# PROSPECTS OF VALUE ADDITION IN JASMINE AND TUBEROSE

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***Abstract:*** ***Value- addition is a process of increasing the economic value of a raw product anytime between harvesting and sales of the final product. Among all forms of horti- business activities, floriculture has emerged as a major sector for diversification. Value added products give higher returns, open new markets, create brand recognition and cater to the needs of highly heterozygous consumer. Value addition means doing something more to satisfy the ultimate user or consumer. India has exported mostly and thus it has to venture into production of goods by oneself. That calls not for just having raw materials but also preparing a final finished product which will invite more income to the nation (Kalam, 2015). There is vast opportunity in value added floriculture trade at entrepreneurial level for rural and urban people specially women (Singh, 2017). Recently, the consumption pattern is becoming diversified, leaning towards value added products such as essences, perfumes and other by- products from flowers. There is an urgent need for value addition in floricultural products through processing, packaging and supply chain management to increase the farm income and generate employment (De, 2011). Both jasmine and tuberose are the most important commercial loose flowers of India and have been cultivated for more than a century, predominantly in the southern part of the country. With the passage of time and widening of demand in the International market, there was the realization of product diversification in the form of value addition in jasmine and tuberose. Shifting focus towards creation of varied products in allied industries (epidemiology, agriculture, cosmetic industry, candle making, etc.) can help popularize the plant, creating market demand. Thus, value addition will ensure high premiums to the growers relatively, ensuring a stable income source to the growers, while providing more acceptable quality products for the market.***

***Index Terms- Value Addition, Jasmine, Tuberose, Product diversification.***

## I. Introduction

The floriculture industry comprising of cultivation and trade of cut flowers, cut foliage, potted plants, bedding plants, planting material etc., is experiencing rapid transformation. In the recent times, floriculture is considered as the most lucrative horti-enterprise to make profit in the global market and has been identified as one of the possible sector for diversification. In India, dynamic changes have been seen in decade of the nineties and the consumption of flower is rising significantly. Even though floriculture is fast emerging industry in India, the percent share of floriculture is very low compare to other horticulture sector i.e. only 4%. As the flowers are the utmost perishable horticultural farm produce, there remains some hindrance in proper marketing following the standard postharvest management practices by the common farmers. Hence to increase the floriculture export value in international market and domestic market, we should think about our new market opportunities. In this regard product diversification in general and value addition in particular, increases the economic value and consumer appeal of any floricultural commodity and ensures improvement of the country's economic status. Product diversification includes strategies and tools that will be used to attract new groups of customers by producing new products for new or existing target markets [Table 1]. Diversification normally refers to the addition of revenue-generating products or activities not currently undertaken by the business.

**Tools for Product Diversification**

| Value added Packaging | Essential oil, Absolutes and Hydrosols | Edible products |
|---|---|---|
| Floral ornaments/adornments | Value- added poultry feed | Candied Flowers |
| Tinting | Aromatherapy | Flower Honey |
| By speaking flowers | Natural dyes | Flower Butter |
| Skeletonizing | Pigments | Syrup |
| Potpourri | Insect Repellents | Preserves |
| Addition of Fragrance | | Herbal Tea |
| Fresh and Dry Flower Arrangements | | |

Table 1: Tools for product diversification (Anjali *et al*., 2014)

Value addition is simply enhancement of the value of a material with processes attached. It means doing something more to satisfy the ultimate user or consumer. India has exported mostly and thus must to venture into production of goods by oneself. That calls not for just

having raw materials but also preparing a final finished product which will invite more income to the nation (Mission India: A vision for Indian Youth, Dr A P J Abdul Kalam, 2015). Value addition has become very popular towards the expansion of floricultural trade by the art of preservation of fresh/ usable flowers and utilizes wastes to make some useful and novel products that appeal to swiftly changing consumer preferences, mitigating the unstable price challenge in the market earning more money by avoiding the middleman concept, eventually generating more income opportunities for stakeholders/ entrepreneurs. Various objectives of value addition are:

- To improve flower and allied product quality
- To enhance sales
- To gain relatively higher profits
- To minimize post- harvest loss
- Utilisation of unsold flowers
- To increase export potential

The procreative skills such as flower arrangements, artificial colouring of flowers, aqua packing for better presentation, three dimensional windows packing of flowers, garlands, venis, bouquets, greeting cards using petal-embedded craft papers, dry flowers, potpourris, etc. are some of the value-added products that have acquired a successive position in the global market. Other value-added products obtained from flower crops are essential oils, flavours, fragrance, pharmaceutical and nutraceutical compounds, insecticidal and nematocidal compounds, pigments and natural dye, gulkand, rose water, vanilla products, etc.

**A. Jasmine**

Jasmine (*Jasminum* spp.) is one of the oldest fragrant flowers cultivated by man. The word 'Jasmine' has been reported to be derived from Persian word 'Yasmyn' meaning 'fragrance' or 'gift from God'. Jasmines have been cultivated for various purposes and they have adorned the gardens of Central Asia, Afghanistan, Iran, Nepal and many other tropical and subtropical countries. The flowers are used for various purposes viz., making garlands and bouquets, adoring hair of women, religious offering, etc. They are also used to produce essential oils in the form of 'concrete' and 'absolute', which are used in cosmetic and perfumery industries. In India, Jasmine is used in rituals like marriages, religious ceremonies and festivals. The flowers are also used for preparation of hair ornaments, decorations and Rangoli. Jasmine is also cultivated commercially, for both the domestic and industrial uses, such as the perfume industry.

Several countries and states consider jasmines as a national symbol. In China, Jasmine was used symbol during the 2011 Chinese pro-democracy protests in the People's Republic of China. In Hawaii, *Jasminum sambac* ("*pikake*") is perhaps the most popular of flowers. In Indonesia, *Jasminum sambac* is the national flower, adopted in 1990. It goes by the name "*melati putih*" and is the most important flower in wedding ceremonies for ethnic Indonesians, especially on the island of Java. In Pakistan, *Jasminum officinale*, known as "*chameli*" or "*yasmin*", is the national flower. In Philippines, *Jasminum sambac* is the national flower, adopted in 1935. It is known as "*sampaguita*" in the islands. It is usually strung in garlands which are then used to adorn religious images. In Syria, city Damascus is also called City of Jasmine and uses it as a symbol. In Thailand, Jasmine flowers are used as a symbol of motherhood. A change in presidency in Tunisia in 1987 and the Tunisian Revolution of 2011 are both called "Jasmine revolutions" in reference to the flower. There is a Tuscan tradition of including jasmine in floral bouquets.

These plants are deciduous or evergreen, erect, spreading, or climbing shrubs and vines. Jasmine flowers in the form of Cymose clusters with a minimum of three flowers (or solitary on the ends of branchlets) of 2.5 cm diameter. In Jasmine, flower colour ranges from white or yellow, rarely to slight reddish. Each flower consists of four to nine petals, two locules, one to four ovules, two stamens with very short filaments, linear or ovate bracts and Bell-shaped calyx.

The genus '*Jasmine'* is native to Tropical and Subtropical regions of Eurasia, Australasia and Oceania, and was introduced to India in the mid- 16$^{th}$ century. *Jasminum sambac* (Arabian or Tuscan Jasmine) is native to Tropical Asia, *J. grandiflorum* (Spanish or Catalonian Jasmine) to Southern Europe, *J. auriculatum* to Tropical Asia and *J. officinale* (Royal or Poet's or Common White Jasmine) to North India & Iran. It is widely distributed around the globe, but majority of the species are centred around India, China and Malaya.

In India, jasmine is distributed throughout the country, occupying an area of nearly 25,530 ha [Table 2]. Commercial cultivation of Jasmine is confined mainly to Tamil Nadu (Coimbatore, Madurai, and Dindigul), Karnataka (Bangalore, Bellary, Mysore and Kolar), Uttar Pradesh (Kannauj, Jaunpur and Gazipur), Rajasthan (Udaipur, Jaipur, Ajmer and Kota), West Bengal (Ranaghat, Kolaghat, Pancskura) and parts of Andhra Pradesh and Maharashtra. In Himachal Pradesh, jasmine species found in wild are *Jasminum officinale*, *J. dispermum* and *J. humile*.

**Area and Production of Jasmine in India**
**(2011-2012 to 2016-2017-1st Advance Estimates)**

| Year | Area `000 hectare | Production | |
|---|---|---|---|
| | | Loose (`000 Tonnes) | (Cut `000 Tonnes) |
| 2011- 12 | 41.74 | 206.67 | - |
| 2012- 13 | 10.35 | 50.89 | - |
| 2013- 14 | 12.25 | 65.23 | 1.70 |
| 2014- 15 | 10.01 | 56.57 | 1.73 |
| 2015- 16 | 22.86 | 188.55 | 10.71 |
| 2016- 17 (1$^{st}$ Advance Estimate) | 25.53 | 187.19 | 10.71 |

**Table 2**: Area and production of jasmine in India [Source: Ministry of Agriculture and Farmers Welfare, Govt. of India. (ON1549) & Past Issues].

