Teaoil Camellia – Eastern "Olive" for the World

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Abstract

Teaoil Camellia (*Camellia oleifera* Abel.) is a promising horticultural crop that has been cultivated for various purposes in China for more than 1000 years. It is a small tree, which grows naturally from latitudes of 18° to 34° North and in acidic soils where January mean temperatures do not drop below 2°C. As cooking oil, it compares favorably with olive oil, stores well at room temperature, and has a high smoke temperature. Teaoil is also used in the manufacture of soap, margarine, hair oil, lubricants, paint, rustproof oil and other compounds with a high-molecular weight as well as in cosmetology and dermopharmacy. Extracts from the residues of teaoil processing have been used in livestock feeds, pesticides and fertilizers. The use of tea oil products in controlling rice blast and wheat rust also suggests potential for the development of new biological-based pesticides from this plant. Although edible tea oil production covers about 40,000 km^2 in China, other countries know little about this species, only planting it as an ornamental plant. To share this valued crop to the world, selecting promising clones for targeted habitats is the key to success. Cloning propagation using hypocotyl grafting is recommended. Management practices, such as preparing planting sites with organic fertilizer, controlling weeds, thinning, pruning, alternating harvest time, improving harvest techniques, etc., could significantly increase the economic return for *C. oleifera* plantations. Further studies on the genetic improvement of tea oil will improve its popularity around the world.

INTRODUCTION

Tea oil camellia (*Camellia oleifera* Abel.) is a promising crop for production in China and the rest of the world. It has been cultivated for various purposes in China for more than 1000 years (Shanan and Ying, 1982). Its seeds yield oil that serves as the main cooking oil in China's southern provinces. As cooking oil, it compares favorably with olive oil, stores well at room temperature, and has a high smoke temperature. Tea oil is also used in the manufacture of soap, margarine, hair oil, lubricants, paint, rustproof oil and other compounds with a high-molecular weight (Ruter, 2002). Camellia oil is also used in cosmetology and dermopharmacy (Sabetay, 1972), to create such diverse products as day creams, night creams, anti-wrinkle compounds, lipstick, hair creams, make-up, anti-sun preparations, rouge and make-up removers. Extracts from the residues of tea oil processing have been used in livestock feeds, pesticides and fertilizers. The use of tea oil products in controlling rice blast, sheath and culm blight of rice, wheat rust, rice hopper, cutworms, cotton aphids, scales, longhorned beetles and leeches (Shanan and Ying, 1982) also suggests potential for the development of new biological-based pesticides from this plant.

The plant is a small tree or shrub, with hirsute on young branches. Usually, it is 3-4 m tall, but can have a maximum height of up to 8 m (Chen, 2006). Leaves are simple, alternate, and leathery, with a length of 4-9 cm and a width of 2-4 cm. Sessile flowers are single, originating from leaf axils. Petals are usually white, with 5-7 petals per flower. Many stamens are arranged in 2-4 layers, fused to the based. Pistils have 3-5 divided stigma and 3-5 carpels. Fruit is capsule, with 1-20 seeds. *C. oleifera* usually blooms from November to January, but there are variants with different bloom times. It is an excellent ornamental plant with great potential for breeding new, winter-flowering cultivars.

NATURAL AND CULTIVATED TAXA

Species and Selected Cultivars

Camellia oleifera is the dominant species for tea oil production. However, several other species also produce high yield oil and have been in production for many years. They are *C. chekiangoleosa*, *C. meiocarpa*, *C. reticulata*, *C. vietnamensis*, *C. yuhsiensis* etc. Among the 238 published species of *Camellia* (Zhang, 1981), half can be cultivated for oil production. Also, natural hybridization and mutations have produced many new taxa. Teaoil camellia is quite diverse.

