Research Article

Chemical Composition of Essential Oil from the Peel of Chinese *Torreya grandis* Fort

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The composition of the peel essential oil of *Torreya grandis* fort obtained by cold pressing and steam distillation was determined by GC and GC/MS. 62 constituents accounting for 99.6% of the total pressed oil were identified while 59 compounds accounting for 99.4% of the steam distilled oil were identified. Limonene (35.6–37.1%), α -pinene (20.1–24.1%), and δ -carene (3.3–3.9) were the major constituents. Others include γ -carene (3.8–3.9%), germacrene D (2.5–2.9%), and β -farnesene (2.7–2.8%).

1. Introduction

Torreya grandis Fort. ex. Lindl is a kind of characteristic and economic tree in China, which is grown in Jiangsu, Zhejiang, Anhui, Jiangxi and Hubei province, and so on. It is a variant of *Torreya* cultured by people for about 1300 years and belongs to *Taxaceae* [1, 2]. *Torreya* wood is a good material for carpentering, and it has some advantages such as a long lifetime, infertile tolerance, drought tolerance, and plant diseases and insect pests tolerance [3]. The roasted seed of *Torreya* is crisp, delicious, nutritious, and pharmaceutical [4, 5].

There is a thick layer of soft peel (also called aril) outside the seed of *Torreya grandis* fort, which was often abandoned and then rotten in the past. A photo of the seed of *Torreya grandis* fort on the tree and the micrograph picture of four wheel concentric circles arrangement of resin ducts of a transacted aril in *Torreya grandis* fort are shown, respectively in Figure 1. Essential oil was one of the *Torreya* by-products attracting keen interests of people. Now the essential oil is obtained from the peel with unique aroma like galbanum, which could be used to blend flower flavor, faint scent in the cosmetic, soap, and daily used perfume industry. Some essential oil could serve as the synthetical raw material in the chemical synthesis, and these synthetical chemicals could be used as the fine chemicals or cosmetics ingredients [2, 6].

Currently the yield of *Torreya* seed in Zhejiang province could reach 1000–1500 ton per year. However, the *Torreya* seed yield was only 350 ton per year before 1990s and

the price was only 40–80 RMB per kilogram; now the yield amounted up to 1000 ton per year, while the price also increased up to 100–150 RMB per kilogram, so in the long time, there is no need to worry about the price and market of *Torreya* seed. Therefore, the *Torreya* peel is also sufficient to be a raw material for extraction of its essential oil [3].

The peel of *Torreya* is normally discarded which consequently generated some environmental problems and hampered the development of *Torreya* industry. Exploring essential oil seemed to be an alternative way to evaluate the underlying economical values of *Torreya* due to the special roles it played in food, flavor, and cosmetics industries. With this in mind, in this paper, the chemical composition of essential oil from the peel of *Torreya* would be studied, in an effort to enhance the economic value of this cultivar. Concomitantly, the composition and content comparison between essential oil obtained from two methods was also made in order to determine which method would be more effective in the essential oil yielding.

2. Experimental

2.1. Materials. Fruits of *Torreya grandis* fort were donated on October 10th, 2008 by the private company of Zhaojia Town, Zhuji City, Zhejiang province.

2.2. Pretreatment of *Torreya* Peel. Because the *Torreya* peel is easy to deteriorate, it is necessary to pretreat these peels as soon as possible. In this study, two methods were adopted

FIGURE 1: (a) Photo of the seed of *Torreya* on the tree and (b) the micrograph picture of four wheel concentric circles arrangement of resin ducts of a transacted aril in *Torreya grandis*.

to pretreat these peels in order to find which way is more effectively. One is cold pressing: 6 kilograms wet peels (water content about 80%) were fed into KOMET Oil expellers (Type DD85G, IBG Monforts Oekotec GmbH & Co., Monchengladbach, Germany) for cold pressing, and after pressing and centrifuging, the juice was stored at 0–5°C. The other is drying: 6 kilograms wet peels (water content about 80%) were put into electric heating air-blowing drier (104A-OS, Shanghai Jingsheng Scientific Instrument Co., Ltd., Shanghai, China) for drying at 45°C, after that, the dried peel was crashed into powder with size from 40 mesh to 60 mesh. Finally, the powder was collected and stored in a desiccator at ambient temperature.

2.3. Extraction of Essential Oils. About 200 g *Torreya* peel powder was put in a flask supplied with 600 mL dd H₂O plus 10 g NaCl and subjected to steam distillation until there was no significant increase in the volume of the oil collected. After the oil volume was determined, it was dried by anhydrous Na₂SO₄ for 30 min and extracted by 10 mL CH₂Cl₂, then concentrated under vacuum in a rotary evaporator at 40°C to remove the CH₂Cl₂ [7].

About 200 mL *Torreya* peel juice was put in a flask and subjected to steam distillation until there was no significant increase in the volume of the oil collected. The other procedure was the same as above.