According to Ministry of Agriculture & Farmers Welfare, Government of India and NHB, the major states involved in production of jasmine are Karnataka, Andhra Pradesh, Assam, Telangana, Maharashtra, Bihar, Puducherry, Chhattisgarh, Goa and Andaman & Nicobar. India exports jasmine flowers to neighbouring countries like Srilanka, Singapore, Malaysia and the Gulf [Table 3].

| S No | State | Area (`000 hectare) | Loose Flower Value (`000 Tonnes) |
|---|---|---|---|
| 1 | Karnataka | 6.30 | 38.60 |
| 2 | Andhra Pradesh | 2.63 | 13.99 |
| 3 | Assam | 0.18 | 01.21 |
| 4 | Telangana | 0.58 | 01.50 |
| 5 | Maharashtra | 0.12 | 00.53 |
| 6 | Bihar | 0.11 | 00.32 |
| 7 | Puducherry | 0.03 | 00.31 |
| 8 | Chhattisgarh | 0.04 | 00.09 |
| 9 | Goa | - | 00.01 |
| 10 | Andaman& Nicobar | 0.01 | 00.01 |
| | **Total** | | **56.57** |

**Table 3**: Area and production details of major jasmine producing states of India (2014- 15) [Source: Ministry of Agriculture and Farmers Welfare, Govt. of India and National Horticulture Board]

**Species and Cultivars**

Jasmine belongs to family 'Oleaceae' and bears the basic chromosome number, x=13. There are about 200 species in the genus, but true species are only 89. In India, there are several species found in the wild which can be used as a potential source of creating variability or creation of novel varieties [Table 4]. Most species of Jasmine are diploid; however, natural polyploidy exists, particularly in *Jasminum sambac* (2n=39), *Jasminum flexile* (2n=52), *Jasminum mesnyi* (2n=39), and *Jasminum angustifolium* (2n=52).

| S No | Name of Species | Common Name | Distribution |
|---|---|---|---|
| 1 | *Jasminum grandiflorum* (L.) | Chameli | Subtropical North-west Himalayas, Nilgiri. Pulney and Tinny valley Hills Alt. 700-1800 meters |
| 2 | *Jasminum officinale* (L.) | Sweet Jasmine | Throughout India, common in Sub- Himalayan tract and moist forest |
| 3 | *Jasminum multiflorum* Roth. | Safed Chameli | Western. Coast, Western. Ghats in the south kanara. Mysore, Malabar and Western Nilgiris Altitude 1300 mtrs |
| 4 | *Jasminum humile* Linn. | Pili Chameli | North West Himalayas, Nilgiri Altitude 700-2000mtrs |
| 5 | *Jasminum heterophyllum* Roxb. | ---------- | Mishmi Hills |
| 6 | *Jasminum glandulosum* Wall. (*J. dichotomum*) | ---------- | Subtropical Himalya, Kumaon, Kharia Hills Akei and Liushai Hills Altitude 700-2000 mtrs |
| 7 | *Jasminum angustifolium* Vahl. | Wild Jasmine | Deccan Peninsula, South Travancore |
| 8 | *Jasminum arborescence* Roxb. | Tree Jasmine | Tropical North- west Himalaya, Deccan Peninsula, Chota Nagpur, Orissa |
| 9 | *Jasminum androphyllum* Wall. | ---------- | Kashia Hills |
| 10 | *Jasminum auriculatum Vahl.* | Joohi, jui | North West India, Deccan Peninsula, Bengal, South Travancore and Western Ghats |
| 11 | *Jasminum anastomosans Wall. (J. strinerve Roxb.)* | ---------- | Kashia Hills, Cuttack |
| 12 | *Jasminum attenuatum Roxb.* | ---------- | Assam, Kashia Hills, Altitude 200- 1300 mtrs |
| 13 | *Jasminum azoricum Backer.* | ---------- | South West India especially in Ghats |
| 14 | *Jasminum braviloburn Roxb. (J. nilaglricum Pl.)* | ---------- | Ghats, Nilgiri Hills, Pulney Hills, Altitude 1000-2000 mtrs |
| 15 | *Jasminum brevipetiolum Duthe.* | ---------- | Forests in the pilibhit district of Rehi Khand and the Kheri districts of Upper gangetic plains |

| | | | |
|---|---|---|---|
| 16 | *Jasminum colophyllum Wall.* *(J. courtollense Wt.)* | --------- | South Deccan Peninsula, Nilgiri Hills, Western Ghats, Annamalai and Tinnevely Hills, Altitude up to 1300 mtrs |
| 17 | *Jasminum caudatum Walt.* *(J. ovatum Walt.)* | --------- | Kashai and Mishmi Hills, Altitude up to 1300 mtrs |
| 18 | *Jasminum coaretatum Roxb.* *(J. reticulatum Walt.)* | --------- | Assam, Khasia and Lushi Hills, Altitude 0- 1000 mtrs |
| 19 | *Jasminum cardifolium Walt.* *(J. eretiflorum Wt.)* | --------- | Western Ghats, Nilgiri Coimbatore, Tinnelvelly, South and Middle Andaman |
| 20 | *Jasminum dispermum Wall.* | --------- | Temperate Himalya, Kashmir, Kashia and Jaintia Hills, Altitude 1000- 2500 mtrs |
| 21 | *Jasminum flexile Vahl.* | --------- | Deccan Peninsula in rain forest of southern ghats of North Kanara, West Coast and Western Ghats in all districts up to 1700 mtrs |
| 22 | *Jasminum malabaricum Wt.* | Mogra | Western Coast, Western Ghats in the South Kanaa, Malabar, West Nilgiris, Altitude 1300 mtrs |
| 23 | *Jasminum dumicolum W.W. Smith* | --------- | Naga Hills, Manipur |

**Table 4**: List of species of jasmine in India [Sabharwal *et al*., 2013]

Important cultivars among the three commercially important species of Jasmine, were catalogued by Tamil Nadu Agricultural University (TNAU), Coimbatore (Veluswamy *et al*., 1973) [Table. 5].

| Species | Variety | Description |
|---|---|---|
| *Jasminum Sambac* | Gundumalli | Round flowers with good fragrance. Higher yielder, Chromosome number is 39 |
| | Ramabanam | Flower Bud Long, High yielder, Chromosome number is 26 |
| | Madanban | Long bold buds with short corolla tube, High yielder, Chromosome number is 26 |
| | Single Mogra | Flowers with three or four whorls, Chromosome number is 26 |
| | Double Mogra | Flowers with good fragrance resembling white rose with 8 to 10 whorls, Chromosome number is 52. |
| | Iruvatchi | Flowers with shorter corolla tube with 3 or 4 whorls, Chromosome number is 26 and 39 |
| | Kasthurimalli | Flowers with medium long tube. Chromosome number is 26 |
| | Oosimalli | Long slender buds |
| | Soojimalli | Long buds, Chromosome number is 26 |
| Jasminum grandiflorum | Triploid | Large sized flowers with pinkish buds, highly sterile, Chromosome number is 39 |
| Jasminum auriculatum | Long Point<br>Medium Point<br>Short Point<br>Short Round | Five variants, differing chiefly in the bud characters. A double flowered type of this species is commonly grown for garden decoration. |

**Table 5**: List of cultivars of three commercially important jasmine species (TNAU)

The National Horticulture Board (NHB) also has the record of only few varieties among these three species of Jasmine [Table 6].

| Species | Variety | Description |
|---|---|---|
| *Jasminum auriculatum (Jui)* | Parimullai | Medium round bud<br>Flowering duration- 9 months/year<br>Average yield is 8t/ha/year |
| | CO- 1 | Flowers have a long corolla tube (Easy to harvest)<br>Average yield is 8.8 t/ha/year |
| | CO- 2 | Flower buds- bold with long corolla tube<br>Average yield is 11.1 t/ha/year |

| | | |
|---|---|---|
| *Jasminum grandiflorum* (Chameli) | CO- 1 Pitchi | Released by T.N.A.U., Coimbatore<br>Suitable for loose flower production and oil extraction<br>Average flower yield is about 10 t/ha/year<br>Estimated concrete yield is 29 kg/ha |
| | CO- 2 Pitchi | Bold pink buds with long corolla tube<br>Average yield is 11.68t/ha/ year |
| | Arka Surabhi (Pink Pin) | It is released by IIHR, Bangalore. The average flower yield is 10 t/ha. |
| *Jasminum sambac* (Mogra) | Gundumalli | Flowers are round with good fragrance<br>Average yield of flowers is 7-8 t/ha, while the estimated concrete yield is 15kg/ha. |
| | Ramban & Madanban | High yielding variety with long flower buds |
| | Double Mogra | Flowers have 8-10 whorls of petals with excellent fragrance resembling that of white rose |

**Table 6**: List of cultivars of three commercially important jasmine species (NHB)

### A. 1. Value addition in Jasmine

Various value- added products of jasmine [Fig 1] are:

#### 1. Rangoli

Selected design is drawn on the ground, after that petal, the whole flowers and foliage are arranged with proper colour combination. Distinct types of flowers can be used in a floral Rangoli. Water Rangoli gives simple and elegant look. The flower petals are designed in water surface. Containers are made up of plastic, ceramic or glass material. Flower petals of Jasmine with different coloured flower petals of marigold, rose, crossandra, chrysanthemum etc.

