis, I., Voyiatzi, C., & Tamoutseli, K. (1997). The use of the olive tree in ancient and contemporary garden design of the Mediterranean Region. III International Symposium on olive growing 474, p. 767-770.

Uma, S., Saraswathi, M. S., Durai, P. & Sathiamoorthy, S. (2006). Diversity and distribution of the section Rhodochlamys (Genus *Musa*, Musaceae) in India and breeding potential for banana improvement programs. Plant Genet. Resour. Newsl., 146: 17-23.

Uzun, A., Gulsen, O., Kafa, G., & Seday, U. (2015). New lemon genotype for ornamental use obtained from gamma irradiation. Acta Hortic., 1065: 245-247.

Višnjevec, A. M., Arbeiter, A. B., Hladnik, M., Ota, A., Skrt, M., Butinar, B., ... & Ulrih, N. P. (2019). An integrated characterization of jujube (*Ziziphus jujuba* Mill.) grown in the North Adriatic Region. Food technology and biotechnology, 57(1): 17.

Vodičková V. (1999). Oxycoccus Hill, klikva, Vacciniaceae (Oxycoccus Hill, cranberry, Vacciniaceae). In: Mareček F. *(ed.),* Zahradnický Slovník Naučný 4. Ústav zemědělských a potravinářských informací, Prague, p. 177.

Vrchotová, N., Dadáková, E., Matějíček, A., Tříska, J., & Kaplan, J. (2017). Effect of variety on content of bioactive phenolic compounds in common elder (*Sambucus nigra* L.). Natural product research, 31(6): 700-703.

Wallace, R., Krewer, G., & Fonsah E. G. (2007). Ornamental bananas: New hybrids from a group of underutilized landscape plants. Southeast. Palms, 15:10-18.

Whistler, W. A. (2000). Plants in Samoan Culture: The Ethnobotany of Samoa. Isle Botanica, Honolulu, Hawaii.

Xue, Z., Feng, W., Cao, J., Cao, D., & Jiang, W. (2009). Antioxidant activity and total phenolic contents in peel and pulp of Chinese jujube (*Ziziphus jujuba* Mill) fruits. Journal of Food Biochemistry, 33(5): 613-629.

Yan, Z. H. U., Daqian, F., Yang, L. I., & Lu, Z. H. E. N. G. (2005). Study on the ornamental characters of *Viburnum opulus* L. and its physiological and ecological indexes. Arid Zone Research, 22(2): 214-218.

Yao, S. & Heyduck, R. (2018). Ornamental jujube cultivar evaluation in the Southwestern United States. Horttechnology, 28(4): 557-561.

Yao, S. (2013). Unique fruit development of ornamental 'Teapot' jujube. HortTechnology, 23(3): 364-368.

Yılmaz, C. (2010). Tokat Yöresinde Yetişen Bazı Üvez (*Sorbus domestica* L.) Tiplerinin Tohumlarının Çimlenmesi Üzerine Farklı Uygulamaların Etkileri. Yüksek Lisans Tezi, Gaziosmanpaşa Üniversitesi Fen Bilimleri Enstitüsü, Tokat.

Zhao, A., Li, D., Wang, Y., Sui, C., Cao, Y., & Liang, Q. (2009). Study on the contents of cAMP and cGMP in different cultivars, growing periods and organs in Chinese jujube. Acta Hort. Sinica, 36: 1134-1139.

URL-1. https://greenharvest.com.au/GreenGardenNotes/FruitTreesForSmallGardens.html (Access date: 25.10.2020)

URL-2. https://pixabay.com (Access date: 26.10.2020)

URL-3. https://landscapeplants.oregonstate.edu/plants/eriobotrya-japonica (Access date: 25.10.2020)

URL-4. https://mswn.com/plants/vitis-californica-rogers-red-california-grape/ (Access date: 27.10.2020)

URL-5. http://plantbreeding.coe.uga.edu/images/f/f6/Fig20-2-5.png (Access date: 28.10.2020)

URL-6. https://tr.decorexpro.com/besedka/dlya-vinograda/ (Access date: 29.10.2020)

URL-7. https://bilgihanem.com/igde-agaci-nedir/ (Access date: 25.10.2020)

URL-8. https://i.pinimg.com/originals/fa/75/30/fa753082a60e8f95b8d89ba33ed5a4f6.jpg (Access date: 02.11.2020)

URL-9. http://fruiteten.blogspot.com/2013/08/aardbeiboom.html (Access date: 04.11.2020)

URL-10. https://www.amazon.ca/Strawberry-tree-Arbutus-unedo-bonsai/dp/B010P9O434 (Access date: 05.11.2020)

URL-11. https://forestryandland.gov.scot/learn/trees/rowan (Access date: 08.11.2020)

URL-12. https://www.polliceverdestore.com/en/wild-olive-bonsai-tree-177 (Access date: 09.11.2020)

URL-13. http://www.landscape.net.au/kitchen-gardens/ (Access date: 10.11.2020)

URL-14. https://www.pinterest.com.au/pin/365987907191577292/ (Access date: 15.11.2020)

URL-15. https://aces.nmsu.edu/jujube/ornamentals.html (Access date: 15.11.2020)

URL-16. https://www.pomonafruits.co.uk/fruit-nut-trees/apple-trees/crab-apple-trees-malus/malus-royalty-crab-apple-tree (Access date: 15.11.2020)

URL-17. https://www.gardensillustrated.com/plants/trees/the-best-crab-apple-trees-for-colour-and form/?image=7&type=gallery&gallery=1&embedded_slideshow=1 (Access date: 16.11.2020)

URL-18. https://www.gardenia.net (Access date: 17.11.2020)

URL-19. https://i.pinimg.com/originals/af/f9/ac/aff9ac4518300087eabaeda01916cd88.jpg (Access date: 18.11.2020)

URL-20. https://www.monrovia.com/plant-catalog/plants/3037/black-lace-elderberry/ (Access date: 20.11.2020)

URL-21. http://www.plantmedia.com.tr/view.asp?Id=1978&title=sambucus-racemosa-captifoliaceae-kirmizi-meyveli-murver (Access date: 25.11.2020)

URL-22. https://www.phillyorchards.org/wp-content/uploads/2016/03/Cornelian-Cherry-Tree.jpg (Access date: 25.11.2020)

URL-23. https://balconygardenweb.com/how-to-grow-banana-trees-growing-banana-trees-in-pots/ (Access date: 25.11.2020)

CHAPTER 20

GRAFTING IN THE PRODUCTION OF POT CACTI

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INTRODUCTION

The family of Cactaceae is native to North and South America continents. The natural distribution area ranges from the southern tip of South America in south to Canada in north (Anderson, 2001), however *Rhipsalis baccifera* is a cactus species succeed to distribute naturally also at new habitats as Africa and Sri Lanka. The family has about 127 genera with 1750 species (Christenhusz & Byng, 2016). With the exception of some groups (e.g. *Pereskia* species) almost all of the cactus species are succulent and leafless plants, having many different mechanisms of drought resistance. Main diversity centers of cacti are in semiarid and arid regions. However, habitats of the cacti species vary from extremely dry deserts to lush tropical rain forests (Anderson, 2001; Pérez et al., 2015). This wide diversity of habitats has led to formation of many different shaped and sized cacti (Anderson, 2001). There are many features, have been considered on, to describe and group the cacti forms. In terms of their forms, different descriptions and groupings of cacti have been made by botanists and horticulturists. In a grouping, made by Innes and Glass (1997), 8 basic shapes (columnar, globular, padded/jointed, clustering, leaf-like, pendent, sprawling/trailing and climbing) and detailed variations within these shapes were described.

