



Methodology Article

Development and Utilization of Medicinal Parasitic Plant Dodder as Source of Nectar and Pollen

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To cite this article:

Mingxing Zhao. Development and Utilization of Medicinal Parasitic Plant Dodder as Source of Nectar and Pollen. *American Journal of Agriculture and Forestry*. Vol. 7, No. 1, 2019, pp. 23-27. doi: 10.11648/j.ajaf.20190701.14

Received: December 26, 2018; **Accepted:** January 24, 2019; **Published:** February 21, 2019

Abstract: Dodder, a parasitic herbage, is widely distributed throughout china. It is a very troublesome hogweed in agricultural production. People have to spend more human and material resources to get rid of it. Does dodder has some useful values? It has been provided by clinical applicant text and modern medical analysis that dodder is a medical plant. Although it is harmful in agriculture, its seeds, nectar and pollen play an important role in preventing and curing disease, preserving health and cosmetology. The traditional method of cultivating dodder is to cultivate soybean, flax and other annal plants firstly. Then use these plants as the hosts to cultivate dodder. But this method has some disadvantages such as complicated program and low efficiency. The new method by using drylands willow to cultivate dodder is worth popularizing for its simplicity and high efficiency.

Keywords: Dodder (*Cuscuta L*), Parasitic Plants, Medicinal Plants, Nectar and Pollen Plants, Development and Utilization

1. Foreword

Dodder (*Cuscuta L*), belonging to the genus *Cuscuta*, family Convolvulaceae according to plant taxonomy, has been given all sorts of folk names including angel hair, devil's hair, devil's ringlet, goldthread, hairweed, lady's laces, strangleweed, witch's hair and many others. With a wide distribution in China, Afghanistan, Iran, Japan, North Korea, Vietnam, Madagascar, Sri Lanka, Australia, Malaysia, Indonesia, Denmark, Finland, Italy, USA, Germany, France, Morocco, Nepal, Guinea and so on [1], dodders are often found on roadsides, hillsides, fields, ditches, bean field, grasslands, highway slopes, etc. at altitudes of 200 to 2,100 m. The dodder is a parasitic plant that lives on other plants such as family Leguminosae, family Salicaceae, family Ulmaceae, family Asteraceae, family Rosaceae, family Solanaceae, family Simaroubaceae, etc. The dodders do not have any chloroplasts and chlorophyll necessary for photosynthesis and do not make their own food, getting nutrients from the hosts via haustoria.

The dodder has been regarded as a harmful weed and removed continuously. But its medicinal value has been

appreciated by people. Since the Han Dynasty in China, dodder has been used as the superior medicine in nourishing liver and kidney, replenishing vital essence and improving eyesight. In recent years, through clinical trials and modern medical analysis, it has been found that its seed as well as nectar and pollen plays an important role in preventing and curing disease, preserving health and cosmetology. As medicinal, nectar and pollen plants, dodder has broad prospects for development and utilization. During the production, people usually use soybean, flax, dry-land willow and weeping willows as the hosts to cultivate dodder. Among which the new technique of cultivating dodder by using dry-land willow is worth using and spreading because of its simple way, low cost and high benefit.

2. Botanical Characteristics of Dodder

2.1. Morphological Characteristics of Dodder

Dodder (*Cuscuta L*) is a group of annual herbs with the following characteristics: yellow or reddish herbs; twining and filiform stems; tiny white or orange flowers, mostly in spicate or cymose clusters; bracts minute or absent; sepals 4~5,

separated or united slightly; 4~5-lobed corolla in cyathiform or campanulate, white or pinkish; stamens 4~5, inserted on corolla above scales; 2-loculed ovary in ovoid or subglobose; styles 2; 2-lobed stigmas; capsule ovoid or globose, surrounded by persistent corolla, circumscissile or opening irregularly; seeds ovoid, brown, and glabrous; it usually blooms from July to August with rich aroma, and bears fruits from August to September [2].