#### 2. Garlands

These are prepared by using one type of flower or combination of different flowers. Garlands are mainly used for marriages, dance ceremonies and other functions. In Thailand, jasmine flower is very popular in preparation of garlands, but yellowing of flower buds and opening occur within a few days. These problems affect marketing. There are many chemical compounds that can be applied as an essential tool for extending the vase life. Suntipabvivattana and Tongdeesuntorn (2017) carried out an experiment to extend the shelf life of Jasmine flower buds. The buds were harvested early in the morning and were then kept at 5º C for one night. The flower buds were treated with boric acid (Experiment 1) or benzyl adenine (Experiment 2) at concentration of 0, 100, 500 and 1000 mg $L^{-1}$ for 15 min before completion of garlands. Distilled water was used as a control. In the final experiment, the best treatment of experiment 1 and 2 were selected to combine with Polypropylene (PP) and Polyethylene (PE) bags. All treatments were stored at 5º C. Results revealed that both benzyl adenine and boric acid could reduce respiration and weight loss. Moreover, both chemicals also gave good effects on extending the shelf-life. In addition, pre-treated garlands packed in PP and PE bag were compared. PP bag could maintain quality of jasmine garlands better than PE bag. The shelf-life of jasmine garland was extended to 10 days by the application of 500 mg $L^{-1}$ benzyl adenine or boric acid combined with packing in PP bag.

#### 3. Hair Adornment/ Decoration

The flowers are arranged into mini-garland like short chains called Gajra which are used for hair adornment. Gajra is very famous with women of South India for hair decoration, used daily or at special occasions. Venis are used to decorate long plaits of hair in marriages or dance ceremonies. Hard cardboard or tough leathery leaves of 90 cm long and 5-10 cm breadth are used to make venis. With growing fashion trends, the designers are coming up with ideas of fusing traditional with the modern and as a result floral hair bands are trending with youth, to be worn in parties or marriages.


Water Rangoli

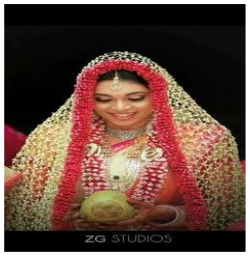

Garland


Gajra


Veni


Hair Bands

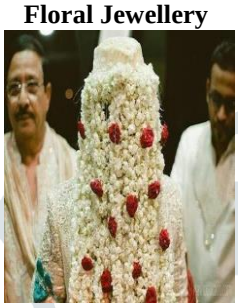

Floral Jewellery



Ghoonghat


Bridal Crowns


Floral rakhis


Sehra for grooms


Flower Curtains


Wedding Phulkari

Corsages


Value added Pot plants & Bonsai


Buttonaires


Wreaths


Lamp Shades & Fan


Jasmine Essence and Tea


Jasmine Infused Honey and Syrup



Jasmine Toiletry Products



**Jasmine Pressed Badges** **Incense Sticks** **Candles**

**Fig 1:** Value- added products of jasmine

**4. Floral adornments**

Floral Jewellery consists of decorative ornaments made of flowers worn for adornment, such as brooches, rings, necklaces, earrings, pendants, bridal crowns and bracelets. Also, 'Ghoonghats' or veil made of flowers (Jasmine, tuberose, etc.) are popularizing with brides in south India. Floral Sehra for Grooms and Wedding Phulkari/ Baagh are popular floral wedding items famous in north India. Customized resin Jewellery is being marketed by national and international aesthetic Jewellery companies owing to its demand among youth. Even floral rakhis are being made which not only is fashionable but also eco-friendly like other floral ornaments.

Flowers are worn by both men and women on special occasion such as weddings, parties and holiday celebration. Flower arrangements worn by woman are corsage, is a cluster of flowers, foliage and accessories that accents women's dress. Whereas flower worn by men called 'Boutonnieres', usually consists of single flower with a foliage, but recent trend is using of multiple flowers.

**5. Fresh flower arrangements**

A flower bouquet is a collection of flowers in a creative arrangement. A flower bouquet can be arranged for the decor of homes or public buildings or may be handheld. Bouquets arranged in vases or planters for home decoration. They can be arranged in traditional or modern styles. Floral wreaths are circular in shape, mainly used for condolence functions or Christmas.

**6. Dry Flower Products**

Potpourri is usually a mixture of dried, sweet-scented plant parts including flowers, leaves, seeds, stems and roots. The basis of a potpourri is the aromatic oils found within the plant. Jasmine tea is not tea made from jasmine. Brewed Green tea is infused with jasmine buds. The resulting flavor of jasmine tea is subtly sweet and highly fragrant. It is the most famous scented tea in China and most popular drink of Japan. It reduces cholesterol level. Jasmine species commonly used for Jasmine tea are *Jasminum officinale* and *Jasminum sambac.* Different companies dealing, and manufacturing Jasmine tea are Ahmad Tea Ltd (UK), Organic India (USA), Harney and sons (China), Jasmine Pearl Tea Company (Oregon), Twinings (China), Triple Leaf Tea (China), TGL Co. (China), Tea Forte, Tailors of Harrogate (UK) and World Classics (New Jersey) etc.

**7. Edible Products**

Different edible products are prepared from flowers and likewise edible products made prepared from jasmine. In confectionaries and food industry, jasmine essence is used to add fragrance to sweets, cakes and other products.

**8. Jasmine Essential Oil**

Essential oil is a concentrated hydrophobic liquid containing volatile aroma compounds from plants. Essential oils are also known as volatile oils used for aromatherapy, medicines, perfumes, soaps, cosmetics and confectionary etc. These oils are extracted using solvent extraction method, distillation, maceration, enfleurage and expression (Rajamani, 2003). Next to rose, jasmine is the most important perfumery raw material used since the beginning of human civilization. Egypt is the largest producer of jasmine oil (10-15 tonnes concrete/year) followed by Morocco, France, Algeria, Italy and India. Main constituents of jasmine concrete are benzyl acetate, benzyl benzoate, geraniol, eugenol, benzaldehyde, indole, nerol, methyl jasmonate etc. *Jasminum auriculatum or* 'Juhi' has highest oil recovery (0.29%) and *Jasminum grandiflorum* or 'Chameli' has best quality oil (0.25-0.30%) (Prajapati *et al*., 2016).

The concrete and oil yield of Jasminum sambac, Jasminum sambac and Jasminum sambac is 0.14- 0.19 % and 11.18- 15.44 kg $ha^{-1}$; 0.25- 0.32 % and 13.85- 29.42 kg $ha^{-1}$; and 0.28- 0.36 % and 13.44- 28.24 kg $ha^{-1}$, respectively (Singh, 2006 and De L C, 2011). A price list generated for some of the Indian Jasmine Otto companies and their prices are presented below in Table 7

| S. No | Companies | Price (INR) |
|---|---|---|
| 1 | Kazima Perfumers, Delhi | 5100/ kg; 252/ 10 ml bottle |
| 2 | Surajbala Exports, Pvt. Ltd, New Delhi | 8000/kg |
| 3 | Ubielixir Essentials, Delhi | 2000/ 10 ml |
| 4 | Kannauj Fragrance India, Chennai | 3500/ kg |
| 5 | Fabulous India Merchants, Thoothukudi, TN | 456/ Dozen |
| 6 | J. R. T. Aromatic, Chennai | 4000/ kg |
| 7 | Lala Jagdish Prasad and Co., Kanpur | 720/ml |
| 8 | P. M. Rathod & Co., Ahmedabad | 2000/kg |
| 9 | Vaibhav Perfumery, Jaipur | 6000/kg |
| 10 | Kanchan Enterprises, Kannauj | 250/ 100 ml |

**Table 7**: Jasmine attar (Otto) companies and prices (doi: www.indiamart.com)

The sweet smell of aroma of *Jasminum sambac* (L.) is releasing while the flowers are blooming. Although components of volatile oil have been extensively studied, there are problematic issues, such as low efficiency of yield, flavor distortion. Ye *et al*. (2015) performed the subcritical fluid extraction (SFE) to extract fragrant volatiles from activated carbon that had absorbed the aroma of jasmine flowers,

effectively obtaining the main aromatic compounds with quality significantly better than solvent extraction (SE). Based on the analysis data with response surface methodology (RSM), the extraction conditions were optimized which consisted of a temperature of 44º C, a solvent-to- material ratio of 3:5:1, and an extraction time of 53 min. Under these conditions, the extraction yield was 4.91 %. Furthermore, the key jasmine essential oil components, benzyl acetate and linalool, increase 7- fold and 2- fold respectively which lead to strong typical smell of the jasmine oil. The new method can reduce spicy components which lead to the essential oils smelling sweeter. Thus, the quality of the jasmine essence oil was dramatically improved, and yields based on the key component increased dramatically.

