

Chapter

A Review on the Botanical, Phytochemical and Pharmacological Characteristics of *Cuscuta* Spp.

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Abstract

Parasitic life is an example of interaction between two species. The result is positive for one and negative for another. Parasitic plants are more evolved than other species in the same family. *Cuscuta spp.* or dodder is one of the medicinal herbs that belong to the Convolvulaceae plant family. They are annual parasitic plants that reproduce by seed. These parasitic plants do not have any roots, leaves or chlorophyll to produce their own food. Dodders live by attaching to a host plant with small appendages (called “haustoria”) and extract its necessary growth elements. The active compounds of *Cuscuta* species include flavonoids, lignans, quinic acid and poly-saccharides. Flavonoids are kinds of effective antioxidants, and poly-saccharides are the effective constituents to improve the immune system. *Cuscuta epithymum* is an important herbal medicine that is effective in the treatment of liver and kidney failure, sexual impotence and vision weakness. It also prevents abortion senescence and aging. *C. epithymum* possesses anticancer, immuno-stimulatory, anti-oxidant and anti-osteoporotic activities.

Keywords: *Cuscuta spp.*, flavonoids, lignans, health benefits, medicine

1. Introduction

Parasitic life is an example of two-way interactions that result in positive outcomes for one species and negative for the other. Parasites are usually smaller than their host and often do not live independently and freely, and in all or at least one stage of their lives, they act on and feed on another living organism called the host. Parasites do not kill their host because in this case they also die, but in many cases, they disrupt the life of the host [1]. Parasitic angiosperms are found worldwide and in most large ecosystems, from tundra and taiga to temperate deserts and equatorial forests [2]. The effect of the parasite in plant communities is highly variable and unpredictable. Parasitic insects steal water and food from a nearby plant and alter the structure and balance of society. The effect of parasitic plants directly on the amount and volume of biomass, vegetation cycle and interaction with other nutrient levels of pollinators, vegetarians and fungal coexistence is undeniable. The dual effects of parasite can be attributed to the opposite effect of parasite in both living

and non-living environments, both of which are key to the structure and function of plant communities. These plants are considered in both positive and negative directions. Many of these plants have industrial, medicinal, food and forage values, and some species can also increase biodiversity [1].

The genus *Cuscuta* spp. commonly known as dodder is one of the essential herbal constituents of pharma foods and curative tonics that are frequently prescribed to nourish various body parts. It is used to enhance the nutritional value of porridge and alcoholic beverages [3]. The genus has a rich history of folk medicinal uses, and numerous phytoconstituents of therapeutic value have been isolated and identified [4]. Various species are indigenously used to cure fits, melancholy, insanity [5], fertility problems [6], tumors [7], scabies, eczema [8], chronic ulcer, jaundice, inflammation [9], chest pain [10], fever, itching [11], osteoporosis [12], diarrhea, oedema, stomach ache, infections, measles, sores, kidney problems [13], sprain [14], alleviation of high blood pressure, leucorrhoea [15], obesity [16], migraine, amnesia, epilepsy and constipation [17].

Cuscuta species are among the most successful and common parasitic plants that can be found anywhere on crops and non-crops. The ability to invade different species indicates that these plants have a variety of mechanisms for attaching to host plants. Also, the chemical composition of *cuscuta* will vary depending on the host plant, so *cuscuta*, which is hosted by medicinal plants, can have more beneficial therapeutic effects. In any case, this article could be an opening on this topic of the *Cuscuta* parasitic species. Undoubtedly, a large number of species in each vegetation and habitat area have medicinal and nutritional values that have often been considered. Parasitic plants such as *Cuscuta* are no exception to this rule, and many parasitic species have medicinal value and have long been traditionally used.

2. Materials and methods

The present review covers the literature available from 1956 to 2019. The information was collected from journals, books, theses and electronic search (Google Scholar, PubMed, ScienceDirect, ESBCO, Springerlink and CNKI). Literature abstracts and full-text articles were analyzed and included in the review.

