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## New Resources of Essential Oils in China

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China's enormous land area extends over a great variety of land types which includes tropical, subtropical and temperate zones. Favorable conditions, therefore, exist for the growth of a wide range of aromatic plants. There are more than 600 species of the aromatic plants found, which belong to 77 plant families and 192 genera.

The domestic essential oils and perfumery industry has expanded immensely during the past 30-40 years, so that about 100 different kinds of essential oils are now being produced, and many of them exported, e.g., cassia oil, cedarwood oil, star anise oil, peppermint oil, eucalyptus oil, turpentine oil, litsea cubeba oil, saffras oil, etc.

I recently found aromatic plant, *Micrometum integerrimum*, which belongs to Rutacea family which grows in the Southern part of Yunnan Province. The essential oil is obtained by steam distillation of flowers and fruits with 0.11-0.20% yield. The main components in the fresh flower oil are:  $\gamma$ -muurolene (53.54%),  $\gamma$ -elemene (10.61%),  $\beta$ -elemene (9.55%) and benzyl salicylate (5.04%). The fruit oil contains: decanal (47.51%), lauric aldehyde (35.94%),  $\gamma$ -muurolene (6.41%), decanol (1.95%),  $\gamma$ -elemene (1.30%),  $\beta$ -elemene (0.70%) and  $\delta$ -cadinene (0.27%).<sup>1</sup>

Most plants of the *Cinnamomum* family are rich in essential oils. *Cinnamomum burmannii* Blume f. *heyneanum* (Nees) H.W.Li was found in the Southern part of Yunnan. By steam distillation of the leaves and stems, oil is obtained (0.60-0.90% yield) which is rich in safrole (99%).<sup>2</sup> There are three different chemotypes of *Cinnamomum burmannii* found in Eastern Guangdong Province.<sup>5,7</sup>

*Cinnamomum rigidissimum* H.T.Chang grown in Sichuan

Province. The essential oil of wood contains 60% of safrole and 28% of methyl eugenol.<sup>3</sup>

*Cinnamomum longepaniculatum* (Gamble) N Chao et H.W.Li grows wild in the Southwestern part of China. The oil from leaves and stems contains 57% of 1,8-cineole.<sup>4</sup>

Another species of *Cinnamomum*, *C. appelianum* Schewe grows in the same region. The oil from this species contains 37% of 1,8-cineole and 16% of bornyl acetate.<sup>5</sup>

The trees of *Cinnamomum bodinieri* Levl. var. *hupehanum* (Gamble) G.F.Tao grows in Hubei Province. The oil from leaves and stems contains 88% d-camphor.<sup>6</sup>

On examination of the oil composition of wild populations of *Cinnamomum parthenoxylon* (Jack) Nees., four different chemotypes were revealed: chemotype 1, 62% 1,8-cineole; chemotype 2, 80% d-camphor; chemotype 3, more than 50% farnesene + nerolidol; and chemotype 4, 70% citral.<sup>8</sup>

The perennial and woody member of the *Cinnamomum* family occurs throughout the forest of Yunnan, Xishuangbanna. The main constituent of *Cinnamomum camphora* oil from leaf and stem is d-camphor which is a valuable source of this compound.

The analysis of the leaf oil composition of wild populations of *Cinnamomum Camphora* (L.) Presl. revealed the existence of different chemotypes. Oils which are rich in l-linalool (90%); borneol (81%); 1,8-cineole (50%); d-camphor (83%) and nerolidol (57%).<sup>9,10</sup> *Cinnamomum tenuipilis* Kosterm. is found throughout Southern Yunnan. Oil from the stems and leaves is rich in l-linalool (97%), geraniol and citral.<sup>10</sup>

Two different chemotypes of *Cinnamomum wilsonii* were found in the Western part of Hubei Province. The oils were rich in citral (78-86%) or 1,8-cineole (65%).<sup>11</sup>

On examination of the stem and leaf oil of *Cinnamomum platyphyllum* (Diels) Allen in Sichuan and Hubei Provinces, two chemotypes were found: d-camphor (28%) and (E)-methyl eugenol (94%).<sup>12</sup>

*Cinnamomum charthylum* H.W.Li is found throughout Southern Yunnan. Three chemotypes were found in oil: (1) 97% l-linalool; (2) more than 50% geraniol, and (3) more than 60% citral.<sup>11</sup>

Besides *Eucalyptus citriodora* Hook., *Eucalyptus globulus* Labill. is widely distributed in central and the northwestern part of Yunnan. The main composition of the leaf oil is 1,8-cineole (60-70%). It is the so-called "natural eucalyptus oil in Yunnan." At present the annual output of the oil is about 500 tons and can easily be increased to 2,000 tons if necessary.<sup>12</sup>

China is rich in resources of turpentine oil. Currently, the annual production of turpentine oil is about 20,000 tons. Most of the oil contains mainly the  $\alpha$ -pinene. Few years ago, some *Pinus* species, i.e., *Pinus yunnanensis* Franch. and *Pinus kesiya* Royle ex. Gord var. *longbianensis* (A.Chew) Gaussen has been found in South Yunnan. Besides  $\alpha$ -pinene (60-80%), there is 20-42% of  $\beta$ -pinene in the turpentine oil. Now, part of  $\beta$ -pinene can be isolated from the oil by rectification to

be used for further processing. The total of up to 700 tons of  $\beta$ -pinene can be isolated annually.<sup>12</sup>