With their wide feature, cacti have attracted the attention of human since ancient time. There is evidence that *Echinopsis pachanoi* was grown in Peru 3000 years ago. Cacti are also present in the archaeological records. One of them is 12000 years old cave paintings in Brazil, in which *Tacinga inamoena* was depicted in. (Anderson, 2001). There are reports early in the sixteenth, that cacti were used by natives for healing, defense, making wine, and as a source of the dye (Howard & Touw, 1981). After the encountering of European people with this family, different species of cacti started to be carrying to Europe and other continents. Medicinal practices (Shetty et al., 2012), food obtaining (fruits, stem segments, wine), religious instruments, source of dyes, furniture, fence (Anderson, 2001), gums and mucilages (for pottery, glue (Moerman, 1998) and edible coating (Del-Valle et al., 2005)) and animal food (Brutsch & Zimmermann, 1993; Nefzaoui & Salem, 2002) are some of the current uses of cacti. Among other purposes, growing as an ornamental plant is one of the most common worldwide use of cacti.

With their original characteristics and diversity of appearance, cacti have attracted many people around the world and have been cultivated as ornamental plant for centuries. More than 300 species have been cultivated as ornamental plants, with many others also available in the collections. Illegal collecting of cacti, in Mexico, the United States and other countries is still one of the most important threats for endangered populations (Anderson, 2001).

Species of cacti have a wide range of use area as an ornamental plant, with their diverse forms and sizes and with aesthetic aspects. They are grown in different sized pots or in the ground as a houseplant or an outdoor plant. While a dwarf specimen displays its beauty in a small pot, a huge one can be placed in gardens or parks.

All cacti species start to bloom when they reach to a certain maturity stage, which takes for a few to several years. Although the flowers, cacti produce, are usually short-lived (even less than one day for some species), they are attractive with their bright colors and forms. Besides this, flowers of some species (e.g *Schlumbergera lemaire* species) which are also important as ornamental plant, live for longer time. And such species, having partly gradual flowering characteristics as well, have a longer flowering period.

Increasing interest and demand for cacti as ornamental plants have led to their collection from nature, propagation, cultivation and breeding. Ornamental cacti are being propagated via different methods such as using seeds, cuttings, grafting methods and micropropagation techniques. Grafting in cacti, one of these propagation methods, has not only been a propagation method but also a means of creating a new ornamental plant group. The combination of a green cactus and another cactus growing on it in different forms and bright colors, being also called as moon cacti or ruby ball, has taken its place in the markets. Grafted cacti are an important ornamental crop traded worldwide. Here we present the grafting and cultivation of grafted potted cacti in mass production.

1. PROPAGATION IN CACTI

Cactus species are generally slow-growing perennials, except for some species. Size of the plant (especially for slow growing species) is a major factor for pricing. Propagation and enlargement of some species is limited due to their slow growth and limited propagation material yield per plant in a unit of time.

Cacti can be propagated through seeds, which is the main natural propagation process already occurring in their habitats. However propagation by seeds is a slow process, having necessity to be used in some cases. Most cacti can be propagated easily by rooting the certain sized limbs and offsets removed from the mature plant. Cuttings taken by cutting from a specific point of the shoots are also good vegetative materials to root except some species. Some cacti as *Ariocarpus* and *Aztekium* are difficult to root which must be grown from seed or grafted (Gottlieb, 1997). Another vegetative propagation technique for cacti is micropropagation, being used for different commercial and research purposes. Tissue culture has been considered as an important technique in terms of purposes such as shortening the production period, contributing to the ex-situ conservation of endangered species (Pérez et al., 2015; Badalamenti et al., 2016) and virus-free production. Grafting is another vegetative propagation technique being used for cacti propagation for different purposes, such as increasing offset yield (as propagation material) and growth rate of slow growing genotypes, rescuing a damaged or rotting plant by using its clean shoots, enabling the growth of chlorophyll free cultivars, which are incapable of independent survival and providing faster vegetative production of the species those are rare or difficult to root.

A grafting technique, micrografting is used for the primary steps of the production of the bred chlorophyll-free varieties. Their germinated seedlings are being grafted onto in vitro grown rootstocks. In the studies of Park et al. (2018, 2020) in vitro seedlings of the bred cultivars of *Gymnocalycium* obtained by hybridization were grafted onto *Hylocereus trigonus* Haworth grown in vitro. Micrografting is also considered as a technique may be used for overcoming restrictions of the tissue culture mostly originated from limited information for in vitro requirements of each taxon. Micrografting of rare or endangered taxa, without providing its optimal in vitro requirements, onto a rootstock grown in vitro will provide rapidly production of these species (Badalamenti et al., 2016).

For ornamental use, interspecific and also intergeneric graft compatibilities, give a chance to create aesthetic combinations between different formed cacti, like grafting a pendent formed species onto a columnar rootstock. Grafting Christmas cacti on an *Opuntia* species is an example of such practices, being done by hobbyist (Figure 1).

Figure 1: Grafted *Schlumbergera* on *Opuntia*

Besides the various grafting possibilities, species options and different hobbyist practices, only certain species are widely used in commercial grafted ornamental cactus production worldwide.

2. GRAFTED CACTI PRODUCTION

The wound responses of plants are thought to be one of the possible reasons of the evolving of grafting (Melnyk & Meyerowitz, 2015). Self-repair mechanism plays an important role in the group of succulent plants, which have special adaptations in terms of water storage (Mylo et al., 2020). Grafting which is a technique used for joining the tissues of different plants is also being used in cacti with the common principles but with the differences in application techniques. The plant piece termed scion is attached onto another plant termed rootstock. The rootstock onto which scion will be grafted can be a cutting without roots or a rooted plant. The first is common in the production of grafted potted cacti. Scions of the desired cultivars are usually obtained from the offsets of a mature plant that was already grafted onto another cactus. This is also the only option for chlorophyll-deficient cultivars. In some cases in cultivars with sufficient chlorophyll content, plants grown from seeds or cuttings can also be used as a scion source. However, cacti grafted onto a stronger rootstock tend to quickly produce higher numbers of more robust offsets.

Optimization of cultivation conditions is effective both in increasing rootstock and scion yield and quality, and in improving post-grafting growth. Free drainage is the main characteristic that the growing media should have. The use of materials such as sand and perlite is necessary to improve drainage, especially in mixtures of soil-less origin growing media on which plants will be grown for a long time. While the pH values required for soil vary by the different cactus species, e.g. *Hylocereus trigonus*, widely used rootstock requires acid soils. Although cacti are drought-adapted plants, regular irrigation will improve their growth, but the soil should not be constantly wet and should be allowed to dry before the following watering. Proper fertigation is important to ensure adequate growth and shoot yield of cacti. One of the points to consider is that excessive nitrogen use reduces shoot quality. *Hylocereus trigonus*, which is a climbing forest plant in its wild habitat, requires filtered light. Shading should be done especially in spring and summer. Cultivars being used for the upper portion of the graft also require semi-shade.

Virus infections are great problems reducing the growth rate, quality and graft-take ratio (Chung, et al, 2003; Lee & Oda, 2003). Therefore, it is important to start with virus-free plants and prevent infection during cultivation.

2.1. Stock Plants

Hylocereus trigonus has been the most used rootstock for the mass production of grafted cacti with its rapid and uniform growth. However, *Myrtillocactus geometrizans*, *Eriocereus jusbertii*, *Eriocereus tortuusus*, *Cereus peruvianus* are some other rootstocks that have also been used with their various characteristics (Lee & Oda, 2003)

H. trigonus, which will be used in the production of rootstocks to be used in grafting, is commonly propagated with cuttings. Healthy cuttings of this rootstock are planted into beds or benches filled with a well-drained proper growing media (rich in sand) (Figure 2). It should be preferred to plant cuttings in the warm period. Depending also on the season and/or climatic conditions provided, they root quickly and new shoots start to appear. In case of healthy growth, stock plants can be used as a cutting source for up to three years.

Figure 2: *H. trigonus* for rootstock production (Erken, 2007)

2.2. Scion Production

The certain cacti species, being used for grafted ornamental cacti production, have various cultivars have been bred. While chlorophyll deficient ones having different colors with various tones (red, pink, yellow, purple, orange) are mainly used, some green cultivars containing chlorophyll are also used as the scion source. While the *Gymnocalycium mihanovichii* is the most common one, *G. denudatum*, *Notocactus scopa*, *Eriocactus leninghausii*, *Chamaecereus silvestrii*, *Mammillaria theresae*, *Cereus cristata* and *Sulcorebutia rauschii* are the some other important species.