**9. Toiletries and other products**

Various toiletry and other products are made of jasmine using jasmine oils, essence and plant material etc., such as soaps, moisturizers, massage oils, hair spa products, face washes, face packs, candles, incense sticks and reed diffusers etc. The companies dealing and manufacturing these products are Cowshed (UK), Soulflower India Pvt. Ltd. (Mumbai), Khadi Natural Healthcare (India), Faith in Nature (UK), Beaumont Products, Inc. (USA), Bain de Terre (UK) and K Hall Designs (USA) etc.

All around the globe, the value-added products of jasmine are appreciated by the consumers which is evident from the increasing demand of such products. Jasmine flowers possess a short shelf life and start losing fragrance after 24 hours. Thus, sale of the fresh flowers and manufacturing its value- added products, both in the national and international market gets difficult, rather impossible, levying heavy losses to the growers and the entrepreneurs. Thus, methods to improve the shelf life of the flowers is the need of the hour.

One such technology was developed by Jawaharlal *et al.,* (2012), who standardised the packaging technology for export of jasmine (*Jasminum sambac* Ait.) flowers. They studied the effects of various chemical treatments (viz., $T_1$ - Sucrose 2%, $T_2$ - Sucrose 4%, $T_3$ - Boric acid 2%, $T_4$ - Boric acid 4%, $T_5$ - Salicylic acid 25 ppm, $T_6$ - Salicylic acid 50 ppm, $T_7$ - Ascorbic acid 50 ppm, $T_8$ – Ascorbic acid 100 ppm, $T_9$ - NAA 50 ppm, $T_{10}$ - NAA 100 ppm, $T_{11}$ - Distilled water, $T_{12}$ - No soaking), three types of packing boxes (viz., Box A – Aluminium-foil lined cardboard boxes of dimensions 14 x 11 x 14 cm; Box B - 0.5 mm thick polypropylene boxes of dimensions 16 x 11 x 4 cm, and Box C - 0.3 mm thick Polypropylene boxes of dimension 10 x 7 x 4 cm), on the shelf life of jasmine flower buds and their interaction with packaging were studied. Ten grams of fresh-flower buds of uniform size were treated with the chemicals, air dried and packed in boxes A, B, and C lined with butter papers. These boxes, in turn, were packed in thermocol boxes (60 cm x 45 cm x 30 cm capable of holding 50, 40 and 50 Boxes A, B & C, respectively) with intermittent gel-ice layers, lined with aluminium-foil and butter paper. This package was stored under ambient conditions and observations were recorded at 24 hours and 36 hours after storage. Flowers treated with 4% boric acid, packed in aluminium-foil lined boxes and further packed in thermocol boxes under gel-ice cold condition was found to be significantly superior to control, recorded a shelf life of 42.88 hours. This package also recorded maximum freshness index (70 to 90%), minimum flower-opening index (10.5 to 50%) and maximum colour retention index (77.77 to 88.88%) of flowers.

Later, the value chain on flowers for domestic and export markets under TNAU'S NAIP Project was developed based on the best results of the experiment carried out by Jawaharlal *et al.* (2012). A value chain or export packaging technology was developed for Dubai and USA market on the basis of the best treatment result where shelf life of jasmine was extended to 42.88 hours by the treatment combination of 4% boric acid, packing in aluminium-foil lined boxes and further packaging in thermocol boxes under gel-ice cold condition (Doi: http://www.naiptnauflowers.com). Strings of fresh flowers of jasmine were treated with Boric acid @ 4% and packed in ventilated Corrugated Fibre Board Boxes and air lifted to Dubai market. Fresh flowers of jasmine were wired to form strings. The strings were treated with Boric acid @ 4% and packed in small boxes, which were kept in thermocol boxes lined with aluminium foil. Ice gel packs were placed over small boxes and covered with aluminium foil, then air lifted to Dubai market.

**A. 2. Jasmine and Product Diversification**

Various parts of the jasmine plant and the plant as a whole have traditionally been used as a remedy for various health issues. The whole plant is considered cool and sweet, and is used as an astringent, thermogenic, aphrodisiac, antiseptic, depurative, diuretic, anthelmintic, deobstruant, dentrificant, for weakness of sight, tonic for insanity. Roots are used as anaesthetic and used for the treatment of cephalalgia, paralysis, mental disability, constipation, sterility, dysmenorrhoea, amenorrhoea, ringworm, leprosy, skin diseases, wounds & snake bites, headaches & pain due to broken bones and dislocated joints. Leaves are used for odontalgia, fixing loose teeth, ulcerative stomatitis, leprosy, skin diseases, dysmenorrhoea, ulcers, wounds, corns, gall stones and fever. Similarly, traditionally their flowers are used for cephalopathy, odontopathy, ophthalmopathy, leprosy, skin diseases, dysmenorrhoea, ulcers, ophthalmic, antipyretic, decongestant, antidepressant, insanity, vomiting and as a refrigerant. Asian and Indian folk practitioners recommend Jasmine for liver complaints, dysentery, several types of aches, skin diseases like Leprosy. In addition, Jasmine oil is applied externally is used to Soften and smoothen the skin, for cancer, heart disease, etc. Aroma therapists believe Jasmine oil can be useful as an antidepressant, calming agent, aphrodisiac. Jasmine scent increases beta waves in the brain, which are associated with increased states of alertness. In Ayurveda, leaves are chewed to cure stomatitis, toothache, ulcer in the mouth and leaf-juice or oil obtained from it is dropped in to the ear. Plant is used in scorpion-string. Charaka used the sprouts or dried flowers, in prescriptions for treating nasal haemorrhage and dermatosis. Sushruta used jasmine as an ingredient of a medicated clarified butter for external application on infected wounds, for cleansing and sterilizing the interior of ulcer. As an ingredient of hair oil for baldness and alopecia, as an ingredient of an eye- slave for loss of vision. Jasmine was used externally in leprosy, malignant ulcers and her virulent skin diseases (Sandeep & Paarakh, 2009, Mittal *et al*., 2011 and Sabharwal *et al*., 2013).

**Pharmacological activities**

The plant is recognised to possess positive effects as odontalgic, thermogenic, aphrodisiac, antiseptic, emollient, anthelmintic, deobstruant, suppurative, tonic, in fixing loose teeth, ulcerative stomatitis, leprosy, skin diseases, ottorrhoea, otalgia, wounds, corns and aromatherapy. Pharmacological actions of the plant reported so far are spasmolytic, anti-inflammatory, anti-microbial, antioxidant, antiulcer, cyto-protective, chemoprotective, wound healing and anti-acne activity (Pradhan, 2015).

Allelopathy is generally defined as any direct or indirect harmful or beneficial effect of one plant on another mediated by the production allelochemicals. Rodino *et al*., (2017) evaluated the potential allelopathic effect of *Jasminum officinale* against some weed species. The effects of extracts obtained from root, stem and leaves of *J. officinale*, were evaluated against ragweed (*Ambrosia artemisiifolia*), ryegrass (*Lolium perenne*), and Johnsonn grass (*Sorghum halepense*). The aqueous leachates of jasmine demonstrated promising allelopathic potential by inhibiting seed germination and radicle elongation of all tested species. The best results were observed against Johnsonn grass, with the leaves extract strongly inhibiting the germination rate, while the roots extract inhibited the radicle elongation.

India is endemic to mosquito-borne diseases which are major health problems in tropical regions. Chemical pesticides have been used for several decades in controlling pests and vectors of various human diseases but resulted in several problems such as resistance and resurgence of pests, affecting human health and ecosystem being disrupted leading to the threat that their continued use may further harm the environment. This necessitated the need for environmentally safe and biodegradable indigenous method of vector control. Plant products are a potential alternative approach as they are environmentally safe, target specific and biodegradable. Dengue and chikungunya are transmitted by *Aedes aegypti* and for controlling these diseases, the vector mosquito must be controlled. Extensive use of synthetic and chemical insecticides has resulted in environmental hazards and in development of physiological resistance among vector mosquito species. Plant products are a potential alternative approach as they are environmentally safe, target specific and biodegradable.