*Clausena dunniana* Levl. belongs to Rutaceae family and *Acorus illicioides* F.N.Wei et Y.K.Lee belongs to the Araceae family. It is surprising that the main composition of the leaf oil of both species is estragole (93% and 74%). Estragole can be easily converted to anethole by alkaline or catalytic isomerization. Therefore, this could be another way to obtain anethol besides its isolation from anise oil.<sup>13,14</sup>

*Elsholtzia ciliata* (Thunb.) Hyland belongs to the Labiatae family. The composition of oil from different regions in China is quite different. The oil from Haizhou region contains thymol (30%) and carvacrol (33%); the oil from Mont Qinba, Shanxi Province contains limonene (31%), linalool (8%) and thymol (9%).<sup>6,15</sup>

A Chinese citrus fruit, *Citrus grandis* Osbeck was planted in Guangxi. The composition of the peel oil was investigated: d-limonene (95%), and a small amount of farnesyl acetate and nootkatone. The oil from *Citrus grandis* flowers contains linalool (71%) and rosefuran (5%).<sup>6</sup>

The peel oil of *Zanthoxylum avicennae* (Lam.) DC contains mainly sylvestrene (50%). The other components are: linalool (2%),  $\alpha$ - and  $\beta$ -pinene (6%) and octanal (8%).<sup>1</sup> The

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peel oil of *Zanthoxylum rhesoides* Drade contains  $\beta$ -terpinene (29%),  $\beta$ -phellandrene (10%), linalool (11%) and myrcene (10%). The trees of the *Zanthoxylum* genus are widely distributed in Guangdong Province.<sup>6</sup>

The main composition of leaf oil of *Acronychia pedunculata* (L.) Miq. in Guangdong is  $\beta$ -thujene.<sup>6</sup>

Trees and shrubs of the *Murraya* genus grow in the southern provinces of China. Eight chemotypes of essential oils have been examined. The oil of *Murraya alata* Drake mainly contains  $\alpha$ -gurjunene (29%),  $\beta$ -caryophyllene (7%) and 1,8-cineole (6%). Oil from *Murraya koenigii* (L.) Sprng. contains  $\alpha$ -pinene (38%) and (E)-caryophyllene (12%). The oil from *Murraya kwangsiensis* (Huang) Huang mainly contains citral (24%), geranyl acetate (26%) and geraniol (8%). The main constituents of *Murraya paniculata* (L.) Jack are  $\gamma$ -elemene (31%), nerolidol (12%) and  $\beta$ -caryophyllene (11%). Oil from *Murraya exotica* L. contains  $\beta$ -caryophyllene (50%),  $\alpha$ -humulene (7%) and  $\gamma$ -cedrene (5%). *Murraya tetramera* oil contains citral (20%) and limonene (51%).<sup>6</sup>

The chemical constituents of *Litsea Cubeba* oil from different regions in China has been studied (see Table I).<sup>17</sup> This oil is rich in citral (60-80%). The trees are widely distributed in the southern part of Yangtze River. The annual production of *Litsea Cubeba* oil is about 2,000 tons.<sup>12</sup>

*Mosla scabra* (Thunb.) C.Y.Wu is widely distributed in the Mont Qinba region. Its leaf oil contains 1,8-cineole (18%), methyl eugenol (16%), carvacrol (13%) and (E)- $\alpha$ -bergamotene (10%).<sup>15</sup>

*Cleistocalyx operculatus* (Roxb.) Mer. et Perry belongs to the Myrtaceae family. The plants are found widely distributed in Huangxi, Guangdong and Yunnan Provinces. The bud oil contains myrcene (7.25%), (Z)- $\beta$ -ocimene (36.39%), (E)- $\beta$ -ocimene (8.35%) and the leaf oil contains (Z)- $\beta$ -ocimene (53.18%), (E)- $\beta$ -ocimene (4.50%) and nerolidol (2.16%).<sup>18</sup>

*Amorpha fruticosa* is widely distributed in northeast, north and eastern parts of China. The steam distilled seed oil contains  $\alpha$ -bisabolene (20.23%), isocaryophyllene (9.83%),  $\gamma$ -cadinene (16.66%), and  $\alpha$ -copaene (4.36%). The oil has been used for the compounding of fragrances by Chinese perfumers.<sup>19</sup>

*Valeriana officinalis* L. var. *latifolia* Miq. is widely distributed in northeastern, northwestern and the eastern parts of China. The root oil is obtained by steam distillation with 2% yield. The composition of the oil was determined: bornyl acetate (50.56%), camphene (16.17%), myrcenol (5.47%), limonene (1.77%), dihydrocarvyl acetate (1.62%) and  $\beta$ -pinene (6.48%). The oil is used directly in tobacco, flavor and fragrance compounding in China.<sup>20</sup>