2.4. Analysis of Essential Oils. The oil was immediately analyzed by an Agilent 7890 system equipped with a HP-INNOWAX capillary column (60 m × 0.25 mm × 0.25 μm). The analyses were carried out using helium as carrier at 1 mL/min in a split ratio of 50:1 and programmed: (a) 60°C for 1 min, (b) rate of 3°C/min from 60 to 220°C, and holding for 5 min. The injector temperature was held at 250°C. Injection volume was 0.2 μL [8].

GC/MS analyses were carried out on the same chromatograph equipped with a Hewlett-Packard MS computerized system, Model 5975C, ionization voltage 70 eV, electron multiplier 1035 V, ion source temperature 230°C, quadruple

rods temperature 150°C, mass range *m/z* 20–450, scanning interval 0.5 s, and scanning speed 1000 amu/sec. GC conditions were the same as above. Identification of components was based on computer matching with NIST107 and NIST21 library and comparison of the fragmentation patterns with those reported in the literatures [9, 10]. Relative percentage amounts were calculated from total ion chromatogram (TIC) by the computer. The retention indices were calculated for all volatile constituents, using a homologous series of *n*-alkanes (C₇–C₃₀) (49451-U, Sigma-Aldrich, Sigma-Aldrich (Shanghai) Trading Co., Ltd.) [10].

3. Results and Discussion

The oils isolated by hydrodistillation from the peel of Chinese *Torreya grandis* fort were found to be yellow liquids and obtained in yields of 1.25% (v/w, mL/g) based on dry weights of *Torreya* peel and 0.5% (v/w, mL/g) based on wet weights of *Torreya* peel, respectively.

Two methods for extracting the essential oil from the peel of *Torreya grandis* fort were compared in this paper, and it was found that, in the reported 62 and 59 compounds of the essential oil according to steam distillation and cold pressing, there was a large similarity between these reported compounds from essential oil by two different methods. 62 and 59 compounds with 99.6% and 99.4% of total areas were identified, respectively, using both chromatographic (retention indices) and spectroscopic (mass spectra) criteria. That is to say, 65 compounds were totally identified from essential oils by both methods. The major components were found to be limonene (37.06% and 35.63%), α-pinene (20.13% and 24.11%), δ-cadinene (4.82% and 4.24%), 3-carene (3.92% and 3.81%), germacrene D (2.9% and 2.46%), and β-farnesene (2.78% and 2.68%) by cold pressing and warm drying treatment, respectively.

Chemical composition of the Chinese *Torreya grandis* fort oils can be seen in Table 1. The components are listed in the order of their elution on the HP-INNOWAX column.

Comparison of the oil composition by two treatments of the peel showed that the amounts of the main and some

TABLE 1: Percentage composition of the oils of Chinese *Torreya grandis* Fort.

No.	Compound	RI ^a	Pretreatment method		Mass percentage%		Method of identification
			Standard RI ^b		Cold pressing	Warm drying	
1	Tricyclen	1018	1014		0.2	0.2	MS ^c , RI
2	α -Pinene	1037	1026		20.1	24.1	MS, RI
3	Fenchene	1068	1045		0.3	0.3	MS, RI
4	Camphene	1077	1076		0.7	0.8	MS, RI
5	β -Pinene	1117	1115		2.4	2.5	MS, RI
6	Sabinene	1130	1132		0.9	0.5	MS, RI
7	γ -Carene	1159	1148		3.9	3.8	MS, RI
8	β -Myrcene	1170	1160		3.6	3.3	MS, RI
9	Limonene	1212	1218		37.1	35.6	MS, RI
10	β -phellandrene	1218	1210		0.8	0.7	MS, RI
11	cis-Ocimene	1241	1223		0.2	0.1	MS, RI
12	trans- β -Ocimene	1258	1235		0.2	0.1	MS, RI
13	p-cymene	1278	1261		0.3	0.4	MS, RI
14	α -Terpinolene	1288	1278		0.4	0.3	MS, RI
15	Isoterpinolene	1380	1390		—	0.1	MS, RI
16	o-Allyltoluene	1442			0.1	0.1	MS
17	cis-Limonene oxide	1450			—	0.1	MS
18	α -Cubebene	1462	1468		0.3	0.5	MS, RI
19	δ -Elemene	1474	1479		—	0.1	MS, RI
20	α -Copaene	1495	1497		0.1	0.1	MS, RI
21	Methyl pulegenate	1499			0.1	—	MS
22	α -Gurjunene	1535	1544		0.1	0.1	MS, RI
23	β -Cubebene	1542	1543		0.5	0.3	MS, RI
24	Bornyl acetate	1582	1570		0.2	0.1	MS, RI
25	β -Elemene	1592	1578		0.2	0.2	MS, RI
26	Epi-bicyclosesquiphellandrene	1595	1638		1.0	0.9	MS, RI
27	caryophyllene oxide	1601	1579		1.1	1.0	MS, RI
28	Aromadendrene	1611	1609		0.1	0.17	MS, RI
29	trans-p-Mentha-2,8-dien-1-ol	1626			0.2	0.2	MS
30	γ -Elemene	1641	1651		0.1	0.1	MS, RI
31	cis-Verbenol	1654	1663		0.1	—	MS, RI
32	trans- β -Farnesene	1667	1662		2.8	2.7	MS, RI
33	α -Humulene	1675	1662		0.6	0.8	MS, RI
34	1,8-menthadien-4-ol	1685			0.1	0.1	MS
35	γ -Muurolene	1692	1706		0.7	1	MS, RI
36	α -Terpineol	1694	1706		0.4	0.3	MS, RI
37	α -Terpinenyl acetate	1696			0.3	0.3	MS
38	Isoborneol	1698	1664		0.4	0.3	MS, RI
30	Verbenone	1709	1733		0.1	0.1	MS, RI
40	Germacrene D	1714	1721		2.9	2.5	MS, RI
41	2-Isopropyl-5-methyl-9-methylene-bicyclo[4.4.0]dec-1-ene	1719			1.0	1.1	MS
42	β -Selinene	1724	1618		0.4	0.3	MS, RI
43	α -amorphene	1728			1.8	1.7	MS
44	Carvone	1737	1751		0.4	—	MS, RI
45	1-Decanol	1756	1752		0.2	0.1	MS, RI
46	γ -Cadinene	1762	1765		4.8	4.2	MS, RI