Preethi *et al*., (2014) studied the effect of crude chloroform, methanol and aqueous flower extracts of *Jasminum officinale*, *Jasminum auriculatum* and *Jasminum grandiflorum* for the larvicidal efficacy against the third instar larvae of *Aedes aegypti* at concentrations of 62.5, 125, 250, 500, 1000, 2000, 4000 and 8000 mg/L. Mortality was recorded after 24 and 48 h. Amongst the extracts of *Jasminum* species tested, the crude chloroform flower extract of *Jasminum grandiflorum* was found to be effective showing 100% mortality at 1000 mg/L with LC50 value of 344.01 and 300.47 after 24 and 48 h respectively followed by the crude methanolic flower extracts of *Jasminum officinale* and *Jasminum auriculatum*. Further investigations are needed to elucidate the larvicidal activity of Jasminum grandiflorum crude chloroform flower extract against a wide range of all stages of mosquito species and also the active ingredient(s) of the extract responsible for larvicidal activity should be identified.

Crude hexane and chloroform flower extracts of *Jasminum auriculatum*, *Jasminum grandiflorum* and *Jasminum officinale* were tested for the larvicidal efficacy against the third instar larvae of *Culex quinquefasciatus* at concentrations of 62.5, 125, 250, 500, 1000, 2000, 4000 and 8000 mg/L. Mortality was recorded after 24 and 48 h. Amongst the crude flower extracts of *Jasminum* species tested, the crude chloroform extract of *Jasminum grandiflorum* was found to be effective showing 100% mortality at 500 mg/L and LC50 value of 212.10 mg/L after 48 h (Raveen *et al*., 2015).

While walking in the garden, the fragrance of jasmine flowers (*Jasminum* spp.) gives us pleasure. The dominant chemical responsible for the fragrance is the methyl ester of (–) jasmonic acid (JA), an attractant for pollinators but also used by most higher plants as a phytohormone. JA and its derivatives, collectively termed as jasmonates regulate plant seed germination, root elongation, trichome development, anthocyanin accumulation, flowering time, fertility, senescence, and defence responses. The landmark breakthrough in research in this field was the identification of JAZ proteins in 2007, providing the long-sought central signalling molecules bridging perception to downstream transcriptional regulation (Zhu and Napier, 2017).

Silver and gold nanoparticles of *Jasminum nervosum* L. had high larvicidal activity on the filarial and arboviral vector, *Culex quinquefasciatus*, than the leaf aqueous extract. Lallawmawma *et al*. (2015) observed that the lethal time to kill 50 % of *C. quinquefasciatus* larvae were 2.24 and 4.51 hat 150 µg/ml of AgNPs and AuNPs, respectively, while in the case of aqueous leaf extract of *J. nervosum*, it was 9.44 h at 500 µg/ml. The principal component analysis plot presented differential clustering of the aqueous leaf extract, AgNP and AuNPs in relation to lethal dose and lethal time. It wass concluded that the biosynthesised AgNPs and AuNPs using leaf aqueous extract of *J. nervosum* could be an environmentally safer nano- biopesticide and provided potential larvicidal effect on *C. quinquefasciatus* larvae which could be used for prevention of several dreadful diseases.

### A. 3. Entrepreneurship and Employment generation

Most of the farm work is taken up by women, although not systematically accounted for in statistical and national data collections, for them particularly it can ensure financial empowerment and less drudgery in comparison to other field work. Dry flower production as a cottage industry can be taken up by the farmers individually as well as cooperatively (forming self- help groups), as an addition to the main agriculture and horticulture production assuring additional income. To uplift the livelihood and financial conditions of the rural women value addition of horticultural crops can offer tremendous opportunity. Value added product-based entrepreneurship can be started by smaller women group with minimum initial investment (Chatterjee *et al*, 2017).

Krishi Vigyan Kendra, Namakkal popularized jasmine (*Jasminum sambac*) cultivation by supplying 7,660 three months old rooted cuttings of jasmine variety Ramanathapuram Gundu malligai to twelve farm women covering an area of 1.66 ha. as a sustainable livelihood income generating activity to mitigate poverty. Jasmine being a hardy crop withstood drought, long dry spells and survived to yield flowers throughout the year and was a perennial source of income (average profit Rs.40000/ 800 square metre / year) that helped sustaining the interest of the farm women. The income from jasmine cultivation improved the quality of life, mainly health of the farm family and also helped them to build their asset base by repairing of home and vehicles etc. (Bharathi et al., 2015).

Jasmine flower selling is a profession for many elderly local village women in Goa. Jasmine flower vendors selling readymade strings of jasmine are a common sight on streets and road sides in many parts of Goa. It brings them a steady income. They grow a few jasmine plants and every day make strings or garlands out of the jasmine flowers and bring them to the market or sides of the road for selling the same. It includes sweet-smelling mogras (*Jasminum sambac*) to jayo (*Jasminum auriculatum*) and juyo (*Jasminum grandiflorum*) flowers woven into pretty strings or garlands. They usually sell on an average more than 10 fati (flower braids) every day and the demand increase during festival time and marriage season. 1 fati (30 cm length) of stringed jasmines with *Jasminum sambac* (mogra) and *Jasminum grandflorum* (Jai) costs around Rs. 20-30/- and Rs.40/-, respectively (Safeena *et al*., 2016).

## B. Tuberose

Tuberose (*Polianthes tuberosa* L.) is one of the most important tropical ornamental bulbous flowering plants cultivated for production of long lasting flower spikes. Tuberose word roots from the Latin word ‘tuberosa’, which means ‘swollen’ referring to its tuberous roots. ‘Polianthes’ is a greek term for ‘many flowers’. It is popularly known as Rajanigandha or Nishigandha. It belongs to the family Amaryllidaceae and the chromosome number of *Polianthes tuberosa* is 2n= 30. Tuberose is an important commercial cut as well as loose flower crop due to pleasant fragrance, longer vase-life of spikes, higher returns and wide adaptability to varied climate and soil. They are valued much by the aesthetic world for their beauty and fragrance. The flowers are attractive and elegant in appearance with sweet fragrance. It has long been cherished for the aromatic oils extracted from its fragrant white flowers. Flowers have a funnel shaped perianth and are fragrant, waxy white, about 25 mm long. Stamens are six in number, ovary 3 locular, ovules numerous and fruits are capsule. The plant has thin leaves and large white heavily-scented flowers. Tuberose is half-hardy, perennial, bulbous plant. Bulbs are made of scales and leaf bases

and stem remains concealed within scales. Roots are mainly adventitious and shallow. Tuberose blooms throughout the year and its clustered spikes are rich in fragrance; florets are star shaped, waxy and loosely arranged on spike that can reach up to 30 to 45 cm in length.

It is native of Mexico. Tuberose is being successfully grown in tropical, subtropical and subtemperate areas, and thrives well in countries such as France, India, China, Hawaii, and Morocco. The leading producers for export market are Kenya and Egypt. At present the total area [Table 8] under tuberose cultivation in India is estimated to be about 3,000 hectare, with Karnataka (Mysore, Devanahalli, Tumkur, Kolar, Belgaum and Mysore), Maharashtra (Pune, Nashik, Ahmednagar and Thane districts), Assam (Guwahati and Jorhat), Rajasthan (Udaipur, Ajmer and Jaipur), Gujrat (Navsari and Valsad), Tamil Nadu (Coimbatore and Madurai districts), Andhra Pradesh (East Godavari and Guntur) and West Bengal (Midnapur district) being the main centres of its commercial production.

| S No. | State | Loose Value (In ' 000 Tonnes) | Cut Value (In' 000 Tonnes) | Total Value (In '000 Tonnes) |
|---|---|---|---|---|
| 1 | Karnataka | 14.70 | 5.93 | 20.63 |
| 2 | Andhra Pradesh | 14.06 | 0.00 | 14.06 |
| 3 | Chhattisgarh | 5.90 | 0.00 | 5.90 |
| 4 | Assam | 2.60 | 0.01 | 2.61 |
| 5 | Maharashtra | 2.18 | 0.00 | 2.18 |
| 6 | Orissa | 1.28 | 0.00 | 1.28 |
| 7 | Madhya Pradesh | 1.00 | 0.00 | 1.00 |
| 8 | Bihar | 0.60 | 0.00 | 0.60 |
| 9 | Uttarakhand | 0.32 | 0.00 | 0.32 |
| 10 | Telangana | 0.06 | 0.00 | 0.06 |
| 11 | Puducherry | 0.02 | 0.00 | 0.02 |
| | Total | 42.70 | 5.94 | 48.64 |