Once a new chlorophyll deficient cultivar was bred, it is propagated firstly in in vitro and then in in vivo. In vivo vegetative propagation is continued unless a problem based on viral infection is seen. The scion-source plants, grafted on a healthy rootstock may be selected from the larger ones which were propagated for sell. However it should be preferred to use grafted plants specially produced for scion production. Since the rootstock is the photosynthetic part of the grafted cactus, the growth of the scion and its offset yield is significantly affected by the size of this lower portion. For that the length of *Hylocereus* cuttings, onto which scions will be grafted to obtain a scion source plant, are preferred to be at least 14 cm. These plants are transplanted to larger pots or can be planted into growing beds. By the growth of the plants, the upper part of the graft union starts to enlarge and new offsets appear at the areoles (modified lateral buds). Depending on the species and varieties, the annual offset yield per plant varies. *Chamaecereus silvestrii* tends to produce more offset. To promote the offset yield, sometimes the upper part of the *C. silvestrii* scion is cut. A plant can be used as a scion source for up to 1-1,5 years.

2.3. Grafting and Post Grafting Care

Plant materials needed in cactus grafting are scions and rootstocks. It is not difficult to achieve a high ratio of graft-take when basic rules of the grafting technique of the cacti are observed. Although cactus grafting can be done year-round, it is usually carried out from early spring to October. In this period that plants show active growth, rootstock and offset yields are higher and the necessary climatic conditions can be provided more easily during the grafting process. Offsets which are also called pups are the scion resources being obtained by removing from the matured plant. Rootstocks are prepared from the shoots cut from *Hylocereus trigonus.* Both rootstock and scion source plants are irrigated the day before the harvest of rootstocks and scions. Preferably, offsets with a diameter of at least 1 cm or more are collected. To prepare the stocks, actively grooving shoots of *H. trigonus* are cut. The shoots or shoot parts with proper form are used and ones with the disordered or weak growth are eliminated. Generally, these shoots are prepared in 3 different size groups (6, 9 or 14 cm). Rootstock length is determined by the targeted size of the grafted cactus. Some stock lengths for desirable size of *Gymnocalycium mihanovichii* are seen in Table 1.

Table 1: Some roostock lengths for desirable size of *Gymnocalycium mihanovichii* (Jeong et al., 2004)

Product size	Stock lenght (cm)	Desirable globe diameter (cm)
Large	12-14	4.5
Medium	9	3.0
Small	6	2.5

Both rootstocks and offsets are harvested on the day of grafting. In order to prevent dehydration, especially offsets are collected maximum 1.5-2 hours before the grafting procedure. To remove the upper areolas (which have a potential to produce shoots), each rib in the upper part of the rootstock is cut with a slight bevel towards the top. With this cut, the top of the rootstock takes a conical shape and reveals the central texture in the middle (Figure 3). This also helps the scion to hold better by covering the grafting point as it enlarges. As the rootstock cut surfaces dry out, the middle part collapses. If this cut is not applied surrounding tissues of the rootstock may push the scion upwards, which can prevent the contact of the new cactus has been grafted on top with the bottom. Also, cutting the ribs on the lower part of the rootstock with a slight bevel will increase the wound and rooting surface.

A thin slice from the upper stem tip of the rootstocks and about a quarter of the offset base is cut horizontally to the axis, just before they are joined together. These cuts should be done quickly with a sharp cutter to avoid crushing the tissues and to produce a perfectly flat surface. It must be ensured that the cutters used in all cutting processes and all tools used in grafting are clean. They should be sterilized frequently. As soon as the two cacti tissues are sliced off, the scions are placed onto rootstock without allowing the surfaces to dry (Figure 4). Scion may be rotated with gentle pressure to remove any air in between tissues.

Figure 3: Rootstock prepared grafting

Figure 4: Placing the scion onto rootstock (Erken, 2007)

Figure 5: Cross section of the rootstock and scion

Ensuring contact of both scion and rootstock vascular tissues are essential for the success of grafting. In the cross section of a cactus stem the vascular ring, which is located between the pith and cortex is visible (Figure 5). Clips, rubber bands, or cotton thread are used to hold the scion and rootstock together after they are joined (Figure 6).

Then they are lined up in special boxes without allowing any damage in their attached form. These boxes must be suitable for sufficient air circulation inside. They are kept under temperature and humidity-controlled conditions (30°C, 85% relative humidity (Lee & Oda, 2003; Jeong et al., 2007)) for about a week to promote callus growth, healing, and graft adhesion (Figure 7).

Figure 6: Use of clips and cotton threads in grafting (Erken, 2007)

Figure 7: Curing of grafted cacti (Erken, 2007)

In some cacti nurseries, grafted cacti are also kept in greenhouses to complete this curing period. If proper temperature and humidity cannot be maintained during the curing phase, adhesion can take up to 2 weeks or more with a lower graft-take rate. However grafting process and curing are critical not just at the rate of graft-take but also for the post-growth and quality. Temperatures in the curing stage affect the percentage of marketable grafted cacti produced (Jeong et al., 2007).

Figure 8: Grafted cacti after curing phase (Erken, 2007)

Figure 9: Grafted cacti planted after curing (Erken, 2007)

Figure 10: Grafted cacti in different stages of growth (Erken, 2007)

After the curing, which is a stage that also encourages rooting that will occur afterwards, clips are removed (Figure 8). Then the cacti in which grafting is successful are planted in pots or beds for rooting and growth (Figure 9).

Figure 11: Grafted cacti prepared for market (Erken, 2007)

Plants root in 2-4 weeks. In cooler months root-zone heating is an application encouraging the rooting. The production period varies from 2-3 to 8 months, depending on climate control in the greenhouse, cultivation conditions, cultivars and desirable cactus size. The production period takes longer to obtain larger diameter cacti. Grafted cacti in different stages of growth are seen in Figure 10.

Depending on distance or demand, grafted cacti are sent to the market in the pots (Figure 11) or with the roots removed.

CONCLUSION

Grafting has been used as a way of obtaining different advantages of cultivation in different plant groups. It is also an important method in cacti propagation. Today, the most common use of grafting in ornamental cacti is potted cactus production, which takes attention with their new cultivars worldwide. Studies in the optimization of factors which are effective on cultivation, breeding of varieties with improved growth, appearance and tolerance characteristics will obtain further improvement in grafted cactus production.

The diversity of species in cacti and their graft compatibility characteristics are the great potentials, which may lead to further diversification of the grafted potted cacti as well as the widespread use of grafting for outdoor cacti in the future.

REFERENCES

Anderson, E. F. (2001). The Cactus Family. Timber Press (OR)., p. 776.

Badalamenti, O., Carra, A., Oddo, E., Carimi, F., & Sajeva, M. (2016). Is in vitro micrografting a possible valid alternative to traditional micropropagation in Cactaceae? *Pelecyphora aselliformis* as a case study. SpringerPlus, 5(1): 1-4.

Brutsch, M. O. & Zimmermann, H. G. (1993). The prickly pear (*Opuntia ficus-indica* [Cactaceae]) in South Africa: Utilization of the naturalized weed, and of the cultivated plants. Economic Botany, 47(2): 154-162.

Christenhusz, M. J. & Byng, J. W. (2016). The number of known plants species in the world and its annual increase. Phytotaxa, 261(3): 201-217.

Chung, B. N., Kim, J. S., & Jeong, M. I. (2003). Effect of CVX infection on graft-take and growth of *Gymnocalycium mihanovichii* in grafting cactus. Journal of the Korean Soceity for Horticultural Science, 44(5): 748-752.

Del-Valle, V., Hernandez, M. P., Guarda, A., Galotto, M. J. (2005). Development of a cactus mucilage edible coating and its application to extend strawberry shelf life. Food Chem., 91: 751-756.

Erken, K. (2007). Grafted Cacti. Unpublished Document. Yalova, Turkey.