2.2. Differences of Common Didders

There are three main types of didders commonly found in Northern China: *Cuscuta chinensis* Lam; *Cuscuta australis* R.Br.; and *Cuscuta japonica* Choisy. The difference between *Cuscuta chinensis* Lam, *Cuscuta australis* R.Br. and *Cuscuta japonica* Choisy is that, *Cuscuta chinensis* Lam and *Cuscuta australis* R.Br. have filiform and yellow stems, membranous sepals, white or yellowish corolla, styles 2 with non-lobed stigma, and seeds of rough surface; while *Cuscuta japonica* Choisy has thick, slightly fleshy, orange stem with purplish nodular spots, fleshy sepal lobes with purplish fleshy nodular protrusions on the back, reddish or greenish white corolla, style 1 with 2-lobed stigma, and seeds of smooth surface. The difference between *Cuscuta chinensis* Lam and *Cuscuta australis* R.Br. is that, the stamens of *Cuscuta* are grown in the lower part of the corolla lobes notch, with urceolate or campanulate white corolla, subglobular ovary, and subglobular capsule that is almost entirely surrounded by remaining corolla and dehiscent by lid or circumscissile; while the stamens of *Cuscuta australis* R.Br. are grown at the notch of the corolla lobes, with cyathiform shaped creamy white or light yellow corolla, hemispherical ovary, and oblate capsule that is partially surrounded by remaining corolla at the lower part and opening irregularly when mature [3].

3. Development and Utilization Value of Dodder

The stems of dodder are entangled on the stem of the host plants and form haustoria into the host plants tissue. Then some of the cells differentiate into ducts and sieve tubes which absorb water and nutrients from the host plants by way of communicating with the ducts and sieve tubes of the host plants respectively. The stems continuously entangle and elongate to form new haustoria and branches with the growth of the host plant. The dodder often spreads all over the whole host plants, disturbing photosynthesis thereof, further leading to death of host plants due to entanglement and malnutrition. For a long time, dodder has been listed as a harmful weed and guarded strictly, but its medicinal value has been appreciated by people.

3.1. Application Results of Clinical Medicine

Dodder is an important Chinese herbal medicine documented in "Chinese Materia Medica". The main medicinal parts are the seeds of *Cuscuta chinensis* Lam, *Cuscuta australis* R.Br., and *Cuscuta japonica* Choisy [4]. As

early as 2000 years ago, Chinese people had already understood the medicinal value of dodder. In "*Shen Nong's Herbal Classic*", an ancient book completed in Qin and Han dynasties, such records can be found: "The dodder is spicy, mild, non-toxic, with the major functions of treating injuries, supplementing insufficiency, enriching essence, strengthening the body, and eliminating freckles. A long-term intake of didders leads to eyesight improvement, body comfort and prolonged life". On the basis of the previous primordial literatures, the medicinal properties and indications of didders have been supplemented and revised to varying degrees, so that the functions and indications of dodder are improved. For example, in "*Compendium of Materia Medica*" written by Li Shizhen (Ming dynasty), it is recorded that "The dodder is spicy, mild, non-toxic with the major functions of treating injuries, supplementing insufficiency, enriching essence, strengthening the body, nourishing muscle, reinforcing YIN essence, strengthening bones and muscles, treating deficiency of the kidney, spermatorrhea, incontinence, bitter taste, thirst, and circulation stagnancy. A long-term intake of didders leads to eyesight improvement, body comfort and prolonged life, with effects of curing male and female asthenia cold syndrome, enriching essence, nourishing the bone marrow, relieving backache and knee cold, treating diabetes, diminishing chloasma, improving beauty, tonifying five kinds of strain and seven kinds of impairment, treating spermatorrhea and hematuria, nourishing the heart and lung, and reinforcing wind and deficiency of the liver. Miaomedicine: sweet, mild, non-toxic. Indications: grind and take the liquid to spread on the face to diminish chloasma; rub and boil, take the liquid to bathe the children to cure prickly heat." [5] The first *Pharmacopoeia of the People's Republic of China*, published in 1963, describes the functions and indications of dodder: "reinforcing liver and kidney, enriching essence, improving eyesight, with the major functions of treating waist and knee pain, spermatorrhea, poor vision, and frequent urination." [6] The 10th edition of *Pharmacopoeia of the People's Republic of China* revised in 2015 further indicates: the dodder is "spicy, sweet and mild, with the attribution to the liver, kidney and spleen meridian. Function and indication: reinforcing the liver and kidney, conserving essence and reducing urination, preventing miscarriage, improving eyesight, and relieving diarrhea. It is used for in insufficiency of the liver and kidney, soreness of the waist and knees, impotence, spermatorrhea, incontinence and frequent urination, vertigo, tinnitus, vaginal bleeding during pregnancy due to kidney deficiency, frequent fetal movement, and deficiency type diarrhea due to spleen and kidney deficiency. It is used for treating vitiligo by external application." [7].