During its long history of cultivation, many elite teaoil cultivars have been introduced, mostly as a result of the breeding and selection work in the last 50 years. In the Hunan Province alone, 88 elite cultivars and 100 superior clones have been selected in recent years (Chen and Wang, 2001). Similar elite cultivars were also reported from the adjacent Jiangxi and Guanxi provinces. Based on the yield and quality of oil, the most popular cultivars are 'Changlin #43', 'Edong Redfruit', 'Ganyou #1', 'Ganyou #2', 'Hengdong Peach', 'Shishi Redpeel', 'Xianglin #1', 'Xianglin #210', 'XIJ2', 'XLC14', 'Yongxin Redball', 'Zhushan Redflower'.

Natural and Cultivated Distribution

C. oleifera grows naturally from latitudes of 18° to 34° North and in acidic soils where January mean temperatures do not drop below 35.6°F (Shanan and Ying, 1982). It is now cultivated at similar latitudes in 550 counties within 15 Chinese provinces on a total area of 9,884,400 acres. Among them, 150 counties have more than 16,475 acres of tea oil plantations each. The top three provinces producing teaoil are Hunan (3,953,760 acres), Jiangxi (2,471,100 acres) and Guangxi (1,072,457 acres) (Fig. 1). Jiangxi Province's tea oil production represents 80% of the province's non-agronomic/timber crop production (Wang, 2004). This acreage, yielding a total of 33,069 tons of tea oil, represents a significant percent of the total income for farmers, providing as much as 60-80% of farmers' total income in some areas. Based on the plant's cultivated habitat, He and He (2002) classified the overall production area into 32 regions and 36 districts. The plant can grow in various soil types, such as clay, loam, sand, slightly alkaline, acidic, and well-drained soils. In the US, this plant could be cultivated from USDA hardiness zones 6 to 9, which covers about half of the continental USA (Gilman and Watson, 1993).

UTILIZATION

Cooking Oil

Teaoil camellia seeds yield oil that serves as the main cooking oil in China's southern provinces. Tea oil is one of the four best edible oils produced from woody plants in the world (Chen, 2006). As cooking oil, it compares favorably with olive oil, stores well at room temperature, and has a high smoke temperature (Table 1). From our survey in China, the market price is 2-3 times higher than vegetable oil and the current production cannot match the demands of the market.

Ornamental Value

Although it is not common in ornamental gardens, *C. oleifera* is one of the most cold hardy camellia species. While regular ornamental camellias can not handle -15°C

temperatures, *C. oleifera* from Lu Shan Botanical Garden survived at -26°C in the US National Arboretum (Lee, 1998). Ackerman named this plant as a new cultivar, 'Lu Shan Snow'. Since then, 'Lu Shan Snow' was hybridized with many other popular camellia cultivars. Some cold hardy cultivars have been introduced to the nursery industry. The most common ones are 'Frost Princess', 'Polar Ice', 'Snow Flurry', 'Winter's Beauty', 'Winter Charm', 'Winter Interlude', 'Winter Rose', 'Winter Star' and 'Winter Waterlily' (Ackerman, 2002; Ackerman and Egolf, 1991, 1992; Ackerman and Williams, 1981; Dirr, 1998). These cultivars greatly extended the cultivated areas of camellias.

Gilman and Watson (1993) indicated that teaoil camellia could be planted as a container or above-ground planter, bonsai, hedge, or mass planting. The plants have a dense and compact crown and they do not need too much pruning. They are ideally suited for informal borders or natural screens. Teaoil camellia is an attractive ornamental plant. Its evergreen foliage, various flower colors (white to pink, usually blooming from October to January), overlapping flowering and fruiting features, fruit shapes and colors all provide an excellent winter display. In China, many beautiful ornamental cultivars were produced from selections and breeding of *C. oleifera* for its seed yield and oil quality. Senior authors have visited several seed and scion orchards in the Hunan and Jiangxi provinces and were impressed by the diversity of teaoil plants and their potential for ornamental selections. Further work will focus on selecting existed cultivars with great ornamental market value.

Currently, teaoil has been widely used for cooking oil and ornamental production. As mentioned previously, it can also be used for cosmetics, medicines, and many other applications. Further research on these applications need to be addressed.