Gottlieb, A. (1997). Peyote and Other Psychoactive Cacti. Ronin Publishing., p. 98.

Howard, R. A. & Touw, M. (1981). The cacti of the Lesser Antilles and the typification of the genus *Opuntia* Miller. Cactus and Succulent Journal, 53(5): 233-237.

Innes C. & Glass G. (1997). The Illustrated Encyclopedia of Cacti. Knickerbocker Press, New York, USA.

Jeong, I. M., Cho, C. H., & Lee, J. M. (2004). Production and breeding of cacti for grafting in Korea. Chronica Horticulturae, 44(3): 7-10.

Jeong, S. J., Kim, W. S., & Lee, J. S. (2007). Effect of stationary room temperature on graft-take and post-graft growth of grafted cactus Ruby Ball. Horticulture Environment and Biotechnology, 48(6): 393-396.

Lee, M. & Oda, J. L. M. (2003). Grafting of herbaceous vegetable and ornamental crops. Hortic. Rev., 28: 61-124.

Melnyk, C. W. & Meyerowitz, E. M. (2015). Plant grafting. Current Biology, 25(5): R183-R188.

Moerman, D. (1998). Native American Ethnobotany Timber Press. Portland OR.

Mylo, M. D., Krüger, F., Speck, T., & Speck, O. (2020). Self-Repair in Cacti branches: Comparative analyses of their morphology, anatomy, and biomechanics. International Journal of Molecular Sciences, 21(13): 4630.

Nefzaoui, A. & Salem, H. B. (2002). Forage, Fodder, and Animal Nutrition. In: Cacti: Biology and Uses, p.199-210.

Park, P. M., Kwon, O. K., Park, P. H., An, H. R., & Lee, S. Y. (2018). Breeding of moon cactus 'Yeonbit' with pink color. Flower Research Journal, 26(3):161-165.

Park, P. M., Kwon, O. K., Park, P. H., An, H. R., & Lee, S. Y. (2020). Breeding of moon cactus ‘Aul’ with symmetric bicolor offsets. 28(3): 205-209.

Pérez-Molphe-Balch, E., Santos-Díaz, M. D. S., Ramírez-Malagón, R., & Ochoa-Alejo, N. (2015). Tissue culture of ornamental cacti. Scientia Agricola, 72(6): 540-561.

Shetty, A. A., Rana, M. K., & Preetham, S. P. (2012). Cactus: A medicinal food. Journal of Food Science and Technology, 49(5): 530-536.

CHAPTER 21

THE IMPORTANCE OF HYDRO-SEEDING REVEGETATION TECHNIQUES IN LANDSCAPE REPAIR

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INTRODUCTION

The progress of civilization leads to the increase of collective living spaces, intensive structuring and consequently increases people's longing for natüre (Temizel & Erdoğan, 2019). Lawn areas (grass fields), which constitute one of the most important elements of life in the modern world, are also an important indicator of development (Yazici & Ünsal, 2019; Temizel et al., 2019). People who had to live collectively in cities by breaking away from nature tried to create healthier environments by vegetating their living spaces. In recent years, the construction industry has been growing exponentially with the uneven population increase. The lawn areas problem, which is an important problem caused by population and unplanned urbanization, is becoming increasingly important. In addition to the raising in the awareness of people about the environment in the last few years, increasingly the concrete cities coming to a point where it can no longer be lived by everyone has accelerated this process.

As a result, a city that includes asphalt, concrete and excavation has been encountered. It seems that municipal officials and decision-makers are also aware of the situation, and even local election strategies are now being built on promises to increase green space (Yazici & Gülgün, 2017).

Lawn area covers that constitute the most important plant element of outdoor spaces-; In addition to its optical and aesthetic advantages such as appealing to the eye and providing peace of mind, it also has features such as soil protection (erosion control), dust control, development of natural beauties, vegetation of road-rail slopes and water channels and cooling the environment (Palacios et al., 2010).

1. LAWN AREAS (GRASS FIELDS) IN HISTORY

Lawn areas or grass fields had been a full scientific discipline in 1946 and revolutions began in lawn areas culture. In the 1950s;

- ✓ New types of grass have been improved for grass areas,
- ✓ Herbicide (weed fighting chemical), pesticide (insect and disease fighting chemical) technology has been developed to control insects, diseases and foreign plants in grass areas,
- ✓ Special fertilizer and fertilization techniques have been found for grass areas,
- ✓ Modern techniques have been introduced for the shape (mechanization), maintenance, irrigation and fertilization of grass areas (Avcıoğlu, 1997) (Figure 1).

Figure 1: England, United Kingdom (URL-1)

2. DEFINITION AND IMPORTANCE OF GRASS AREAS

Grass is a plant that forms a soft shaped and body. Perennial grass species grow upright and grow up to 90 cm in length. The leaves are glabrous, bright green color and the leaf blades are folded on young grass shoots. Grass spikelet ensemble forms a grass spike about 30 cm long (Arnáez & Larrea, 1994; Yılmaz et al., 2012) (Figure 2).

Figure 2: (a) Grass general view, Grass spike view (b) (URL-2,3)

The weight of 1000 seeds of grass is approximately 2 grams. Annual grasses have two sub-varieties: one-year and two-year. Annual grasses are taller than perennial grasses, their stems grow upright and are about 130 cm tall. The leaves of the annual grass are also glabrous. But the leaf of young shoots is not folded. The grass spikelet community is taller.

3. QUALITY CRITERIA OF GRASS PLANTS

Gramineae bitkileri, generatif gövdelerin altında üretici organ taslağına sahiptir. As the plant grows, it grows upwards, and leaving up from the last leaf tip, it forms the "Flower state" which is the collection of flowers (Anonymous, 2017).

3.1. Color

Firstly, the heritable color hue of the grass plant or plants to be selected must be investigated. Especially, it should be taken into account that some types of grass, which are successfully grown in the regions located in the Mediterranean climate zone, are green in spring and summer but yellow in winter. This is not a problem for residences to be used only in summer. However, some different applications (e.g. overseeding) should be made in places that use summer and winter. For example, green color can be provided in winter by overseeding (Anonymous, 2017).

3.2. Growth and Development Speed

In the region where the grass species to be selected will be used, it should be preferred to consist of plants that germinate or rooting quickly, after planting rapidly develop and produce new stems and leaves and cover the soil surface. After sowing or planting, relatively slow growth and development are desirable in grass areas that are completely covered with vegetation, despite their rapid growth and development. Because in this way, shape, maintenance operations, etc. are reduced and easier. Also, the aforementioned situation results in significant reductions in the annual maintenance costs of the lawn (Anonymous, 2017).

3.3. Resistance to Dense and Hard Cut

Grass genera and species can have very different resistance to cutting. This quality should be sought especially in the types to be selected for special playgrounds (golf, etc.) which are frequently cut.

3.4. Resistance to Crush and Traffic Effect

Lawn areas that look like a carpet consisting of shoots of grass species, leaves, and stems; symbolizes the recreational and sports environments that are used by applying traffic effects (people, animals, vehicles, etc.) as well as decorative. For this reason, grass types, which can quickly renew their stems and leaves, which are pressed and crushed with different effects and broken, and can cover such prints with the least damage, are the most preferred. As will be explained later, creeping stems (Stolon) on the soil or subterranean stems that can grow in the soil and give new shoots are extremely important in terms of resistance to important (Arslan, 2018).

3.5. Growth Form

Gramineae (grass) plants, which are the basic elements of the grass areas, essentially have three types of growth forms; some varieties multiply from the bottom and "Tillers" form, others produce spreading shoots lying on the soil and have a "Stolon" structure, another group shows a "Rhizome" growth form with shoots lying in the soil. Tillers grass types give positive results in heavy soils with heavy rainfall, where soil aeration may cause problems. In hot, dry, and light-textured soils, "Stolon" and "Rhizome" growth forms that cover the soil surface better, preserve the temper, and spread like a web in the soil texture are more successful. It is possible to obtain the best results by using the species with tillers, stolon, and rhizome or mixed with all three types in the grass areas to be established in ecologies with these very different soil and climate characteristics (Açıkgöz, 1993; Arslan, 2018).