**Table 8**: Production statistics of Tuberose in India (2014- 15), NHB

**Tuberose: Types & Varieties**

Barba-Gonzalez et al., (2012) has reported 15 species three varieties and two cultivars native to mexico. Some wild species of *Polianthes* are *Polianthes geminiflora* var. *clivicola, P. geminiflora, P. geminiflora* var. *graminifolia, P. geminiflora* var. *germiniflora, P. geminiflora* var. *clivicola, P. graminifolia, P. howardii, P. longiflora, P. multicolor, P. nelsonii, P. palustris, P. platyphylla, P. pringlei, P. sessiliflora* and *P. montana.*

Out of these fifteen species under the genus *Polianthes,* nine species have white flowers, one is white tinged with red and two are red. Except *Polianthes tuberosa* L., all the others are found growing wild. There are four types of tuberoses named based on the number of rows of petals they bear. They are:

**1. Single:**

They bear pure white flowers with One whorl of corolla and are highly scented which are chiefly used for concrete extraction. Flowers are highly scented and are extensively used for loose flower purpose, essential oil and concrete extraction. Single types are more fragrant than double. Concrete content has been observed to be 0.08 to 0.11 per cent. Loose flowers are used for making floral ornaments. Its floral buds are greenish white. Also, the per cent seed setting is high in single. Single Mexican, Kalyani Single, Shringar, Prajwal, Arka Nirantara, Rajat Rekha, Hyderabad Single, Calcutta Single, Phule Rajani, Kahikuchi Single, Pune Single Kalyani Single are main varieties of Single types.

**Description of some important single varieties**

**a. Arka Nirantara**

Arka Nirantara is released by Indian Institute of Horticultural Research (IIHR), Bangalore. It has white, single flowers with prolonged blooming.

**b. Shringar**

This tuberose hybrid has been developed from a cross between 'Single x Double' and was released by Indian Institute of Horticultural Research (IIHR), Bangalore. It bears single type fragrant flowers on strong and sturdy, medium spikes. The flower buds are attractive with slightly pinkish tinge. The spikes have more number of flowers and the individual florets are larger and appealing compared to the local 'single' cultivar. Loose flowers of this hybrid can be used for garlands and for extraction of tuberose concrete. The spikes can also be used as cut flower and loose flower yield of this hybrid is about 36 percent higher than the existing local single variety. Yield of loose flowers is about 15,000 kg/ha per year, which is 40% higher than 'Calcutta' or 'Mexican Single'. The concrete content of the hybrid is at par with Mexican Single. Shringar is preferred by farmers and perfumery industries. This hybrid is tolerant to root knot nematodes (*Meloidogyne incognita*).

**c. Prajwal**

This hybrid which bears single type flowers on tall stiff spikes is a cross between 'Shringar' x 'Mexican Single'. The hybrid was released by Indian Institute of Horticultural Research (IIHR), Bangalore. The flower buds are slightly pinkish in colour, while the flowers are white. The individual florets are large, compared to 'Local Single'. It yields twenty per cent more loose flowers than 'Shringar'. It is recommended both for loose flower and cut flower purpose.

d. **Single Mexican**

It is a single flowered variety. This variety produces maximum flowers is considered as lean months for tuberose flowers yield.

2. **Semi-double:**

They consist of flowers bearing 2-3 rows of corolla segments on straight spikes.

**Figure 2:** Different varieties of Tuberose (Top: Prajwal, Shringar, Mexican Single; Center: Suvasini, Vaibhav; Bottom: Chia Nong Pink Sapphire, Cindrella, Yellow Baby)

3. **Double:**

They bear flowers having more than three rows of corolla segments It is a single flowered variety. This on straight spikes. Flower colour is white and tinged with pinkish red. The main varieties are Pearl for Double, Kalyani Double, Swarna Rekha, Hyderabad Double, Calcutta Double, Vaibhav and Suvasini.

**Description of some important double varieties**

**a. Suvasini**

It is a double flowered multi whorled variety released by Indian Institute of Horticultural Research (IIHR), Bangalore. It is a cross between 'Single' and 'Double'. This variety produces more number of flowers per spike. The spikes are best suited for cut flowers. This tuberose hybrid is multi-whorled with bold, large, pure white fragrant flowers borne on long spikes in contrast to off-white flowers of local cv. 'Double'. The number of flowers per spike is more and flower opening is uniform in this hybrid as compared to the local 'Double' cultivar. Spike yield is 26 percent more compared to the local Pearl Double 'Double' cultivar. Spikes are best suited for cut flower purpose.

**b. Vaibhav**

This hybrid which bears double flowers on medium spikes is from the cross 'Mexican Single' x IIHR – 2' and was released by Indian Institute of Horticultural Research (IIHR), Bangalore. The flower buds are greenish in colour in contrast to pinkish buds in 'Suvasini' and 'Local Double'. Flowers are white. Spike yield is 50 per cent higher compared to 'Suvasini'. Hence, recommended for cut flower purpose.

**c. Pearl Double**

The flowers tinged with red in the 'Double' type are known as 'Pearl'. Pearl Double is high flower yielder with quality flowers. They are mainly used for cut flower and bouquet purpose as well as loose flower and for extraction of essential oil. Concrete recovery has been found to be 0.06%. It does not open well and is not commercially viable as the single cultivar.

4. **Variegated:**

These are some streaked leaf-forms, known as 'variegated'. In these varieties, silvery white or golden yellow streaks are visible on leaves. National Botanical Research Institute, Lucknow has developed two variegated varieties Rajat Rekha and Swarna Rekha by gamma irradiation.

a. **Rajat Rekha**

Rajat Rekha is a gamma ray induced mutant evolved by irradiating bulbs of single flowered cultivar. It is a single flowered variety released by National Botanical Research Institute (NBRI), Lucknow. Flowers have silvery white streaks along the middle of the leaf blade. Concrete content has been found to be 0.089 per cent.

b. **Swarna Rekha**

It is a double flowered variety released by National Botanical Research Institute (NBRI), Lucknow. The flowers are double with golden yellow steaks along the margins of leaf. It is a gamma ray induced mutant, in which mutation occurred in chlorophyll synthesis resulting in change in leaf colour. Concrete content has been found to be 0.062 per cent.

## B. 2. Value addition in Tuberose

Tuberose, grown in many countries around the world, has been considered a sacred flower to some cultures, being associated with traditional rituals and ceremonies. Aztec healers refer to this as the bone flower because of its waxy, luminous white flowers, important as a medicinal plant. Hawaiians make use of tuberose for leis. In Indonesia, it is used to make soy sauce and soups. Thick Indonesian soy sauce like Kecap, usually contains tuberose. Ketchups in The United States of America is a rather innocuous descendant of Kecap. In India, it has been used prominently in various rituals including wedding ceremonies. The flower also has immense use in the Ayurvedic tradition. It is used to increase emotional stamina of a person. In other parts of the world, it is cultivated for its hypnotic aroma and has enormous potential in the ornamental flower market. Its extracts are used in flavoring industry, making candles, soft drinks, perfume industry etc. Oil of tuberose is used on heavier types of scents and used in non- alcoholic beverages, ice cream, candy, baked goods etc. Fragrant flowers are added along with other ingredients to beverages prepared from chocolate and served hot or cold. In Java, the flowers are eaten along with the juices of the vegetables.

The flowers of tuberose are also used for making artistic garlands, floral ornaments, bouquets, buttonholes, gajras and extraction of essential oil [Figure 3]. It is also a popular cut flower, not only for use in arrangements, but also for the individual florets that can provide

fragrance to bouquets and boutonnieres. The long flower spikes are excellent as cut flowers for table decoration. The flowers emit a delightful fragrance. Tuberose represents sensuality and is used in aromatherapy for its ability to open the heart and calm the nerves, restoring joy, peace and harmony. Tuberose flowers have long been used in perfumery as a source of essential oils and aroma compounds. Tuberose oil is used in high value perfumes and cosmetic products. Furthermore, fragrant flowers are added along with stimulants or sedatives to the favorite beverage prepared from chocolate and served either cold or hot as desired. Tuberose bulbs contain an alkaloid - lycorine, which causes vomiting. The bulbs are rubbed with turmeric and butter and applied as a paste over red pimples of infants. Dried tuberose bulbs in powdered form are used as a remedy for gonorrhea.