*Adenosma indianum* (Lour.) Merr. belongs to Scrophulariaceae family. This plant grows wild in Guangdong, Guangxi and Yunnan. The yield of leaf oil by steam distillation is about 0.4%. The constituents of the oil were determined:  $\alpha$ -pinene (5.52%),  $\beta$ -pinene (4.07%), limonene (12.36%), 1,8-cineole + *p*-cymene (12.79%),

**Table I. Chemical Constituents of *Litsea cubeba* Oil from Different Regions**

Compounds	Hunan	Yunnan	Fujian
$\alpha$ -pinene	2.20%	1.60%	3.57%
camphene	1.10	3.50	1.30
methyl heptenone	7.12	3.10	7.40
$\beta$ -pinene	1.50	-	3.16
selinene	0.75	-	2.33
<i>p</i> -cymene	0.10	0.30	0.10
limonene	14.04	11.60	17.49
linalool	3.45	2.50	4.88
2-propenyl-3-methyl-4-hydroxy-cyclopent-2-ene	0.75	-	1.40
camphor	0.10	0.80	0.93
citronellal	1.70	7.60	0.69
pulegone	0.80	-	3.01
$\alpha$ -terpineol	1.60	1.50	2.30
$\alpha$ -citral + $\beta$ -citral	37.80	62.50	26.55
	24.00		20.47
piperitone	0.10	-	0.10
geraniol	0.10	1.10	0.10
$\alpha$ -humulene	0.40	1.20	0.82
pseudoionone	0.10	-	0.10
geranyl acetate	-	0.90	-
safrole	-	0.90	-

linalool (7.29%), fenchone (13.90%), anethole (5.27%) and patchouli alcohol (2.56%).<sup>21</sup>

The chemical composition of *Aquilaria sinensis* (Lour.) Gilg. is quite different with *Aquilaria agallocha* and *Aquilaria malaccensis*. Two new sesquiterpenoids, sinenofuranal and sinenofuranol have recently been found.<sup>22</sup>

*Rosa rugosa* x *R. setata* and *Rosa chinensis* Jacq. Crimson Glory' H.T. belongs to the rose family. *Rosa rugosa* x *R. setata* is planted in Gansu Province. The main composition of the oil is: citronellol (52%), geraniol (14%), rose oxide (1%) and citronellyl acetate (3%).<sup>23</sup> The *R. chinensis* Jacq. Crimson Glory' H.T. oil contains linalyl acetate (15%), limonene (12%), methyl phenyl ether (10%), citronellol (5%) and  $\beta$ -caryophyllene (4%).<sup>24</sup>

*Narcissus tazetta* L. var. *chinensis* Roem. belongs to the Amaryllidaceae family. Its essential oil contains benzyl acetate (28%), linalool (7%), 1,8-cineole (14%), 3-methylbutenyl acetate (7%), linalool oxide (3%) and phenylethyl acetate (3%).<sup>6</sup>

*Chloranthus spicatus* (Thunb.) Makino belongs to the Chloranthaceae family. Its greenish-yellow flowers possess a very delicate fragrance and is used traditionally to process flower tea in China traditionally. The evergreen shrub is planted in Yunnan, Guangdong, Sichuan, Fujian and Guizhou Provinces. The main composition of the headspace of the flower is: (Z)- $\beta$ -ocimene (32%), (Z)-methyl jasmonate (34%), methyl jasmonate II (0.61%), etc.<sup>6</sup>

*Buddleja asiatica* Lour. is an evergreen shrub. It widely spreads in an area between 80-2,800 meter above sea level in Yunnan Province. The flower possesses delicate fragrance and a sweet Acacia-like floral note. The major

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volatile components are: Matsutaki alcohol (32.08%), linalool (19.42%), 4-hydroxy-4-methyl-pentan-2-one (8.96%), ethyl octanoate (6.66%), carveol (3.68%), methyl 2,4-dimethyl benzoate (2.09%), citronellol (1.51%) and  $\beta$ -irone (0.71%).<sup>25</sup>

The bergamot tree (*Citrus bergamia* Risso) was introduced to China in the 1970s. Now the trees grow well in Sichuan Province. The yield of petitgrain bergamot oil is 0.31-0.72% based on leaf. The physical constants are:  $d_4^{25}$  0.8842-0.8904,  $n_D^{20}$  1.4583-1.4625,  $[\alpha]_D^{25}$  -5.92-6.85°; acid No. 0.53-2.42, ester content (as linalyl acetate) 39.85-52.23%. The oil has a strong and fresh, green, sweet fruity note. The organoleptic quality is very close to Italian product.<sup>26</sup>

*Hierochloe odorata* var. *pubescens* Kryl. belongs to the Fabaceae family. It was used as a Chinese herbal medicine traditionally. The plant had been acclimatized and studied on Xincao farm (Jiangsu Province) for several years. The extract of *Hierochloe odorata* var. *pubescens* was used successfully as an excellent tobacco flavor ingredient in China since 1982. Preliminary studies show that the coumarin and coumaric acid- $\beta$ -glucoside are their main components.<sup>27</sup>

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