3.6. Resistance to Drought and Temperature

There are many different mechanisms, organs, and special formations that provide drought resistance in all cultivated plants. While some species may be covered with feathers and wax, some species have a thick and protective tissue on the leaf surface. Also, some plants are more successful in hot and arid conditions due to their special cell structures in leaf tissues and biochemical properties in these cells. While warm climate grass plants (C-4 plants) have this special ability, cool-climate grass plants (C-3 plants) do not contain the mentioned properties. For this reason, cool-climate grass species, which are tried to be cultivated in the regions of our country under the influence of the Mediterranean climate and the influence of hot, dry, and low relative humidity, cannot grow and develop normally and cannot be successful. However, hot climate grass plants adapt very well to this climate due to their special protective structures and biochemical privileges, and they are very successful with their low water requirements, balanced growth that does not require frequent shaping, and adaptation to almost any soil structure. It should be remembered that the "Heat Resistance" and "Dryness Resistance" of lawns are completely different concepts (Açıkgöz, 1993; Anonymous, 2017).

3.7. Disease and Pest Resistance

In Turkey, the least known in terms of green spaces and is rarely a factor taken into account, diseases caused by harmful microorganisms and the damages caused by insects, worms, blind mice, etc. As with other agricultural plants, it is necessary to fight against many diseases and pests in grass plants (Açıkgöz, 1993; Anonymous, 2017).

3.8. Quality Criteria for Grass Covers

Quality lawn area should exhibit complete integrity with it is general appearance, and should not contain bare areas and foreign plants, yellowing that show the damage of insects and diseases, and anomalies resulting from decay. The "Density" criteria, which expresses the number of shoots per unit area, is required to be high in qualified grass areas. Because frequent shoots are important in terms of preventing foreign plants, completely covering the area, and creating good green vegetation. Experience shows that stolon and rhizome grass types produce the denser cover and maximize plant density by producing up to 200 shoots per 1 dm^2. The main element that creates the green texture of the grass area is the width of the leaf back. There may be many different leaf widths depending on the plant species (Figure 3). If less than 1 mm the texture of the grass cover is "very thin", if 1-2 mm is "thin" if 2-3 mm is "medium" if 3-4 mm is "rough" and if more than 4 mm " It is described as "very rough" (Orçun, 1979; Arslan, 2018; Ankara Metropolitan Municipality, 2020).

The fact that the grass cover has a flat surface is very important in terms of both appearance and functions to be performed on it. A criterion in this respect; can be defined as the absence of any obstacle that would affect the movement of a rolling ball. In terms of revealing the quality of lawn areas, many other features can be considered as quality criteria. These are properties such as color, dry matter yield, shoot strength, after cutting growth rate, botanical composition. Especially "color" is the criteria that draws the most attention in terms of revealing the quality of green spaces (Anonymous, 2017; González et al., 2008).

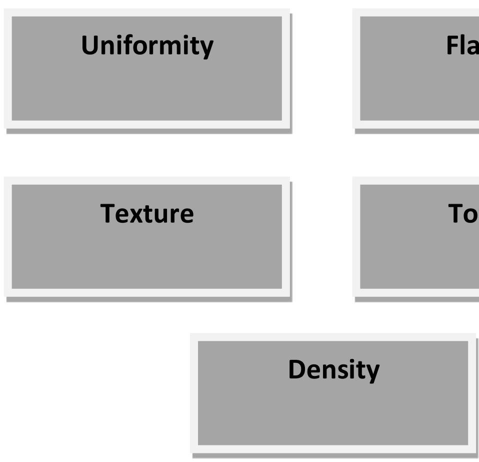

Figure 3: Quality criteria for grass covers

3.9. Criteria to be Considered in Seed Selection for Grass Field Making

- The seed should be selected according to the intended use. Such as sports fields, urban-rural recreation areas, special places (villa gardens, etc.), meadow-pasture areas, rehabilitation purposes.
- The seed should be suitable for the climate of the application area. There are three main types of climate types in Turkey. However,

even in the same region, environmental factors and climate should be determined for each application, and species suitable for the region should be selected.

- The seed should be selected by the content of the soil in the application area (salinity, acidity, etc.)
- The seed should be chosen according to the enlightenment of the area to be used (shadow, semi-shadow, direct sunlight, etc.)
- The seed should be prepared in a mixture according to all needs. The seed type to be decided as a result of soil analysis should be compatible with the soil according to the mineral status.
- Preparation of the correct seed mixture is the first step in seed selection.

Other points to be considered are listed below:

- The freshness and youth of the seed mixture.
- Germination percentages of separate seeds that make up the seed mixture,
- The number of live seeds in the seed mixture,
- The quality of the seeds that make up the seed mixture,
- The seeds that make up the seed mix must be certified (URL-4).

4. HYDROSEEDING

Hydroseeding is called by various names such as ‘wet seeding, spraying grass’. This study is carried out as follows, The material formed by mixing various materials such as seeds, fertilizers, quick-start products, mulch/mulch, adhesive with water (called hydromulcher – hydroseeder

– wet seeding machine – spray grass machine) in the tank, then it is done by spraying it to the soil surface with a hose or a tower on the machine.

Hydroseeding germination in landscape architecture; it is a grass planting method developed to create fast, cost-effective, high-quality grass and meadow areas used in erosion control, regular storage areas, golf – sports fields, and various field works. Used materials and mixing ratios; it changes/is determined according to the topographic structure, ecology, soil structure, climate, and purpose of use of the land (Albaladejo et al., 2000; Brofas et al., 2007; Optimum Lanscape & Construction, 2014).

4.1. Hydroseeding Revegetation Techniques

The hydroseeding mixture, using a hydroseeding machine, allows it to hold in the soil with a protective cover mixture for all kinds of seeds. It also contains the soil to make it habitable for the seed, fertilizers in all useful forms, nutrients, enzymes, hormones, water holders, pH regulators, seaweed, humic acid, bio mixtures (beneficial microbes – enzymes – soil bacteria), and nutrients to ensure their activation and biostimulants for germination (Tormo et al., 2007).

This technology, which does not recognize any problem in the formation of herbaceous vegetation above ground, requires engineering and technical support. Expert assistance should be sought for dozens of factors affecting hydroseeding application (such as soil, geography, climate, environmental pressure, wind, the purpose of use). Correct application methods should be determined and correct mixture prescriptions should be prepared (Salman, 2012) (Figure 4,5).

Figure 4: Revegetation techniques with hydroseeding (URL-5)

Figure 5: Revegetation techniques with hydroseeding (URL-5)

In the hydroseeding mixture, spraying each mixed material onto the soil surface is not hydroseeding. Grass planting with hydroseeding results in the correct application and selection of materials. Hydroseeding is a set of plans and programs with the consumable ratios of the mixture to be determined after all kinds of preliminary studies that will be the basis for the application and the application technique to be determined. In short, it can be called Green Environmental Engineering, in which measurable results are obtained with measurable data. Hydroseeding is a process starting from the selection of the seed mixture to be applied, the application method, the thickness of the application layer, the determination of the irrigation periods, the programmed application speed, and the expected observation examinations after the first 21-28 days after the application. Hydroseeding/hydroseeding is the grass application method; the right material, the right usage rates, the right application methods, and the right HydroMulcher / Hydroseeder (URL-5).

4.2. Hydroseeding Superior Features and Application advantages

The purpose of all seeding methods are strong, high quality, wide coverage and to create healthy germination. The superior and unique features of hydroseeding ability are described below (Table 1) (Optimum Lanscape & Construction, 2014).