3. History

Aftimun is a plant used in traditional medicine of the Middle East, China, India and European countries. In 1652, the use of this plant was recommended for the treatment of Black Bile. The Chinese believe that the sauce plant increases longevity [18]. Among the many species of the genus *Cuscuta*, Aftimun is one of the plants that has the most writing in the authoritative old and new sources of the world. This plant, which lives as a parasite on other plants, has sucking organs on narrow, very thin stems resembling threads, and with these sucking organs, it penetrates into the trunks of nearby plants and uses the sap of those plants [18].

4. Botany

Cuscuta, a flowering parasitic genus was previously placed in the Convolvulaceae family, but later it was segregated as the separate family Cuscutaceae [19–22]. *Cuscuta* is an annual plant that is propagated by seeds. This plant is leafless, colorless and often without chlorophyll. It is a twisting and parasitic plant. Seeds of this plant grow in

the soil and the young stem, which is thread like emerges from the soil and quickly wraps around the host plant, takes root and dips its sucking root into the bark of the stem of the plant. If a piece of the stem of this plant is placed on the host plant, it will start growing immediately. *Cuscuta*, in addition to being a parasite of green plants and feeding on their sap, causes the transmission of various plant diseases and viruses from plant to plant. *Cuscuta* fertilizes in summer and produces seeds in autumn [23].

The number of species of this plant is between 100 and 200. The difference between *cuscuta* species and other species of the family, in addition to being parasitic, is the sticky sepals and scales under the flag. Its complex yellow stem has scaly leaves. The flowers are small and a few millimeters in diameter, including sepals with a 4- or 5-part cover. Although the green color is not seen in the sauce, it has a small amount of chlorophyll and therefore cannot be called a complete parasite. However, photosynthesis is negligible in most species and by default it is parasitic in nature because it is almost entirely dependent on the host from the first days after germination. This species can be identified only through its flowers. Thus, the number and shape of the flower cover parts, the shape and arrangement of the stigma and cream, the shape and the way of opening the capsule and the shape of the scales under the flags are important indicators to identify this species [21].

Medicinally important species are *Cuscuta reflexa* Roxb. [24], *Cuscuta chinensis* Lam. [25], *Cuscuta japonica* Choisy [26], *Cuscuta australis* R. Br. [27], *Cuscuta*



Figure 1.
Cuscuta plant.



Figure 2.
Cuscuta flower and seed.

europaea Linn. [28], *Cuscuta gigantea* Griff. [29], *Cuscuta hyaline* Roth. [30], *Cuscuta campestris* Yuncker. [31], *Cuscuta racemosa* Mart. [32], *Cuscuta pedicellata* Ledeb. [33], *Cuscuta epithymum* L. [34], *Cuscuta kilimanjari* Oliv. [35], *Crepis kotschyana* Boiss. [36], *Cuscuta mitraeformis* Engelm. [37], *Cuscuta tinctoria* Mart [38] and *Cuscuta capitata* Roxb [39]. The usual growing season is early summer; germination starts in May; parasites invade the host by haustoria and may wither and die in the absence of a suitable host within 2 weeks [40]. Flowering starts in June and seed production in November (Figures 1 and 2) [41].

5. Medicinal uses

Potentially useful plants have been acknowledged and sequentially conveyed throughout the centuries in all societies. Some of them are used through self-medication, while others are recommended by traditional healers [42]. Plant utilization as medicine ranges from the direct administration of the leaves, seeds, barks, roots, and stems to the extracts and decoctions from different parts of the plants [43]. Many *Cuscuta* species being rich sources of diverse phytochemicals are popular components of various folk medicinal systems. *Cuscuta* species are used in traditional medicine as a purgative, diaphoretic, anthelmintic, diuretic and tonic as well as a treatment for itching and bilious disorders [44, 45]. Seeds, stem and whole plant are utilized as prescription to treat different types of ailments. *Cuscuta epithymum* is a mild diuretic and used to treat sciatica and scurvy. The fresh plant is applied to the skin against scrofula derma and scleroderma. It is associated with the health of liver and kidneys and used in various formulas. It is considered a mild laxative [46, 47].

The whole plant is dried and used as astringent and detergent [34]. Whole plant decoction of *C. campestris* is used as purgative and poultice [48]. The sap of *C. tinctoria* is used to cure ringworm and warts [38]. The juice of *C. gigantea* plant is famous as an anti-poisonous agent [49, 50]. The sap of *C. europaea* is used as a carminative, and the extract is applied to treat psoriasis [51]. Seeds of this vegetative parasitic plant are used as laxative, diuretic and pain reliever and are poisonous. The juice is used for skin treatment [52, 53].

