

Tea Oil Camellia: A New Edible Oil Crop for the United States[®]

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INTRODUCTION

Camellia oleifera has been cultivated in China as a source of edible oil, but there is no documentation that the crop has ever been grown for edible purposes in the United States. This species has been used as a parent of hardy ornamental camellia hybrids in the USA since at least the late 1970s; the U.S. National Arboretum having released more than a dozen such cultivars (Ackerman, 2007). However, these cultivars are grown and used only as ornamental landscape plants. Traditional row crop agriculture is in need of new crops for the southeastern U.S.A. In 1999, I initiated a research program to evaluate *C. oleifera* as a commercial oil seed crop for the southeast (Ruter, 2002).

Considerable research is being conducted to develop agricultural crops with high levels of oleic acid due to oleic acid's ability to help reduce low density lipoproteins (LDL, or "bad cholesterol"). The percentage of oleic acid in *C. oleifera* oil typically ranges from 75 to 85% (Shanan and Ying, 1982; Xia et al., 1993). In China, tea oil is known as "eastern olive oil" (Zhang et al., 2008). Olive oil, which also contains a large percentage of oleic acid, has been reported to reduce the risk of cancer (Anonymous, 2005a) and the U.S. Food and Drug Administration have approved the health claim for olive oil to fight heart disease (Anonymous, 2005b). One study reported that the oleic acid content of olive oil was 81.6%, while that of tea oil was 85.3% (Weng, 2003). Gao (1993) reported that tea oil can reduce serum triglycerides and increase high-density lipoproteins (good cholesterol) in humans. Recent research at Clemson University (Chen, 2007) has shown that camellia oil and camellia oil meal had different levels of antiproliferative activities against three lines of cancer cells (human uterus, human breast cancer, and human colon cancer). Antiproliferative and antioxidative bioactivities of the meal have been attributed to kaemperol, kaemperol glycosidic flavinoids, saponins, and five-ring tripterpenes. Squalene, a triterpenic hydrocarbon, is found in olive oil and camellia oil (Li et al., 2006) and is known to have antitumor and anticarcinoma activities. Camellia oil and its meal are known to have antioxidant, antimicrobial, and other bioactivities.

In addition to oleic acid, tea oil contains several other fatty acids, including stearic, palmitic, linoleic and linolenic acids (Xia et al., 1993; Zhang et al., 2008). Tea oil also contains several trace elements as well as Vitamin E and selenium. Camellia oil was found to have better stability against oxidation compared to olive and corn oils, while having suitable nutritional values (Chen, 2007). In addition, the smoke point for tea oil [252 °C (485 °F)], is reported to be higher than that of extra-virgin olive oil [161 °C (322 °F)], which makes it better for cooking over high heat (Anonymous, 2007).

Tea oil is a good raw material for industrial uses and is used to manufacture soap, margarine, hair oil, lubricants, paint, synthesis of other high-molecular weight

compounds, and rust-proof oil. Camellia oil has been proven to have its place in all emulsions used in the cosmetology and dermatopharmacy fields (Sabetay, 1972). Uses include day or night creams, anti-wrinkle compounds, lipstick, hair creams, make-up, anti-sun preparations, rouge, and make-up remover products. Extraction of the fruit hulls also yields useful compounds such as saponins, tannin, and pentosan. Saponin is used as an emulsifying agent in pesticides, for foam-forming fire extinguishers, and in detergents (Shanan and Ying, 1982). Extracts from the residue of tea oil processing have also been used to feed livestock and are used to formulate pesticides, feeds, and fertilizers. The triterpenoid saponin from camellia has been shown to improve immune function, enhance antibacterial and antiviral activities, and to have antimutagen and antioxidant properties in humans and animals (Zhan, 1999).

Tea oil residues have been used for effective control of the following pests: rice blast, sheath and culm blight of rice, wheat rust, rice hopper, cutworms, cotton aphids, scale insects, long-horned beetles, and leeches (Shanan and Ying, 1982). Extracts of the seed cake left over after processing are known to deter larval development in insects (Duke and Ayensu, 1985). The possibility of developing new biologically based pesticides exists for this product. Tea oil camellia appears to have few pests and may be suitable for organic production as well.

In China, tea oil camellia occurs from 18° to 34° North latitude and grows on acidic soils where mean January temperatures do not drop below 2 °C (Shanan and Ying, 1982). Extensive provenance trials were conducted in China in the 1960s and 1970s (Fang, 1994). Elite plants were selected numerous local cultivar trials were installed. Families were selected for superior fruit production and selections were made for different parts of China. Superior clones in regional tests increased oil production 3 to 5 times compared to local seedling stands (Zhuang et al., 1992). Tea oil camellia should be well adapted to the lower Piedmont and Coastal Plain regions of the southeastern United States.