PRODUCTION

Propagation and Seedling Growth

Seed germination rate varies between cultivars. Field observations of more than 40 clones at Tijiling Nursery in Changsha, Hunan, China have indicated 10 to 90% germination rates (data not presented) in 2005. Ruter (2002) reported that seedling grew better under 30% shade cloth in Georgia (USA). Full sun light produced shorter plants, but did not have a significant effect on the photosynthesis rate of the plants.

For clonal production, these cultivars can be propagated from cuttings (Ackerman, 2002). Studies on cutting propagation have focused on the hormonal responses and the season to collect cuttings. These plants can also be budded or grafted to other cultivars or common seedlings in the early spring. In our production, hypocotyl grafting has been employed.

Hypocotyl grafting describes the graft of a mature hardwood scion (one-year-old node with a leaf) to a just-differentiated tender young stock (underground hypocotyl). The procedure is described in the following:

1. Seed Germination (as Rootstocks). Seeds were collected from October to December, and then stored in moist sand over winter with a mean temperature of around 50°C. In late March or April (the mean temperature usually is higher than 150°C), seeds germinate in the sand. Before hypocotyl reaches the sand surface (about 5-7 cm in length), the whole plant is removed from the sand bed.

2. Preparation of Rootstock. Both hypocotyl and radicle are trimmed to 4-7 cm in length, the hypocotyl is split for grafting.

3. Preparation of Scion. One year old branches are collected from mature plants (usually 3-6 years old). Both sides of the stems are cut and a one-node scion is made with an attached leaf.

4. Grafting. Gently insert the scion into the split rootstock.

5. Grafting Wrap. Heavy aluminum foil strips (2-3 cm long and 0.3-0.6 cm wide) are gently wrapped around the grafted unions.

6. Transplanting. Grafted seedlings are immediately transplanted into raised field beds, and then covered with plastic tunnels. The plastic tunnels should then be covered with shade cloth (30-60%) about one meter above the tunnel.

Hypocotyl grafting is a popular clonal propagation technique for teaoil camellia in China. The grafted unions completely join within 40 d. The survival rates are generally more than 95%.

In addition, grafting superior clones on low-production seedlings has resulted in reduced incidence of anthracnose, a serious fruit disease (Niankang, 1996). Obviously, improved cultivars/clones, appropriate propagation methods and good cultural practices are important factors in increasing the economic return for *C. oleifera* plantations.

Management Practice

Teaoil is widely cultivated in Jiangxi Province (China). Under conventional cultivation techniques, the average oil yield of teaoil camellia was only 30 to 45 kg/ha. Under modern management and practical techniques, such as re-preparing cultivation sites with organic fertilizer, weed control, thinning, pruning, alternated harvest time, improved harvest techniques, using elite clones, etc., the average yield has reached 712.5 kg/ha. The highest yield, 750 kg/ha, was harvested after eight years of utilizing the new management practices (Yu, 2005). Chen et al. (2000) reported that photosynthesis rates of teaoil camellia have increased two fold on a weeded and properly fertigated plantation, which led to three times more biomass than in the control. Teaoil camellia is not a low-yield and low valued crop and the average yield has the potential to improve 6-7 times per hectare with selected clones and proper management. Both management practices and clone selection are key components in reaching this level of production.

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Tables

Table 1. Property of olive oil and teaoil camellia (compiled from McLaughlin, 2002; Zhang and Wang, 2004).

Property	Olive oil	Tea oil
Specific gravity (15°C)	0.914-0.919	0.913-0.918
Dioptre ND25	1.466-1.468	1.466-1.470
Iodine no.	80-88	80-90
Saponification value	188-196	188-196
Smoking temperature	210°C (410°F)	252°C (485°F)
Fatty acid (%)		
C 16:0	7-17	6.1-15
C 16:1	0.5-1.1	-
C 18:0	1.5-4	1.4-3.8
C 18:1	63-83	74-84
C 18:2	7.2-13.5	5.3-14.3
C 18:3	0.9	0.6

Figures

Fig. 1. Distribution of cultivated *Camellia oleifera* in China (adapted from He and He, 2002).