C. capitata whole plant reduces the irritation of the bladder and improves urinary function [54, 55]. *C. hyaline* is used to treat chest pain [10, 14]. Its infusion is used as sores washer and to prevent abortion [11, 31]. It is antiulcer and used against culex mosquito. *C. australis* is used as laxative, anthelmintic, astringent, for treatment of sores, measles and as kidney and liver tonic, emollient, sedative and sudorific [13].

6. Chemical compounds of Aftimun

In the analysis of essential oil from the stems of Aftimun plant, about 81 species of compounds have been identified; the main components of the essential oil include alpha pinene, beta pinene, limonene and linalool [54, 56]. Of course, some sources have mentioned other compounds such as saponin, tannin, camphor and lignan in the composition of Aftimun essential oil. The main constituents of Aftimun seeds include camphor, resin, aluminum, calcium, sodium and potassium [54].

7. Phytochemical and pharmacological properties of aftimun

Aftimun (*Cuscuta* Spp. Or Dodder) is a medicinal plant belonging to the Convolvulaceae family and there are over 150 species of aftimun worldwide. This

plant is a parasitic plant and is distributed all over the world except Antarctica [57, 58]. The most common type of afitimun is *C. epithymum*, which has been used in various treatments in traditional medicine [57, 59]. Previous studies have shown that some afitimun species have anti-cancer properties [57]. Studies evaluating the effects of afitimun (*Cuscuta kotschyana* and *Cuscuta chinensis*) in different cell lines including HL60, MCF7, T47D, CCRF-CEM and Jurkat (JM), show the cytotoxic properties of this plant species, although the evidence available is scarce [36, 60].

In a review study, the antiproliferative property of Afitimun (*C. epithymum*) was mentioned [61]. In another study, the effect of methanolic extract of Afitimun (*C. epithymum*) was investigated and its antibacterial and anti-cancer effects were confirmed and further studies were suggested [55]. Some Afitimun species, such as *Cuscuta reflexa*, are known to be anti-cancer and are used to treat prostate cancer, although there is not enough evidence yet [56]. In a recent study that examined the effect of chloroform and hydroalcoholic extracts of *Cuscuta chinensis* and *C. epithymum* on cells of different classes [57], the results showed that the extracts of the shoots of these two types of Afitimun have properties. They are cytotoxic and are the best candidates for further studies to obtain new cytotoxic agents [57].

Numerous studies have shown that the pharmacological effects of different afitimun species are attributed to their active compounds, including flavonoids, polysaccharides and lignans [55, 56]. Flavonoids are a type of antioxidant, and polysaccharides are effective compounds in modulating the immune system. According to studies, the use of special types of polyhydroxyphenols such as flavonoids reduces the risk of colon and breast cancer [62]. The human diet contains a mixture of plant polyphenols. Various studies indicate that these phenols have cytotoxic effects against various tumors and the mechanism of action of these compounds is through the induction of apoptosis [62].

8. Economical

Cuscutas are plants that are economically one of the most important groups of parasitic plants and can cause great damage to crops by invading by the seeds they produce [63]. For example, *C. campestris* is ubiquitous and is a common species. It attacks at least 25 major crops in 55 countries [64]. Fifteen global species of this genus are known as weeds [63]. However, most species of *cuscuta*, like other parasitic plants, are beneficial [65]. The *cuscuta* species plays a key role in natural ecosystems. *Cuscutas* are able to alter plant community structure and dynamics, nutrient levels, and even modify non-living factors [66].

9. Phytochemistry

As *C. epithymum* is a parasitic plant, its chemical constituents are complex and vary in relation with type of the host invaded by the species [67]. In *cuscutas*, different types of chemical compounds such as 18 types of flavonoid compounds, 13 phenolic compounds, two types of steroids, 10 types of volatile oils, 22 types of lignans, nine polysaccharide compounds, 16 types of fatty acids and various types of alkaloids, steroids and so on are identified. Has been [25]. Flavonoids make up 3% of the total phytochemical composition of *Cuscuta*. The main flavonoid compounds in *cuscuta*, including kaempferol, quercetin, hyperoside, astragaline and ligands, play a very important role in the therapeutic effects of diseases [68].