TABLE 1: Continued.

No.	Compound	RI ^a	Pretreatment method		Mass percentage%		Method of identification
			Standard RI ^b		Cold pressing	Warm drying	
47	δ -Cadinene	1764	1772		0.1	0.3	MS, RI
48	trans-Carveol	1832	1836		0.4	0.3	MS, RI
49	Germacrene B	1834	1811		0.1	0.1	MS, RI
50	Calamenene	1837	1816		1.2	1.4	MS, RI
51	p-Cymen-8-ol	1847	1834		0.3	0.3	MS, RI
52	cis-Carveol	1863	1861		0.2	0.2	MS, RI
53	α -Calacorene	1920	1912		0.1	—	MS, RI
55	Palustrol	1931	1956		0.1	0.2	MS, RI
56	(Z)-3-Decen-1-ol	1983			0.1	—	MS
57	Caryophyllene oxide	1987	1947		0.2	0.2	MS, RI
58	Humulene epoxide II	2045	2002		0.1	—	MS, RI
59	Germacrene D-4-ol	2050	2057		0.1	0.1	MS, RI
60	Spathulenol	2123	2144		1.9	1.7	MS, RI
61	2-isopropyl-5-methyl-9-methylene-Bicyclo[4.4.0]dec-1-ene	2170			0.1	0.1	MSI
62	t-Muurolol	2185	2187		0.2	0.1	MS, RI
63	6-cadinol	2197			1.8	1.9	MS
64	Isospathulenol	2224	2225		0.1	0.1	MS, RI
65	α -Cadinol	2231	2235		0.3	0.1	MS, RI
total					99.6	99.4	

^aRI: retention indices in elution order from HP-INNOWAX column.

^bRI Standard: these data all are published.

^cMS: mass spectroscopy.

minor components are different in the oils by cold pressing treatment (CPT) and warm drying treatment (WDT); for example, the content of limonene of the CPT oil (37.06%) is higher than that of WDT oil (35.63%), while the CPT oil contains α -Pinene (20.13%) in relatively lower amount than WDT oil does (24.11%). The contents of δ -Cadinene and 3-Carene are higher in CPT oil. Some minor components, such as cis-verbenol, carvone, para-cymen-8-ol, α -calacorene, Caryophyllene oxide, Perilla alcohol, humulene epoxide II, cadalin, were found only in CPT oil, while α -pinene oxide, cis-limonene oxide, 2-methylenebicyclo[2.1.1] hexane, δ -elemene and were only found in WDT oil.

In the essential oil herein, such constitutes as limonene, α -pinene, β -pinene, and germacrene D exhibited typical flavors [7]. Limonene exhibited a fresh, light, and sweet odor. Germacrene D possessed a warm-spicy-woody flavor. The odors of α -pinene and β -pinene were warm-resinous, refreshing pinelike. Therefore, the essential oil of Chinese *Torreya grandis* fort constitutes may be valuable for the flavoring of foods, where floral-fresh-fruity aromas are required, such as chewing gums, sweets, teas, soft and energy drinks as well as milk products. In cosmetics, the investigated essential oil with characteristic floral-fresh-fruity odor impressions may be used in shampoos, soaps, shower gels, body lotions, and tooth pastes, while an application of the oils in fine perfumery seems to be interesting as top notes

in perfumes and deodorants. It could also be used in the food preservation due to high percentage of well-known antimicrobial compounds with the α -pinene, β -pinene, and limonene [11–16].

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