3.2. Research Results of Chemical Composition and Pharmacological Function

Modern medicine has proven that the chemical constituents of dodder mainly include flavonoids such as astragaloside, kaempferol [8], quercetin, hyperoside [9], and isorhamnetin [10]; sterols such as stigmasterol, campesterol, oat sterol,

cholesterol, and β -sitosterol [11]; polysaccharides such as galactose, xylose, rhamnose, and arabinose, 16 amino acids, and 21 trace elements including Ca, Mn, Fe, Zn, Cu and so on [12]. The pharmacological effects are mainly manifested in metabolic regulation, immunomodulation [13], anti-oxidation, anti-aging [14], improving experimental myocardial ischemia, improving cardiodynamics, improving reproductive system function, promoting bone cell activity, improving osteoporosis, regulating endocrine system function, lowering blood pressure, lowering blood glucose, liver protection, eyesight improvement and other aspects [15].

3.3. Interdisciplinary Research Achievements of Medicine and Agroforestry

The dodder is one of the nectar source plants recorded in "The Chinese Agricultural Encyclopedia (beekeeping volume)". In recent years, while medical researchers have studied the medicinal and edible value of the dodder, the agricultural and forestry scientists have conducted a comprehensive and interdisciplinary study on the dodder from the perspective of nectar and pollen source, and a great number of research results have been obtained. For example, by determining the chemical composition of the pollen and nectar of the dodder, it is found that a lot of chemical constituents of dodder pollen and nectar are the same as those of dodder seeds. The pollen and nectar of the dodder are used for disease prevention and treatment, health maintenance, beauty preservation, etc. It has the advantages of being convenient for use, having simple manufacturing, good taste and obvious effect as well as being popular with consumers [16].

3.4. Prospect of Development and Application

Practice has proved that not only do the stems and seeds of the dodder have important development and utilization value and broad market prospects, but also the nectar and pollen of dodder have considerable development and utilization value and extensive application prospects.

4. New Techniques of Dodder's Cultivation and Management

Dodder prefers a sunny environment and a high temperature and humid climate. The soil requirements are not strict, and the environment suitable for the growth of host plants is also fine with the growth of dodder. The host plant should be chosen first in planting dodder. The following principles are often followed in selecting the host plant in production: first, the host plant has wide range of distribution, and sufficient adaptability to soil, climate, etc.; second, the cultivation techniques are simple, and there should be less pests and diseases, while the cost is low; third, it should be convenient for the harvest of dodder; fourth, the host plant also has its own value of use [17]. The host plant should be chosen first in planting dodder. The following principles are often followed in selecting the host plant during production.

4.1. Cultivation of the Host Plants

Hankow willow is commonly known as willow. It is a deciduous tree of family *Salicaceae*, native to China. It is mainly distributed in northeast, northwest of China, north China, central China, Jiangsu, Anhui, Sichuan, etc. It is cultivated all over the country now [18]. The hankow willow, with well-developed roots and strong sprouting, is tolerance to drought, cold, infertility and salt. Its dense branches are resistant to pruning. The cultivation of hankow willow is simple, and it has high survival rate. It can be applied for many years after planting. The wicker can be used for making baskets or crafts. The hankow willow is mainly reproduced through cuttage.

4.1.1. Farmland Preparation and Fertilization

Sandy soil or loam which is flat, open, well-lighted, rich in water, loose and fertile, rich in humus with PH of 6.5-7.5, is chosen as the planting land. It is deeply ploughed with a rotary tiller. Combining with deep ploughing, 30000~40000 kg of farmyard manure, 200 kg of urea, 100 kg of potassium sulfate and 600 kg of calcium superphosphate per 1hm² are applied as base fertilizer. Meanwhile 200 kg of carbofuran per 1hm² is applied for killing underground insects.