Table 1: Advantages of hydroseeding (Properties and Application)

Advantageous properties of hydroseeding		
1	**Hydroseeding is natural**	It does not contain any chemicals that will not harm nature. It is odourless. The mulch used and the slurry in it, do not stick to surfaces and plants and leave no traces.
2	**Hydroseeding is economic**	Operations "such as soil transport, lawn seed spreading, cover soil sprinkling and roller pulling" are not used. The material costs used for all these processes are eliminated. In addition to its cost advantage, it also saves 40% water compared to the classical system.
3	**Hydroseeding is healty**	Since barn manure is not used, it does not allow fungal diseases and weeds that may come out of the lawn in hot weather. Since the materials used are sterile, there is no possibility of contamination with diseases or pests.
4	**Hydroseedig is effective**	It can be easily done by 2 - 3 people with hydroseeding technology, which is made by 100 workers in the same area with the traditional method.

5	**Hydroseeding is fast**	Everything necessary for the application is included in the machine and the soil surface is covered with the prepared mixture. Since the transplantation is done with a machine, it is completed very quickly. The daily capacity of our smallest machine is approximately 4,000 m^2 / day.
6	**Hydroseeding has high water holding capacity**	Since the water holding capacity of the products used is much higher than the products used in the classical method, the planted area germinates quickly and in high quality. By adding other seeds into the mixture, wildflowers can be planted in addition to germination.
8	**Hydroseeding provides homogeneous distribution of seed**	The homogeneous spreading of the seeds on the field makes the lawn area appear homogeneously. Due to the adhesive in the mixture, It freezes within 2-3 hours after the application and there are no situations such as transporting the seeds by irrigation water or ants, flowing with rain or wind blowing.
9	**Hydroseeding provides erosion control on ınclined slopes**	Since it does not require processes such as roller drawing, it is a method that can be easily applied on inclined areas and gives good results.
	Application advantages of hydroseeding	
1	**Quality**	Hydroseeding realizes germination with all the same characteristics shown by the seed. This method of creating plants with high root quality increases the understanding of quality by creating strong plants with strong roots.
2	**Inclusion**	Hydroseeding which provides even distribution of plant growth has proved superior soil covering the property.
3	**Erosion control**	It is an unrivaled choice in erosion control researches. Erosion control provides full control with the adherence of the mulch to all surfaces with soil conditioning polymers to prepare a germination bed and the usage of advanced long-lasting mulches. This technology, which offers any environment in which the seed can germinate, regardless of the soil surface request, is successfully used in full erosion control studies.
4	**Versatile use**	This technology, which renews itself over time, including landscape greening, land reclamation, mine rehabilitation, rehabilitation of burnt forest areas, dust control, garbage cover, golf- football fields, pasture cultivation-reclamation, erosion control, river rehabilitation, rainwater control, mud control, flood control, etc. has created large sectors in the fields.
5	**Health**	Hydroseeding implementations are the most ideal microenvironments for seed. Naturally, the seeds germinate in a sterile way and become healthy plants. These plants with strong root systems are more resistant to all environmental stresses.
6	**Effort**	One machine can complete the works that hundreds of people can do by working in 1 day. An incredible area such as 1,500,000 m^2 in a month can be seeded/rehabilitated from an area of 50,000 m^2 per day.

7	**Security**	Hydroseeding applications are works that are completely made of biological materials and have no harmful effects or odors on their environment. It does not cause any harm to humans, animals, or plants. It dissolves 100% in nature and leaves no residue or residue behind. It is not a toxin.
8	**Speed**	Hydroseeding applications can also be defined as jet germination. Species such as "üçgül" clover germinate before the end of 72 hours, and loliums, which are early grasses, begin to germinate before 4 days. This provides both speed and slope stability to the applications.
9	**Water**	Hydroseeding can hold water up to 13-20 times its weight. This capacity is much higher when highly developed mulches are used with water retaining polymers. Since it prevents the loss of water caused by evaporation from the soil surface, it provides a great deal of water savings compared to traditional cultivation methods. It uses less water as well as reduces irrigation periods.

5. HYDROSEEDING APPLICATIONS

Hydroseeding application is a method in which seeds, fertilizers, beneficial enzymes, plant hormones, and many bio initiators are mixed and applied to the field.

Figure 6: Spraying lawn machine (URL-6)

5.1. Soil in Hydroseeding Applications for Landscaping

Regardless of which hydroseeding application will be used for planting lawn seed, the soil is very important. The quality of the soil and the appropriate conditions of the soil determine the quality of lawn and yield of the method. Soil analysis must be done in order to make a healthy hydroseeding application. Hydroseeding applications for landscaping, the stones of the soil should be cleared, finely leveled, the soil should be at normal values and pH should be neutral (URL-5).

After determining the area to be applied hydroseeding, the primary purpose is ventilating the soil, excavate, and level. The basic principle of hydroseeding application is that everything is balanced. It is among the aims of hydroseeding to carry out works in a way that does not require moving soil from inside/outside the project area.

To summarize;

- The soil is not acidic or alkaline, the leveled soil must be neutral.
- The soil should not be suppressed, it should not be hard.
- It should be leveled finely with the help of a rake.
- It should be cleared of stones.

Hydroseeding applications are not only applied in empty areas. Sometimes it may be necessary to apply it on already existing lawn areas. In such a case, instead of applying directly on the lawn, the existing lawn should be completely cleared from the area. These operations are carried out with different techniques depending on whether the area is small or large.

5.2. Soil pH Level

Ambient pH level determines the living conditions of living things. For lawns, the acidic or basic environment makes life more difficult. For this reason, the acidity of the soil should be determined by making soil pH level measurements in hydroseeding applications. If the soil is acidic, it is neutralized by adding limestone to the area. The neutralization process is a bit more complicated if the soil turns out to be alkaline. However, sulfur is added generally (URL-5).

5.3. Drainage

Drainage is so important in landscape and sports field applications. Likewise, hydroseeding applications also need appropriate drainage. Because excess water is harmful to plants. if the water is constantly left in the soil, the plants absorb excess minerals after a while and this causes overfeeding. Shallow root growth occurred and the death of the lawn is inevitable. With the drainage, the salinity in the water is removed and at the same time aeration is provided.

Drainage has a place in sports areas where it is so important to stay dry. Dry ground is important for the health of athletes in lawn areas where such sports competitions are held. For the health of the athletes in the lawn areas where such sports matches are held, the ground must be dry. Due to the drainage in rainy weather, it is ensured that the competitions continue.

In order for hydroseeding applications to result in full efficiency, irrigation and drainage systems must be designed correctly and considered as a whole. However, it can be mentioned that the success of hydroseeding applications and the system works with full performance. The important point in the hydroseeding method is that each step can be designed both separately and whole and get the appropriate results.

6. HYDROSEEDING FOR LANDSCAPE REPAIR

Hydroseeding has a wide range of applications in soil and environmental rehabilitation (URL-5).

- Combating Erosion
- Land Reclamation
- Fight Against Dust Irrigation
- Odor Control
- Landfill Reclamation
- Coastal Landscape
- Agricultural Activities
- Street Cleaning
- Mine Site Closures and Waste Rehabilitation Works
- Steep - Hilly and Very Large Areas Where It Is Not Possible To Sow Seeds By Hand
- Highway Sides and Central Median
- Excavation Areas to be Recycled to Nature
- Quarries
- Mineral Deposits
- Garbage Areas
- Forest Areas Damaged by Fire
- Golf Courses
- Large Areas such as Sports Fields

- All Areas Requiring Combat Erosion
- All Areas Requiring Soil Stabilization
- Efficiency Increase Studies
- Technological Agricultural Activities
- All Areas Requiring Odor Control
- All Areas Requiring Dust Control
- Areas Requiring Fire Fighting

Erosion areas or slope surface areas where have lost their organic structure are areas that have lost their vegetation. These are under threat of runoff, bone erosion, and erosion, respectively, by the effect of rainwater. Vegetation prevents the speed of rain, drop size, and direct hitting the surface. It provides a regular flow of surface waters and supports these waters to go down to groundwater. It protects the soil surface from excessive surface water and supports drainage. It connects the soil with its root systems. Herbaceous vegetation gives the least weight per unit area and provides complete soil stabilization. It improves the organic level of the soil with its vital activities and supports rehabilitation.

