The *Cinnamomum* Species in China:
Resources for the Present and Future

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The *Cinnamomum* genus is widely distributed throughout the tropical and subtropical zones of Asia. Of the more than 250 species known,[1] 41 can be found in China mainly throughout the Yangtze River basin in the southeastern and southern provinces. The distribution of *Cinnamomum* species in China can be seen in Figure 1.

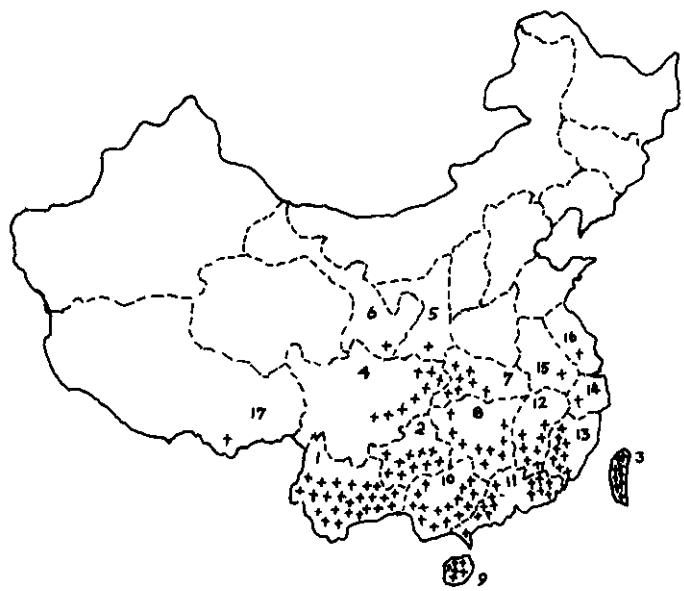

Figure 1. Map of China showing provincial borders. + Refers to the distribution of *Cinnamomum* species in the various provinces.

1. Yunnan, 2. Guizhou, 3. Taiwan, 4. Sichuan, 5. Shanxi, 6. Gansu, 7. Hubei, 8. Hunan, 9. Hainan, 10. Guangxi, 11. Guangdong, 12. Jiangxi, 13. Fujian, 14. Zhejiang, 15. Anhui, 16. Jiangsu and 17. Xizang

Although the seeds of *Cinnamomum* species are rich in fats and oils that are used as sources of C-10 and C-12 fatty acids,[2] it is the essential oils of this genus that are of interest to perfumers and flavorists. Many *Cinnamomum* oils of Chinese origin are of great importance. For example, oils such as cassia, sassafras and camphor earn foreign exchange as do a number of natural isolates such as D-borneol, D-camphor, L- and D-linalool etc., which are available from various organs of different *Cinnamomum* species. The species that have achieved economic importance and those with potential will be discussed separately.

Cinnamomum camphora L.

The utilization of this species has a long history in China because the roots of this and other species have been water distilled to produce camphor for more than a century.[3] Although in the 1920s natural camphor was mass produced from *C. camphora* in Taiwan by the Japanese, between 1930-1960 camphor production was developed in Guangdong, Guangxi, Jiangxi and Fujian provinces. Today, the so-called true camphor oil is produced by steam distillation of the wood and branches of *C. camphora* in the above noted provinces.

The crude oil is first filtered to remove camphor crystals, after which it is fractionally distilled into three fractions:

1. ***Light fraction,*** the so-called white camphor oil, S.G.(20 C):0.860-0.880.

2a. ***Medium fraction,*** the so-called brown camphor oil,

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S.G. (20 C):1.070, a fraction containing up to 80% safrole.

2b. ***Medium fraction,*** the so-called yellow camphor oil which is left behind after the safrole has been removed, S.G.(20 C):0.960-0.980.

3. ***Heavy fraction,*** the so-called blue camphor oil which is very rich in sesquiterpenes.[4]

The estimated annual production of camphor oil in China is 500 tons.

A farm of *Cinnamomum camphora* (D-borneol type) in Gian, Guangxi Province.

Cinnamomum cassia Blume

Cassia oil, which is a highly valued ingredient of the cola-type beverages, is produced by steam distillation of the leaves and branches of *C. cassia*. Although the oil content of the leaf is 1.0-1.6%, the normal yield from a rural distillation is only about 0.5-0.6%. This reduced yield is a direct result of the distillation charge and the water solubility of cinnamic aldehyde (the major constituent). Refined cassia oil is a yellowish liquid which contains more than 85% cinnamic aldehyde. In Guangxi, there are five large factories producing this oil with an annual production of ca. 150 tons. The annual production in Guangdong, the other major producing province, is ca. 100 tons. The estimated annual production for the whole of China is ca. 275 tons.