All species of *cuscuta* have water-soluble phenolic compounds such as hyperoside, quercetin, astragalin, camphor and so on in different amounts, and Chinese *cuscuta* has a high content of camphor glucoside among all species. So far, mineral elements such as calcium, magnesium, iron, manganese and copper have been identified in this plant through atomic absorption spectroscopy [69]. Also, 16 types of fatty acids, which mostly include linoleic acid, oleic acid and linolenic acid, have been identified from the extract of *cuscuta* by hexane [70].

In general, in the science of classification, the appearance of plant organs is used to identify different species. Because the flowers of different species of *cuscuta* are somewhat similar, Luffer et al. [71] investigated the possibility of accurately identifying *cuscuta* species due to the unique type of phenolic compounds present in their body. In this study, nine different species of *cuscuta* have been studied. First, the last 10 cm of their stem was removed and 15 cm of the remaining stem was collected to analyze the compounds inside. The results showed that there were 10 soluble phenolic compounds, including five hydrocyanic acid-derived compounds and five flavonoid compounds (such as kaempferol, quercetin and their derivatives) in all 9 species of *cuscuta*, each of which had different amounts in different species. These nine species of *cuscuta* were divided into three groups: (1) the group in which the hydrocyanic acid content was higher than flavonoids; (2) the group that had more flavonoids than hydrocyanic acid and (3) the group that had the same amount of hydrocyanic acid and flavonoids. Therefore, based on the results of these researchers, it is possible to identify different species of *cuscuta* according to the number of phenolic compounds present in *cuscuta*.

In addition, in the analysis of the essential oil obtained from the stems of the epithymum plant, about 81 species of compounds were identified, the main composition of the essential oil including Limonene, α -pinene, β -pinene and Linalool [72]. Of course, some sources have mentioned other compounds such as saponin, tannin, kaempferol and lignan as compounds in the essential oil of this plant. The main constituents of epithymum seeds include kaempferol, resin, aluminum, calcium, sodium and potassium [73]. The *C. epithymum* plant contains a significant amount of δ -tocopherol, α -tocopherol and γ -tocopherol as its constituents [74].

10. Therapeutic properties of aftimum

This plant has different healing properties. This plant is used to treat diseases of the spleen, liver and gallbladder, including jaundice, has mild laxative and diuretic properties, and is also used to treat scurvy, sciatica and gout. In external and topical use, it has a healing effect and is used to wash wounds and injuries, refreshes cocoons and skin wrinkles, and is effective in treating skin tuberculosis. Another healing property of this plant is its anti-cancer properties [75]. Traditionally it is considered a miracle genus equipped with a broad spectrum of remedial values. Decoctions, extracts, paste, powder, juice and infusions of different parts of the plants are important herbal prescriptions in traditional medicinal systems [76]. In Indian herbal medicine, sauces are used to treat jaundice, muscle and urinary problems. Among the healing properties of other sauces, in addition to the previous cases, we can mention the effect of sexual enhancer, expectorant, antipyretic, diaphoretic and worming. Its effects in the treatment of alopecia, bronchitis, headache, constipation, eczema, epilepsy, muscle pain and urinary problems can also be mentioned. The decoction of the plant with honey is suitable for purifying the blood, and this plant is also used to accelerate the healing of abscesses [77].

11. Conclusion

Cuscuta, commonly known as dodder, is a genus of the Convolvulaceae family. Approximately 170 species of *Cuscuta* are extensively distributed in the temperate and subtropical areas of the world. Species of this genus are widely used as essential constituents in functional foods and traditional medicinal systems. Various parts of many members of *Cuscuta* have been found efficacious against a variety of diseases. Phytochemical investigations have confirmed the presence of biologically active moieties such as flavonoids, alkaloids, lignans, saponins, phenolics, tannins and fatty acids. Pharmacological studies and traditional uses of these plants have proved that they are effective anti-bacterial, anti-oxidant, anti-osteoporotic, hepatoprotective, anti-inflammatory, anti-tumor, antipyretic, antihypertensive, analgesic, anti-hair fall and anti-stereogenic agents.

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Conflict of interest


The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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