PROPAGATION BY SEED

Little information exists regarding the requirements for germination of tea-oil seed. One study suggests that seed should be stored at a low temperature (0.0 to 2.0 °C) for 15 to 30 days (Han, 1984). Germination was accelerated by keeping the seeds between 20 to 25 °C. Plants were suitable for transplanting 25 to 35 days after sowing. Bill Ackerman suggests that tea-oil camellias need a minimum of 5-weeks cold, moist stratification to ensure decent germination (pers. commun.). For camellias in general, Tourje (1958) suggests that germination occurs within 10 to 30 days with an ideal temperature of 18.3 to 21.1 °C. Nonstratified seed of *C. oleifera* germinates slowly over a longer period compared to stratified seed (J. Ruter, pers. observation).

Seed from open-pollinated *Camellia oleifera* 'Lu Shan Snow' were collected, sorted, and placed in zip-lock plastic bags with moist pine bark for cold stratification periods of 15, 30, 45, and 60 days at 4.4 °C. Only seeds that sank during a float test were used. After the stratification period was complete, seed were planted in 60 cell trays (cell size of 4.5 cm wide by 10.0 cm deep) with a substrate of pine bark and sand (8 : 1, v/v). Seeds were covered to a depth of ~1.0 cm. Trays were randomly placed in a growth chamber with set temperatures (12 h) of 24 °C day and 18 °C night. Light intensity measured at the top of the germination trays was ~900 $\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$ during the 12-h-day period. Germination was recorded daily

for 60 days as the visual emergence of the shoot from the substrate (Capon, 1990). Treatments consisted of four stratification periods with six replications consisting of 10 seeds per replication, for a total of 60 seeds per treatment. Replications were randomly assigned within germination trays. Data was analyzed using the nonlinear regression function of SigmaPlot.

Days to germination decreased curvilinearly as cold stratification period increased from 15 to 60 days [(days to germination = $60.1 - 0.89$ (days of cold stratification) + 0.0084 (days of cold stratification)²), $r^2 = 0.99$]. Seed stratified for 15 days germinated in 49 days compared to 31 days for seed receiving 45 and 60 days of cold stratification. Seed germination exceeded 96% for all four treatments.

Seed from *C. oleifera* 'Lu Shan Snow' germinated in high percentages in this study. Cold stratification for 45 to 60 days appears ideal for this species. Differences in days to germination compared with other studies may have been due to different methods (Han, 1984; Tourje, 1958) or determining that germination had occurred when radicle extension was visible versus visible shoot growth. For general production of seedlings, we have found that Beaver Styroblocks (Model 45/340, Stuewe & Sons, Tangent, Oregon) which have 45 cells each with a depth of 15.2 cm work very well, especially when treated with SpinOut®.

PROPAGATION BY CUTTINGS

One- to two-node cuttings from 28 elite selections were stuck by a commercial propagator (Innova Farms, Boston, Georgia) in July of 2010. A minimum of 38 cuttings per selection were used and each cutting was treated with a $3500 \text{ mg} \cdot \text{L}^{-1}$ quick-dip of Dip'N Grow® rooting hormone. The propagation substrate consisted of aged pine bark, perlite, and peat moss (7 : 2 : 1, by vol) amended with $3.6 \text{ kg} \cdot \text{m}^{-3}$ of Osmocote Plus 15-9-12 propagation blend. Plants were misted as needed and mist frequency was reduced when good callus formation was noted. When plants were shifted up in March of 2011, percentage rooting per selection ranged from 74% to 100% for an overall average of 93%. Shading (30% to 55%) and a low rate of controlled-release fertilizer appear to be the best treatments for growing off rooted cuttings in #1 containers in south Georgia. In a recent study using low plastic tunnels without mist, the highest rooting rate was 55% for a single clone (Zhang et al., 2009). In China, commercial rooting rates of 90% have been achieved using hormones at $3,000 \text{ mg} \cdot \text{L}^{-1}$. Hypocotyl grafting is becoming an increasingly popular method of clonal reproduction in China with success rates often reaching 95% (Zhang et al., 2008).

CONTAINER PRODUCTION

In south Georgia, seedlings shifted to #1 containers (3.8 L) grew best when grown under 30% shade cloth, but good survival was possible with plants grown in full sun or under 55% shade. Chlorophyll fluorescence data indicated that plants grown in full sun during the summer were not physiologically damaged by high light conditions (Ruter, 2002). For plants grown in full sun, growth rate increased as fertilizer rate increased from 0.9 kg N/m^3 to 1.5 kg N/m^3 . Plants treated with 8 month Osmocote grew better than plants treated with Multicote (Ruter, unpublished data). In another study using 12 month Polyon 17-5-11 controlled release fertilizer, 90% of maximal growth was achieved with 19 g of fertilizer per pot, while maximum growth occurred between 24 g to 30 g per #1 (3.8 L) container (Ruter, unpublished

data). Further studies in Georgia have shown that the addition of lime and micronutrients have little influence on plant growth if a controlled-release fertilizer with micronutrients is used.