A farm of *Cinnamomum parthenoxylon* (D-linalool type) in Zijing County, Guangdong Province.

Sassafras oil

The sassafras oil of commerce, which originates in China, is obtained partly from the so-called brown camphor oil (*C. camphora*) produced in Hunan, Guangxi and Guangdong, while the majority of it is obtained from *C. porrectum* (Roxb.) Kosterm. and *C. rigidissimum* H.T. Chang.[5] In 1980, the leaf oil of *C. paucifolium* Nees, which is widely distributed in Sichuan, was found to be a rich source of safrole.[6] The leaf oil of the wide-leafed form contains 68-79% safrole, while an oil of the narrow-leafed form contains 90% safrole. As a result, cultivation has already begun with the premise that commercial quantities of oil should be available in 3-4 years. Recently, Cheng et al.[7] found a new chemotype of *C. burmannii* (C.G. & Th. Nees) Blume f. *heyneanum* (Nees) H. W. Li that is rich in safrole. An oil produced in 0.54-0.85% yield from the leaves/branches of this shrub, which is widely distributed throughout southern Yunnan, contains a very high proportion of safrole (97-99%). This content is greater than that found in the oil of *Ocotea pretiosa* (Nees) Mez. Fortunately, the oil composition of *C. burmannii* f. *heyneanum* is very stable so that the shrub can be reproduced by seedlings rather than only by clonal methods. As this is a fast growing species, the shrub can be harvested for oil production 3-4 years after planting. The commercial potential of *C. burmannii* f. *heyne-anum* is currently under evaluation.

The total production of sassafras oil is estimated to be 1,000 tons annually, of which 50% is used to produce heliotropin in China.

Ho or Shiu oil

Ho or Shiu oil is generally a mixture of oils obtained by steam distillation of *C. camphora* L. var. *linaloolifera* Fujita and *C. camphora* L. The oil, which possesses a characteristic floral odor, contains L-linalool(50-75%) as the major component and smaller amounts of 1,8-cineole, α- and β-pinene, camphene and myrcene.[8] Rectification of this oil yields an ideal source of high grade natural L-linalool that can favorably compete with Brazilian bois-de-rose (rosewood) oil. In addition to being accepted internationally as a source of L-linalool, it has been used directly as an ingredient for fine fragrance production by Chinese perfumers.

Ho or Shiu oil is also obtained from the leaves and branches of the same species by water distillation; however, when the oil is produced this way, it takes on a sweet camphoraceous odor. The major components of this oil are camphor (42%), linalool (15%), 1,8-cineole (7%) and safrole (5%). Smaller amounts of eugenol, limonene, camphene, α-terpineol and α- and β-pinene are also found in this oil.[9] The annual production of Ho or Shiu oil in China is about 800 tons.

As the direct result of previously not having clear plans

or a formalized lumbering policy for many years in China, no replanting of harvested trees has occurred. The consequence of this lack of policy is that the widespread availability of *Cinnamomum* species has dwindled drastically. Now areas that were once densely covered with *Cinnamomum* are almost devoid of them, with only residual growth of species in the more inaccessible areas. Recently, it was realized that if the old policy of clear cutting with no replanting continued, the valuable resource of *Cinnamomum* species would be exhausted.

Since the early 1970s, more attention has been paid to the method of harvesting this valuable resource, so that rather than utilizing roots and trunks of the *Cinnamomum* species for distillation, the use of leaves and branches as the raw material to produce the oils of commerce has become the accepted practice. It is of interest to note that the oils produced from the leaves and branches always seem to have the same or more valuable components than those found in the root or trunk oil, such as D-camphor, L-linalool, geraniol, citral, etc. However, the oils produced from the leaves and branches possess different quantitative compositions to those produced from the roots and trunk.