4.1.2. Preparation of Cuttings

Around "spring equinox" solar term in spring, the land begins thaw. The 1 year old hankow willow branches without pests or diseases, which are straight and have full side buds, with diameter of 0.6~1.5 cm, are used as cutting seedlings. They are cut into 15~20 cm segments as cuttings. Each cutting should have 3~4 full side buds. The incisions should be flat while the surface should be intact. The upper incision is 1~1.5 cm from the upper bud, while the lower incision is at the base of the lower bud. Then the cuttings are immersed in 50% carbendazim 300 times solution or 70% mancozeb 500 times solution for sterilization for 24 hours.

4.1.3. Cuttage

The sterilized cuttings are straightly inserted into the soil in line with 20×30 plants and reinforced; 1~1.5 cm of the top part of the cuttings are exposed. When cuttage in the whole field is finished, thoroughly water the land and keep moisture.

4.1.4. Field Management

At the beginning of June, the topdressing is applied once. Generally 300 kg of urea and 450 kg of calcium superphosphate are applied per 1 hm². When the rainfall is insufficient due to summer drought, timely watering will keep the seedlings growing vigorously. Once weeds are found, they should be eradicated in time. At the same time, combined with weeding, intertillage is performed 2~3 times to loose the soil.

4.1.5. Stubble Cleaning and Land Preparation

Next year, after the "Beginning of Spring" solar term but before the land thawing, the hankow willow seedlings are cut completely against the ground (stubble cleaning), while the weeds and fallen leaves on the ground are removed. After thawing of the soil, the field between the rows is ploughed.

Appropriate amount of fertilization is applied combining with ploughing. Generally 8000~15000 kg of farmyard manure, 50~60 kg of urea, 15~20 kg of potassium sulfate, and 150~200 kg of calcium superphosphate are applied per 1hm².

4.2. Sowing

In the middle and late May, when the new seedlings of the hankow willow grow to a height of about 30 cm, the dodder is sowed along the hankow willow at the field between the rows. The sowing depth is 2~3 cm. It is preferable that the seeds cannot be seen at the surface of the ground. Flatten the ground after sowing. The seeds are used 20~25kg per 1hm².

4.3. Management

Weeds should be removed in time after sowing to prevent competition with the hankow willows for soil nutrients and moisture, and to prevent the migration of pests and diseases. When the weather is dry, watering should be properly performed to keep soil moisture. In mid-June, urea, calcium superphosphate, etc. are applied as topdressing combining with watering or in rainy days, the amount is the same as that indicated in step 4.

4.4. Harvest

The life cycle of dodder is 90-110d. It takes 20~25 d from blossom to fruit maturation. Neither the flowering period nor the maturing time of dodder is uniform, thus the harvesting of seeds can be carried out in several times. From August to September, the seeds can be harvested every 10~15d. The stem of dodder has great vitality, and the fracture of any part will not affect the growth of other parts. Therefore the stems and flowers can be harvested at any time in a densely distributed place of dodders as needed. Especially around the "White Dew" solar term, due to the lowering of the temperature, the flowers at this time are basically unable to bear the seeds, thus the stems and flowers can be collected in large quantities [19].

5. Conclusions

Dodder (*Cuscuta L.*) is an important medicinal plant as source of nectar and pollen with broad application prospects and development and utilization value, wherein its seeds have effects of reinforcing the liver and kidney, conserving essence and reducing urination, preventing miscarriage, improving eyesight, and relieving diarrhea; its stems and flowers have effects of removing facial spots and treating vitiligo; and its pollen and nectar also have effects of preserving health and caring skin besides the same effects of seeds. Compared with the traditional method of cultivating dodder with therophytes such as soybean (*Glycine max*) and flax (*Linum usitatissimum*) as the host, the method of planting dodder with hankow willow as the host can overcome the shortcomings that the host needs to be planted every year, great efforts have to be spent on weeding and disease-pest control and prevention, and the yield rate of

dodder is low. The technology of this paper has important promotion and application value.

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