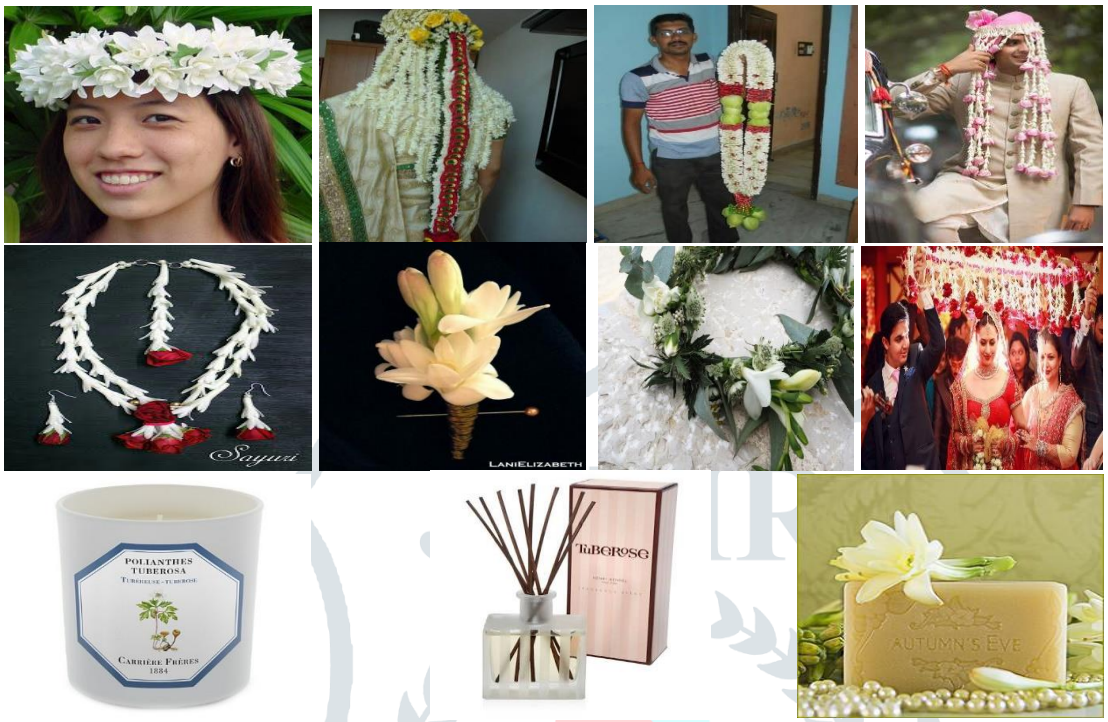



**Figure 3:** Diversified products of Tuberose flowers (Top: Crowns/Tiara, Gajra/ Veni, Garlands, Sehra; Center: Floral Jewellery, Buttonaires, Wreaths, Wedding phulkari/ Baagh; Bottom: Soaps, Candles, Reed Diffuser)

**Tuberose essential Oil**

The magical aroma of the oil is said to rejuvenate one's body and mind, leaving you with a feeling of well-being. As such, it can be used to treat emotional stress and anxiety. Organic tuberose essential oil also has powerful anti-inflammatory and antispasmodic properties. Organic tuberose essential oil's therapeutic application is limited to aromatherapy as an aphrodisiac and mood-lifter. It has soothing effects on the brain and the nerves, and muscles, it is used to reduce stress, tension, depression, and anxiety. Additionally, it is good for aches and pains, also to alleviate nausea. It also positively affects blood circulation, and thus provides enough heat to the body and helps to keep the respiratory system clean, by preventing collection of phlegm and catarrh. The warming effect of tuberose oil also helps to counter cold in winters. It is used to avoid skin infections as cracks that appear on dried skin.

The main chemical constituents of tuberose are benzyl alcohol, butyric acid, eugenol, farnesol, geraniol, menthyl benzoate, menthyl anthranilate and nerol. The heady and popular fragrance of tuberose was traditionally extracted by *Enfleurage*, the same method used to extract the fragrance of jasmine. Enfleurage was labour intensive and was used because the heat of steam distillation would denature the delicate aroma of the flowers. Owing to the labour- intensive nature of this extraction, in modern times tuberose is extracted using solvent extraction - such as via hexane (which creates tuberose *absolute*) or $CO_2$ extraction. Extraction of tuberose using chemical solvents leads to a lesser quality fragrance owing to the possibility of traces of solvent residue remaining in the absolute; but that this extraction method is often performed owing to commercial factors. About 30,000 kg loose flowers yield 27.5 kg of concrete and 5.50 kg of absolute.

Rakhtaworn *et al*. (2009) carried out an experiment to compare essential oil extraction methods from the double flower variety of tuberose (*Polianthes tuberosa* L.). The flowers were extracted by cold or hot enfleurage, or by solvent extraction with hexane or petroleum ether. The chemical composition of the tuberose absolutes was analyzed by gas chromatography-mass spectrometry (GC-MS). The results showed that percentage yields of tuberose oil from cold enfleurage, hot enfleurage, hexane and petroleum ether extractions were 0.3137%, 6.5808%, 0.0279% and 0.0182%, respectively. The main chemical component detected in both enfleurage absolutes was methyl benzoate, while benzyl benzoate and pentacosane were found to be the main chemical components in hexane and petroleum ether absolutes, respectively.

**B. 3. Research in the field of developing packaging technology for Tuberose**

Majumder *et al*. (2014) studied the effect of various chemicals with packaging and storage for prolonging the shelf life of tuberose (*Polianthes tuberosa* L.), florets (in bud) harvested from cv. Prajwal, Arka Niranthara and Mexican Single. The harvested buds were studied with Boric Acid (2%, 3% and 4%) and citric acid (150, 300 and 450 ppm), which were kept in polypropylene (PP) bags with or without vent (0.2%) at 4 ºC. The cultivar Prajwal also produced maximum percentage (30.67 %) of bud open after 5 days in 450 ppm citric acid i.e. with vented polypropylene bags. The maximum $CO_2$ rate (129.04 ml $CO_2$/kg/l) with zero bud rotting was also observed in cv. Prajwal in the treatment of 450 ppm citric acid with vented polypropylene bag.

A survey was conducted by the International Trade Centre UBCTAD/GATT, Geneva, which indicated that tuberose, as a cut flower, has a tremendous demand in Belgium, France and the UK (Anonymous, 1987). Among the major cut flowers produced in the southern part of W. Bengal, India, tuberose is holding the lion's share. Tuberose bunches are enclosed in paper or polyethylene sleeves or covers while transporting to distant markets. However, there are very few reports on the effect of different packaging materials, including banana leaf (as frequently used by local farmers) and their interactions with storage temperature, storage duration and subsequent physiological implications under West Bengal condition.

Roychowdhury *et al.* (2011) studied the effect of packaging and storage on the vase life of tuberose 'Calcutta Double', revealing that the spikes wrapped with banana leaf exhibited maximum vase life with maximum floret opening and least amount of floret wilting. The modified atmosphere inside such packages was having reduced oxygen and elevated carbon dioxide (CO2), either due to selective permeability to gases (for plastics) or due to active respiration (of banana leaf tissue). Further, spikes stored for 24 hours, especially at 10°C exhibited least floret wilting with better turgidity throughout the vase life. Retarded rate of respiration, transpiration, ethylene production and entire metabolism of the flower tissue as a whole was facilitated by low temperature (during storage) that was exhibited by better performance of flowers in vase.

**Utilisation of flower wastes**

Around 1450 tonnes of flowers are being offered to the deities in various temples all over the country. Rose, jasmine, marigolds, chrysanthemum, hyacinth, hibiscus and tuberose are the major flowers being offered in Indian temples (Ravishankar *et al*., 2014). These wastes can be utilized in different ways to produce valuable products. Floral waste utilization would eventually be beneficial to the society as people would get to live in a cleaner and a healthier environment. The "green temple concept" can prove to be helpful in Indian Government policy formulation for waste management and in promoting sustainable development approach towards temples (Yadav *et al*., 2015).

Nugrahini *et al*. (2017) conducted a study to find out whether waste of the tuberose flowers still contain valuable essential oil, when extracted by maceration method, and to determine the characteristics and antioxidant activities of produced essential oil. Hexane and petroleum ether were used as solvents in maceration to extract volatile compound from tuberose flower. The solvent and flower petals were soaked with ratio of 1:2, at ambient temperature for 24 hours. The solvent and flower petals were separated by filtration. The solvent was evaporated to obtain the extract and yield of maceration with hexane (0,12%) is higher than petroleum ether (0,08%). Percentage of antioxidant showed that the yield by extraction with hexane solvent (13,13%) is higher than petroleum ether (9,27%).

**Tinting**

Tinting is one of the important value addition techniques in flower crops where colour pigments are absent or light or dull. This technique enhances the aesthetic beauty of fresh and dry flowers. For decorative purpose where a particular colour is desired, tinting of white flower could be the only way of obtaining the colour of interest. Artificial colouring of spikes can fetch a premium price in the market. Such type of artificial colouring is done by using food colours. Certified synthetic food colours are less expensive and lead to minimum health hazards by imparting an intense and uniform colour. Vase life of tinted flowers is also an important consideration, which varies with the dyes used, its concentration and also with the stage of harvest. Some chemicals prolong the vase life and some chemicals retards the vase life of flowers.