Erosion areas or slope surface areas that have lost their organic structure are under intense pressure from all kinds of environmental factors. The speed, size, density, and amount of rain, as well as the effect of winds, and even day and night temperature differences, constantly trigger erosion and increase the erosion coefficient day by day. It takes many years for these open areas to regain organic characteristics in the natural ecosystem and to form vegetation on it. However, this is true for stable surfaces. The surface, which cannot gain vegetation, is open to continuous erosion and is faced with the danger of erosion (URL-5).

Hydroseeding technology offers solutions including large slopes on surfaces that have lost their organic structure or have not regained their organic structure. Its high rate of application and its ability to plant on slopes steeper than 1: 1 makes it without an alternative in soil stabilization.

Hydroseeding technology prevents soil erosion in two ways (URL-5):

- **Temporary Solution**: From the moment of the first hydroseeding application, physically / temporarily.
- **Permanent Solution:** Prevents erosion as permanent planting and vegetation with plant establishment.

6.1. Hydromulching

Hydromulching and hydromat is the application of erosion control application with erosion mulch (HECM). Unlike hydroseeding; the application is made with mulches that have a strength of 6 - 24 months or more. Hydromat and hydro mulching application have a much thicker application than hydraulic mulches. Also, hydro mulching is a different name for the application of double hydroseeding / twice over the application. Hydromat and hydro mulching are the name similarity of erosion control applications and are generally specified under the name hydroseeding.

Figure 7: Hydromulching (URL-7,8)

Hydromulching and hydromat is a method developed to create fast, cost-effective, high-quality solutions used in erosion control, landfills, golf – sports fields, dust control, and various field Works (Clemente et al., 2016). The mixture of hydro mulching and hydromat ensures that the mixture in the system with the hydroseeding machine adheres the protective cover mixture to the ground for any seed or soil/sand surface. Since the water holding capacity of erosion control mulches is very high in hydro mulching and hydromat applications, it minimizes the irrigation requirement. Also, the main purpose of hydro mulching and hydromat application is to prevent irrigation. Hydromulching and hydromat prevent erosion by accelerating permanent vegetation by preventing temporary erosion on sloping surfaces of 1: 1 and above. Hydroseeding has a wide range of applications in soil and environmental rehabilitation (Figure 8-17).

Figure 8: Mine site closures and waste rehabilitation works (URL-8,9)

Figure 9: Planting of highway-railway slopes and water channels (URL-10,11)

Figure 10: Erosion control researches (URL-12,13)

Figure 11: Erosion control researches (URL-12,13)

Figure 12: Landscaping (URL-16,17,18)

Figure 13: Çankırı Urban Park hydroseeding application (URL-19)

Figure 14: Before and after hydroseeding application (URL-20,21,22)

Figure 15: Before and after hydroseeding application (URL-22,23)

Figure 16: Hydroseeding landscape applications (URL-24,25,26,27)

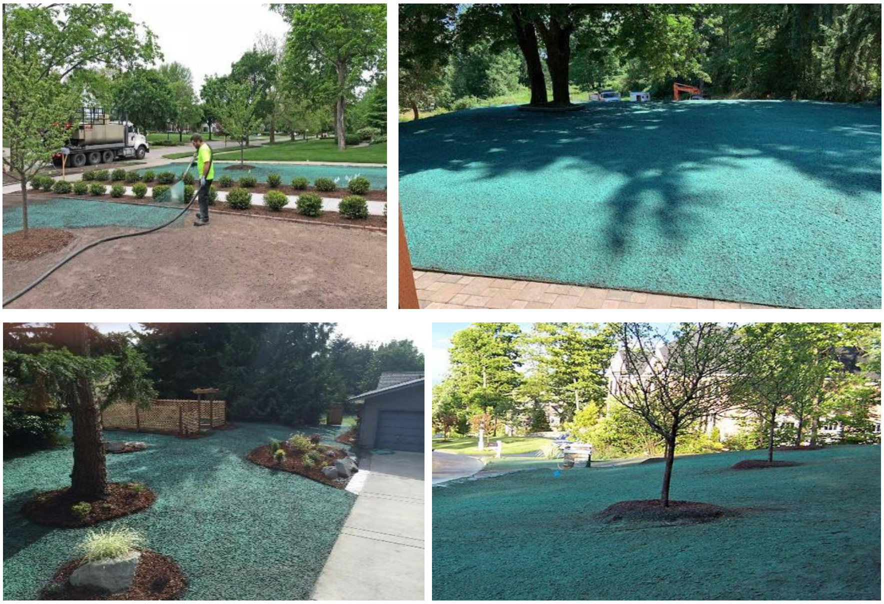

Figure 17: Hydroseeding landscape applications (URL-28,29,30,31)

CONCLUSION

As it can be understood from the chapter of this book, in the hydro-seeding technique, there should be a mixture of seeds, fertilizers, quick start products, mulch and adhesive materials requring experience and expertise. Although we do not want to go into very technical details, in the preparation of the mixture to be used in every implementation, many factors such as soil structure, geography, climate, environmental pressure, wind should be calculated correctly. Hydroseeding / Aqueous Insemination yields lots of benefits and has many advantages. Firstly, to give an example from the green area process of the city, recently the municipalities want to plant on the roadsides, old excavation areas, refuges, in short, every square meter they can green, and reserves large budgets for this purpose. Nowadays, when statistics monitored, active green area per person in Istanbul is around one square meter. In order to compare, this figure is generally 20 square meters in European countries and 80 square meters in developed countries such as Stockholm.

In this sense, Hydroseeding is both a fast and economical method in terms of increasing the green areas of the city. In addition, Hydroseeding is an effective method against erosion and provides successful work on the roadside with its mixtures that allow it to adhere to the surface. Otherwise, as the materials used are sterile, they do not harm the environment and are healthy, has a very significant importance today with its water holding capacity and provides remarkable water savings. Another issue that makes hydroseeding attractive for metropolitan-scale cities like Istanbul is its speed. Even the smallest Hydroseeding machine / hydroseeder provides a daily speed of 6,000 - 7,000 m^2 / day. Regarding all these reasons, official institutions and contractors should increase the use of hydroseeding. Hydroseeding lawn is both an alternative and not an alternative to traditional manual lawn planting and roll turf implementations.

In summary; Hydroseeding lawn can be applied to any soil surface (sloping). Hand lawn planting and roll lawn can only be applied on leveled and low-pitched soil surfaces. Hydroseeding lawn accelerates germination and is more effective than other methods in increasing root development and preventing soil erosion. Further, hydroseeding is a very effective system in erosion control by quickly performing lawn germination. Because the seed is applied via suspending in a nutrient-rich slurry that triggers the germination cycle. However, no method can be the sole solution of a universal problem such as **erosion control**. **Erosion control studies** should be projected in the scope of cause-solution-result relationships by holistic approaches. First of all, the pressures that will increase erosion should be taken under control. After permanent planting works, if required, bushing and then afforestation works can be part of the process.

When the conditions are suitable, lush- green lawn is produced in a very short time. The advantages of Hydroseeding can be counted as making it difficult for birds to access the seed, combating erosion with the mulch layer that holds the seed in the ground (except for heavy rainfall events), disturbing the seed equally / homogeneously, rapid growth of hydroseeding lawn, increasing the growth of the seed for healthier germination and early development.

REFERENCES

Açıkgöz, E. (1993). Çim Alanlar Yapım ve Bakım Tekniği, Çevre ve Peyzaj Mimarlığı Yayınları, Bursa.

Albaladejo, J., Alvarez, J. Querejeta, J., Díaz, E., & Castillo, V. (2000). Three hydro-seeding revegetation techniques for soil erosion control on anthropic steep slopes. Land Degradation & Development, 11: 315- 325.