Now, it is well known that *Cinnamomum* species possess oils that are either rich in a single component or can be found existing in various chemotypic forms. A summary of the information that has been published in China on these various *Cinnamomum* species can be seen as follows:

- The leaf oils of *C. burmannii*(C.G. and Th. Nees) Blume, which was originally discovered in Guangdong province, has been found to exist in four chemotypic forms: (1) p-cymene-type,[10] (2) 1,8-cineole-type,[10,11] (3) D-camphor-type[10] and (4) D-borneol-type.[10,12]
- The leaf oils of *C. porrectum* (Roxb.) Kosterm., which is native to Guangdong province, are known to exist in five chemotypic forms: (1) 1,8-cineole-type,[13,14] (2) D-linalool-type,[13,15] (3) citral-type,[14] (4) D-camphor-type[15] and (5)the safrole-type, from which commercial sassafras oil is obtained.[15]
- Oils produced from the leaves and branches of *C. camphora* L., a species found widely distributed in Gian county, Jiangxi province, can be found to exist in five chemotypic forms:(1) L-linalool-type,[4,15-17] (2) 1,8-cineole-type,[4,15,17] (3) D-camphor-type,[17] (4) nerolidol-type[15,17] and (5) borneol-type.[24]
- Leaf oils of *C. tenuipilum* Kosterm., a species found in Yunnan, has been shown to exist in four chemotypic forms: (1) farnesol-type, (2) geraniol-type, (3) linalool-type and (4) methyl eugenol-type.[19-21]
- The leaf and branch oil obtained from *C. bodinieri* Levl. var. *hupehanum* (Gamble) G.F. Tao trees harvested in Hubei province were found by Tao et al.[16] to contain D-camphor (88%).
- The leaf and branch oils of *C. longepaniculatum* (Gamble) N. Chao ex H.W. Li are found to exist in the following chemotypic forms: (1) D-camphor-type,[23] (2) 1, 8-cineole-type,[15,22,23] (3) methyl eugenol-type,[23] (4) linalool-type,[23] (5) D-borneol-type[23] and (6) an unidentified sesquiterpene-type.[23]
- Seven chemotypes of the leaf oils of *C. parthenoxylon* (Jack) Nees are known to exist: (1) 1,8-cineole-type,[4,24] (2) D-camphor-type,[4,24] (3) farnesene (50%) and nerolidol/9-oxonerolidol-type,[4,24] (4) D-linalool-type,[4,16,24] (5) citral-type,[4,24] (6) monoterpene-type, α-pinene (22.4%) and terpinen-4-ol (21.2%)[4,24] and (7) methyl eugenol-type.[4,24]
- The leaf oil of *C. subavenium* Miq. has been reported to contain safrole (69.7%) and eugenol (4.3%), which could make it a potentially new source of safrole.[4]
- The leaf oils of *C. wilsonii* Gamble, a species native to Hubei province, can be found to exist in three chemotypic forms: (1) citral (78-86%),[25] (2) 1,8-cineole (65%)[25] and (3) borneol/bornyl acetate.[4]
- Three chemotypes of *C. charthyllum* H.W. Li, a species found in southern Yunnan, are known to exist: (1) L-linalool (97%),[25] (2) geraniol (50%)[25] and (3) citral (60%).[25]
- *C. platyphyllum* (Diels) Allen, which can be found in both Sichuan and Hubei provinces, has been reported

to exist in two chemotypic forms: (1) D-camphor (28%)[26] and (2) (E)-methyl isoeugenol (94%).[26]

- The leaf oils of *C. septentrionale* Hand.-Mazz., a species endemic to Hubei, were found to be rich in (1) (E)-methyl isoeugenol (85.7%),[4,27] (2) safrole (95%)[15] and (3) D-camphor (37%).[15]
- The leaf oil of *C. paucifolium* Nees was reported by Lin et al.[15,28] to be rich in safrole (96%).
- The leaf oil of *C. petrophilum* N. Chao was reported by Zhou[29] to be rich in safrole (ca. 90%).
- Two chemotypes of *C. zeylanicum (syn. C. verum* Presl.) leaf oil have been characterized by Cheng and Yu,[30] the (1) eugenol-type and (2) benzyl benzoate-type.
- The leaf and branch oil of *C. appelianum* Schewe has been found rich in 1,8-cineole.[4]

As mentioned earlier, the utilization of leaves and branches (renewable resources) to produce oils from various *Cinnamomum* species has helped immensely in protecting our valuable resources. In China, many scientists are engaged in research studies on the botanical, genetical, ecological, agronomical, biochemical and chemical aspects of this important plant family. In particular, the scientists at the South China Institute of Botany, the Kunming Institute of Botany and the Academica Sinica have made remarkable contributions to our knowledge base on *Cinnamomum* species oils as well as to our essential industry.

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