Tuberose (*Polianthes tuberosa*) is a popular cut flower having white coloured fragrant blooms. To increase the value and appeal of flower along with fragrance, the spikes of tuberose can be tinted with artificial colours. Therefore, three cultivars viz. Shringar, Calcutta Double and Prajwal were selected to carry out tinting and post- harvest studies. The freshly harvested cut flower spikes were treated with five edible dyes (Raspberry Red, Orange Red, Green, Yellow and Chocolate brown) alone or in combination with 8-HQC to observe the effect of edible dyes on quality and vase life of tuberose. The cut ends of tuberose spikes were immersed in dye solution for six hours and after that they were transferred to distilled water.

Minimum weight loss (6.09 g) and percent weight loss (17.71%) was observed in cut spikes of cultivar Prajwal, however, maximum weight loss (12.85 g) and percent weight loss (25.04 %) was recorded in cv. Calcutta Double. Maximum volume of dye uptake (6.89 ml) was recorded with 0.2 % green dye; among cultivars the spikes of cv. Calcutta Double showed maximum dye uptake (5.29 ml). Maximum water uptake (32.80 ml) was recorded in flowers treated with 0.2 % yellow dye + 200 ppm 8HQC (T9). Among three cultivars maximum water uptake (31.46 ml) was recorded in cv. Shringar. Minimum floret drying (26.26%) throughout the studies was observed in flowers treated with 0.2% raspberry red dye + 200ppm 8HQC. Among cultivars, Prajwal showed minimum floret wilting (24.63%). The maximum vase life (12.58 days) was observed with 0.2% raspberry red dye while minimum vase life (9.15 days) was observed with orange red dye. The cultivar Calcutta Double flowers exhibited maximum vase life (12.60 days) while cv. Prajwal flowers showed minimum vase life of 8.81 days (Jain et al., 2015).

A series of experiments were conducted by Safeena *et al*. (2016) to evaluate the influence of colouring agents on vase life of cut spikes of two tuberose cultivars viz., Mexican Single and Pearl Double. Treatments consisted of six different edible dyes viz., Tartrazine, Sunset yellow + Carmosine, Tartrazine + Brilliant blue, Tartrazine + Carmosine + Sunset yellow, Royal blue and Brilliant blue at three different concentrations (0.5%, 1 % and 1.5 %). Various colouring agents successfully induced colour in the cut spikes without affecting their vase life. It was depicted that colour retention at the end of vase life indicated higher time of immersion (24 hours) and maximum concentration (1.5 %) allowed more dye to be translocated throughout the flower spike. In all treatments, there was no adverse significant effect of dye concentration, time of immersion and combination of both factors on the vase life and quality of tuberose cut spikes.

Viradia *et al*. (2015) studied the value addition through use of dye chemicals and floral preservatives in tuberose (*Polianthes tuberosa* L.) cv. 'Double'. Significantly enhanced fresh weight, uptake of water, vase life, minimum physiological loss of weight and loss: uptake ratio was recorded with the preservative $Al_2SO_4$ 500ppm + sucrose 2%. However, the preservative $Al_2SO_4$ 250ppm + sucrose 2% showed minimum loss of water and maximum diameter of florets. All edible dyes retained good shade initially expect black ink. Whereas, effect of different dyeing chemicals and their concentrations were found non-significant on flower qualities and vase life of tuberose. At higher concentration colour and dark shade was obtained quickly except black ink. In case of different dye chemicals, their concentration and duration of absorption found non-significant effect on flower qualities and vase life of tuberose. At higher concentration with higher absorption time obtained dark colour shade of spike.

**Pharmacological benefits**

The bright green leaves clustered at the base of the tuberose plant possess kaempferol and tuberolide (Indole). Kaempferol is a flavonoid with a wide range of pharmacological activities, as numerous preclinical studies suggest, including antioxidant, anti-inflammatory, antimicrobial, anticancer, cardioprotective, neuroprotective, antidiabetic, anti-osteoporotic, estrogenic/antiestrogenic, anxiolytic, analgesic, and antiallergic. Indole is a unique aromatic compound common as a constituent of fragrances and as a precursor to various pharmaceuticals. Three constituents present in the absolute, namely geraniol, indole and methyl anthranilate exhibited significant activity showing total inhibition of the mycelial growth *Colletotrichum gloeosporioides* on potato-dextrose-agar medium at the concentration of 500 mg/L (Nidiry and Babu, 2005).

Lodhia *et al.* (2009) studied the antibacterial activity of essential oils from tuberose, which was determined to be efficacious against Gram-positive and Gram-negative bacteria tested by their study (i.e., *Staphylococcus aureus* and *Escherichia coli*). Such antibacterial activity was found to be dose-dependent such that with an increase in concentration of tuberose essential oil, a corresponding increase in zone of

inhibition can be noted. Methyl benzoate is an organic compound in the form of a colorless liquid with a pleasant smell, whereas benzyl benzoate is a topically administered drug used in the treatment for lice and scabies infestations (Rakthaworn *et al*., 2009).

*Polianthes tuberosa* is traditionally used against snake venom poisoning in Chhattisgarh area in India. After studies, Naja venom neutralization potential of ethanolic extract (400 and 800 mg/kg) of *Polianthes tuberosa* was established which significantly inhibited the Naja venom induced lethality, hemorrhage, necrotizing effect, confirming its snake venom neutralizing properties (Soni *et al*., 2012).

There are several water-borne diseases which are highly pathogenic for humans. Among all, Vibrio genus plays a significant role in causing Cholera. The flowers extract was obtained in Acetone, Methanol, Ethanol and Xylene at different concentration of these solvents (50%, 75%&100%). In which the flowers extract in Acetone, Methanol and Ethanol show the maximum result in 100% concentration (Verma *et al.*, 2013).

Rawani et al. (2012) studied the mosquito larvicidal and biting deterrence activity of bud of *Polianthes tuberosa* plants extract against *Anopheles stephensi* and *Culex quinquefasciatus*. Crude and chloroform: methanol (1:1, v/v) extract showed efficient activity against *Culex. quinquefasciatus*, so it could be used as a mosquito larvicide agent. There is no change in the activity of non-target organism so, it is safe to use. Rumi *et al*. (2014) investigated the crude methanol extract of tuber of *Polianthes tuberosa* Linn. for antioxidant, cytotoxic, antimicrobial, membrane stabilizing and thrombolytic activities. It was concluded that the plant possesses significant bioactivities which rationalize its use as folk medicine.

**Conclusion**

Floriculture is the most lucrative agro-enterprise in terms of profit making. Profit potential is increased when an indistinctive raw commodity is converted into a unique product, whose export e.g. oil (extracted in small units set up in production zones), rather than the raw material, e.g. fresh flowers, can help generate substantial revenue in international market. Value addition is an important arena for proper utilisation of fresh ornamentals in either garden-fresh or processed form. But the challenges encountered are synergy in the plan, technology for value added products, knowledge for standards to be followed, availability of varieties as per market preferences, and approach of various agencies at various levels in different functional areas i.e., research, finance, quality assurance & certification. Value addition is a business strategy for creating new market demands or indulging renewed demand from the set of conventional customers. Exploration of value addition avenues can solve the two major issues- Un- employment and poverty of the nation, by providing a steady source of income to the producers. Government initiatives are essential to benefit the growers and the country's economy on a whole. Enhancing the current techniques of value addition and adoption of more technological interventions. Broadening the mindset towards use of the flowers for other industries and not only ornamental purpose can help us create a source of additional income.

Demand creation is the need of the hour to increase the export of value added products of both the ornamental crops. Customer satisfaction-creating product variability should be the key considerations of the stakeholders of the industry. Diverse kinds of value-added products are nowadays created and marketed. Prior to anything, focusing on the own assets can help us monopolize the market. It is not a good approach to send fresh flowers to other countries (China etc.) and export the processed flower products from the same at higher costs. This can prove detrimental in the long run. Exploring the natural biomes of the species and intervention of breeding and biotechnology can help develop a varietal wealth. Both jasmine and tuberose are the most important commercial loose flowers of India and have been cultivated for more than a century, predominantly in the southern part of the country. Earlier they were used for floral decorations and now the realization of product diversification in the form of value addition is felt. Use of both jasmine and tuberose is medicinal, they can be a good natural antagonist against allelopathic medicines. Essential oil markets are blooming. Short Life span of jasmine and tuberose flowers and storage issues are high in the peak season. Floral wastes are not being utilized in the country, so utilization of such waste can become a source of supplementary income. A viable value chain which benefits both the producer and consumer needs to be created. Increasing export demand is an Eye-opener. High time to work in the direction of value addition as a business venture that can flourish with scientific interventions.

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