FIELD PLOTS IN GEORGIA

Field trials were initiated in 2003–2005 at The University of Georgia Tifton Campus and at Jackson Farms Greenery in Wrightsville, Georgia. Approximately 1,200 seedlings from five different species were planted from #1 (2.8 L) containers using a field spacing of 1.8 m within the row and 3.7 m between rows. Plants in Tifton are irrigated as needed using drip irrigation. After 4 years of harvest in Tifton and 3 in Wrightsville, results indicate that selections are possible which annually produce >3.0 kg fresh weight of fruit per plant. Future plans include clonal selection and evaluation, economic and market analysis, harvesting and processing research, and studies on oil quality, biodiesel production, pharmaceutical, medical, and nutritional uses for this crop.

LITERATURE CITED

- Ackerman, W.L.** 2007. Beyond the camellia belt: Breeding, propagating, and growing cold-hardy camellias. Ball Publishing, Chicago.
- Anonymous.** 2005a. Olive oil “cuts cancer risk” <<http://newsvote.bbc.co.uk/mpapps/pagetools/print/news.bbc.co.uk/2/hi/health/4154269.stm>>.
- Anonymous.** 2005b. Olive oil cleared for heart-healthy claim. <<http://my.webmd.com/content/article/96/103722.htm>>.
- Anonymous.** 2007. Why tea seed oil? <<http://www.emerald-harvest.com/tea-seed/why-tea-seed-oil.htm>>.
- Capon, B.** 1990. Botany for gardeners: An introduction and guide. Timber Press, Portland, Oregon.
- Chen, Y.H.** 2007. Physicochemical properties and bioactivities of tea seed (*Camellia oleifera*) oil. M.S. Thesis. Clemson University, Clemson, South Carolina.
- Duke, J.A., and E.S. Ayensu.** 1985. Medicinal plants of China. Reference Publications, Algonac, Michigan.
- Fang, J.** 1994. Advances in science and technology on tea oil tree and tung oil tree in China. *Forest Sci.* 7:30–38.
- Gao, J.** 1993. The importance of camellias as oil plants in China. *Intl. Camellia J.* 25:53–54.
- Han, N.L.** 1984. Studies in the technique of low temperature storage of seed of *Camellia oleifera*. *Forest Sci.* 12:7–9 (in Chinese).
- Li., D.M., J. Wang, L.W. Bi, and Z.D. Zhao.** 2006. Influence of extraction method on content of bioactive component Squalene in seed oil of *Camellia oleifera* Abel. *Shengwuzhi Huaxue Gongcheng* 40(1):9–12.
- Ruter, J.M.** 2002. Nursery production of tea oil camellia under different light levels, pp. 222–224. In: J. Janick and A. Whipkey (eds.). Trends in new crops and new uses. Amer. Soc. Hort. Soc. Press, Alexandria, Virginia.
- Sabetay, S.** 1972. Camellia seed oil: The seed oil of *Camellia japonica* L. and its uses in cosmetology and dermo-pharmacy. *Soap Perfumery Cosmetics* 45:244, 252.
- Shanan, H., and G. Ying.** 1982. The comprehensive utilization of camellia fruits. *Amer. Camellia Yearb.* 37:104–107.
- Tourje, E.C.** 1958. Camellia seedling culture, pp. 163–170. In: E.C. Tourje. *Camellia Culture*. The Macmillan Company, New York.
- Weng, Y.** 2003. A Chinese story of endangered species *Camellia grijsii*. *Intl. Camellia Cong.* 66–72.
- Xia, L., A. Zhang, and T. Xiao.** 1993. An introduction to the utilization of camellia oil in China. *Amer. Camellia Yearbook* 48:12–15.
- Zhan, Y.** 1999. Animal feed compositions and uses of triterpenoid saponin obtained from *Camellia* L. plants. United States Patent #6,007,822.

- Zhang, B., Z. Li, F. Geng, and D. Zhang.** 2009. Rooting of *Camellia oleifera* Abel cuttings under low plastic tunnels. HortScience 44(3):551.
- Zhang, D., L. Stack, Y. Chen, R. Zhang, J. Yu, B. Xie, and J.M. Ruter.** 2008. Tea oil camellia — eastern “Olive” for the world. Acta Hort. 769:43–48.
- Zhuang, R., A. Huang, R. Dong, D. Wang, Y. Chen, X. Cai, M. Su, X. Deng, and Y. Kuang.** 1992. Studies on the breeding of 19 new tea-oil varieties with high yield. Forest Research 5:619–627. (In Chinese)