Ankara Metropolitan Municipality (2020). Çim alan tesisi. https://www.ankara.bel.tr/files/1514/3893/6143/8-imalantesisi.pdf (Acces date: 14.12.2020)

Anonymous (2017). Çim bitkileri ve yeşil alan tesisi. http://www.bingol.edu.tr/documents/%C3%87im%20Bitkileri%20ve%20Ye%C5%9Fil%20Alan%20Tesisi.pdf (Acces date: 14.12.2020)

Arnáez, J. & Larrea V. (1994). Erosion models and hydrogeomorphological functioning on hill-roads (Iberian System, La-Rioja, Spain). Zeitschrift Fur Geomorphologie 38: 343-354.

Arslan, M. (2018) Çim bitkileri ve diğer yer örtücü bitkilerin işlevleri ve karşilaştirilmasi. https://acikders.ankara.edu.tr/pluginfile.php/64555/mod_resource/content/1/%C3%87im%20Bitkilerinin%20Kalite%20%C3%96l%C3%A7%C3%BCtleri.pdf (Acces date: 14.12.2020)

Avcıoğlu, R., 1997. Çim Tekniği, Yeşil Alanların Ekimi Dikimi ve Bakımı, Ege Üniversitesi Yayınları, Bornova – İzmir .

Brofas, G., Mantakas, G., Tsagari, K., Stefanakis, M., & Varelides, C. (2007). Effectiveness of cellulose, straw and binding materials for mining spoils revegetation by hydro-seeding, in Central Greece. Ecological Engineering, 31(3): 193-199.

Clemente, A. S., Moedas, A. R., Oliveira, G., Martins-Loução, M. A., & Correia, O. (2016). Effect of hydroseeding components on the germination of Mediterranean native plant species. Journal of Arid Environments, 125: 68-72.

González, A. J., Marrs, R. H., & Martínez-Ruiz, C. (2008). The influence of aspect on the early growth dynamics of hydroseeded species in coal reclamation areas, Applied Vegetation Science, 11(3): 405-412.

Optimum Lanscape & Construction (2014). Hydroseeding uygulama avantajları. http://www.optimumcim.com/hydroseeding-uygulama-avantajlari.aspx (Acces date: 15.12.2020)

Orçun, E. (1979). Özel Bahçe Mimarisi (Çim Sahaları Tesis ve Bakım Tekniği), Ege Üniversitesi, Ziraat Fakültesi, Yayın No: 152, Bornova - İzmir.

Palacios, P. G., Soliveres, S., Maestre, F. T., Escudero, A., Castillo-Monroy, A. P., & Valladares, F. (2010). Dominant plant species modulate responses to hydroseeding, irrigation and fertilization during the restoration of semiarid motorway slopes. Ecological Engineering, 36(10): 1290-1298.

Salman, A. (2012). Çim alanlar. https://www.plantdergisi.com/dr-ali-salman/cim-alanlar.html (Access date: 14.12.2020)

Temizel, S. & Erdoğan, E. (2019). Tarihi kent kimliği ve kentsel belleğin korunmasında peyzaj tasarımı. III. Uluslararası AVRASYA Multidisipliner Çalışmalar Kongresi, 4-7 Nisan 2019, Gaziantep, 865-871.

Temizel, S., Kılıç, T., & Yazıcı, K. (2019). Determination of Use Active Green Areas of Urban Public and Requirements of Open- Green Area in Yozgat City/Turkey. In: Research Reviews in Architecture, Planning and Design, Gece Kitaplığı, p. 39-55.

Tormo, T., Bochet, E., & García-Fayos, P. (2007). Roadfill revegetation in semiarid Mediterranean environments. Part II: Topsoiling, Species Selection, and Hydroseeding, Restoration Ecology, 15(1): 97-102.

Yazici, K. & Ünsal, T. (2019). Kentsel yaşam kalitesi açısından süs bitkilerinin önemi Tokat Merkez Yeşilırmak örneği. Ziraat Mühendisliği Dergisi, 367: 66-76.

Yazici, K. & Gülgün, B. (2017). Açık yeşil alanlarda dış mekân süs bitkilerinin önemi ve yaşam kalitesine etkisi Tokat kenti örneği. Ege Üniversitesi Ziraat Fakültesi Dergisi, 54(3): 275-284.

Yılmaz, M., R. Avcıoğlu, A., Salman, A., & Cevheri, C. (2012). Ülkemiz yeşil alan uygulamalarında karşılaşılan sorunlar ve çözüm önerileri. Türk Bilimsel Derlemeler Dergisi 5(2): 60-63.

URL-1. https://www.pikist.com/free-photo-vcgcc/tr (Access date:11.09.2020)

URL-2. https://www.kartal24.com/106437-cim-ekimi-ve-toprak-hazirligi (Access date: 12.09.2020)

URL-3. https://pxhere.com/tr/photo/833763 (Access date: 11.09.2020)

URL-4. https://hydroseeding.com.tr/merak_edilenler/hydroseeding-uygulamalarinda-tohum-secimi/ (Access date: 11.09.2020)

URL-5.http://hydroseeding.com.tr/merak_edilenler/hydroseeding-uygulama-avantajla ri/ (Access date:10.09.2020)

URL-6. http://hydroseeding.com.tr/merak_edilenler/bowie-hydro-mulcher/ (Access date:10.09.2020)

URL-7. http://turfmasterhydromulching.com/ (Access date:10.09.2020)

URL-8. https://www.erizon.com.au/what-is-hydromulching/ (Access date:10.09.2020)

URL-9. https://www.spraygrassaustralia.com.au/best-time-hydroseed-hydromulch/ (Access date: 29.09.2020)

URL-10. https://www.spraygrassaustralia.com.au/hydromulching-solutions-site-rehab ilitation-erosion-control/ (Access date:12.09.2020)

URL-11. https://www.spraygrassaustralia.com.au/what-is-hydroseeding/ (Access date: 18.09.2020)

URL-12. https://www.researchgate.net/figure/Application-of-seeding-rate-and-fertiliz ation-treatments-by-hydroseeding-The-17m-wide_fig1_264883162 (Access date: 18.09.2020)

URL-13. https://www.mining-technology.com/contractors/emission_control/hamilt on-hmi/ (Access date: 18.09.2020)

URL-14. https://www.youtube.com/watch?v=TaOIomyJ_2A (Access date: 18.09.2020)

URL-15. https://oasiserosioncontrol.com/our-services/ (Access date: 12.09.2020)

URL-16. https://www.youtube.com/watch?app=desktop&v=nMAQsae92qw

URL-17. https://www.milliyet.com.tr/yerel-haberler/duzce/peyzaj-calismalarinda-hydroseeding-sistemi-11404141 (Access date: 12.09.2020)

URL-18. http://www.eskisehirbotanik.com/hydroseeding (Access date: 12.09.2020)

URL-19. http://www.krdtohumlama.com/hydroseeding-uygulama-referanslar/devam-eden-projeler/cankiri-kent-parki-hyroseeding#group-2 (Access date: 12.09.2020)

URL-20. http://medeiroshydroseeding.com/our-services/hydroseeding/ (Access date: 22.09.2020)

URL-21. https://www.pinterest.ie/pin/427349452137489816/ (Access date: 22.09.2020)

URL-22. https://www.hydroseedinguk.com/the-ultimate-guide-to-hydroseeding-everything-you-need-to-know/ (Access date: 12.09.2020)
URL-23. http://www.liquidsod.com/ (Access date: 22.09.2020)
URL-24. https://www.perrysburglandscape.com/blog/8-benefits-of-hydro-seeding (Access date: 23.09.2020)
URL-25. https://protilling.com/hydroseeding/ (Access date: 23.09.2020)
URL-26. https://www.superiorgroundcover.com/best-time-to-hydroseed/ (Access date: 23.09.2020)
URL-27. https://www.sopeyzaj.com/hydroseeding/ (Access date: 23.09.2020)
URL-28. https://www.superiorgroundcover.com/hydroseeding-101/ (Access date: 23.09.2020)
URL-29. http://www.nicholshydroseeding.com/ (Access date:12.09.2020)
URL-30. http://www.graceylandscape.com/hydroseeding (Access date: 10.09.2020)
URL-31. http://www.16-9.com.tr/hydroseeding (Access date: 12.09.2020)

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