Hanguk Nonghwahak Hoechi
(J. Korean Agric. Chem. Soc.)
34(4), 344~352(1991)

Volatile flavor components of Jindalrae flower(Korean azalea flower, *Rhododendron mucronulatum* Turczaninow)

Tae Yung Chung and Seung Eun Lee
Department of Food & Nutrition, Pusan National University, Pusan 609-735, Korea

Abstract : The whole volatile flavor concentrate obtained from Jindalrae flower was separated into hydrocarbon and oxygen-containing compound(OCC) fractions, and the OCC-fraction was further separated by column chromatography into nine sub-fractions, respectively. These fractions were analyzed by gas chromatography and combined gas chromatography/mass spectroscopy. One hundred and sixty-two components, including 61 hydrocarbons, 18 aldehydes, 18 esters, 41 alcohols, 3 ketones, 4 oxides, 8 acids, 6 phenols and 3 miscellaneous components, were identified(Received October 28, 1991, accepted December 16, 1991).

Jindalrae of *Ericaceae* family grows wild in mountains with a sunny side and is also a deciduous shrub of about 2 meter high. This tree is perpendicularly distributed between 50 and 2,000 meters above sea level and topographically in China, Japan, Manchuria and all parts of Korea. Buds come into white-pinkish flower from April into May with a characteristic odor before the leaves are out. The corolla of Jindalrae flower is from 3~4 centimeters in diameter and tears in five. A limbus of the corolla is characteristically seamed with wrinkles.[1)]

Jindalrae flower has a characteristic colour and aroma, and is used for raw material of food such as a garniture for a pancake, flavoring source for a honeyed juice and a flower wine and so forth in Korea.[2)]

In the case of foreign countries, the essential oil or extract obtained from the leaves and plant of *Rhododendron* genus, became the subject of research in flavor chemistry.[3,4)] To date, no investigation has been made on the volatile constituents of this flower. Therefore, the authors have undertaken this study in an attempt to identify each volatile component of the hydrocarbon and oxygen-containing compounds(OCC) fractions separated from whole volatile flavor concentrate of Jindalrae flower by column chromatography technique.

Materials and Methods

Material

Jindalrae flowers were collected at Cheonseongsan, Yangsan-gun, Kyeongsangnam-do in April 20th, 1990. The sample cleaned with running water was directly subjected to the experimentation or stored in −20℃ freezing room.

Preparation and fractionation of whole volatile flavor concentrate

The whole volatile flavor concentrate was prepared by a modified Likens-Nickerson apparatus for the distillation-extraction system(DES) at atmospheric pressure. A sample flask containing 500 grams of the flower and 1.5 liters of distilled water was attatched to the lower right joint of DES and a small flask containing 200 m*l* of diethyl ether, the extracting solvent, to its left joint : the sample flask was heated to 100℃ by a heating mantle and the

Key words : Volatile flavor components, column chromatography technique, Korean azalea flower
Corresponding author : T. Y. Chung

small flask was kept at 38℃ by a water bath for 2 hours. The ethereal extract was dried over anhydrous sodium sulfate for over-night at room temperature, and then concentrated to 1~2 mg at 38℃ at atmospheric pressure.

The whole volatile flavor concentrate was fractionated into hydrocarbon and OCC-fractions by silica gel column chromatography. The concentrate was placed on a silica gel column(1 cm×46 cm) and eluted with n-pentane 500 ml and diethyl ether 500 ml, successively. The diethyl ether eluate was concentrated to 0.8~1 mg and then further fractionated into nine sub-fractions : eight sub-fractions were eluted by mixture of n-pentane and diethyl ether and the last one with methanol. n-Pentane content in the mixtures were 98%(No. 1), 97%(No. 2), 95% (No. 3), 93%(No. 4), 90%(No.5), 80%(No. 6), 50%(No. 7) and 0%(No. 8), respectively.

Identification of the volatile constituents in all these fractions was made by GC and GC-MS.

Gas chromatography

A Hewlett-Packard Model 5890A Gas Chromatograph equipped with a flame ionization detector (FID), was used. Three different kinds of fused silica WCOT capillary columns(50 m×0.25 mm i.d.) coated with HP-101, HP-20 M and HP-FFAP, were used. The column oven temperature of HP-101 was programmed from 70℃ to 200℃, that of HP-20 M programmed from 60℃ to 190℃, and that of HP-FFAP programmed from 60℃ to 210℃ at a rate of 3℃/min, respectively. The injection and detector temperatures were kept at 230℃. Nitrogen was used as the carrier gas at a flow rate of 0.6 ml/min with split ratio of 1 : 100.

GC-sniff evaluation

Sensory evaluation of the volatile constituents emitted at each peak on the gas chromatogram was accomplished by sniffing at the exit port of a Gasukuro Kygyo Model Gas Chromatograph equipped with an effluent splitter and a FID. Carrier gas was kept at a flow rate 3.48 ml/min with a split ratio of 1 : 1.5.

Gas chromatography-mass spectrometry

The GC-MS spectra were recorded by a Hewlett-Packard Model 5970 Mass Spectrometer equipped with the same columns as described above. The ionization voltage was 70 eV and ion source temperature kept at 250℃. The column oven and injection port temperatures were kept at the same conditions as metioned above. Helium was used as the carrier gas at flow rate of 1.0 ml/min with a split ratio of 1 : 25.

Results and Discussion

Table 1 lists the yield and odor characteristics of the whole volatile flavor concentrate and their fractions. The approximate yield of the whole volatile flavor concentrate obtained from seven kilograms of Jindalrae flower was 0.1116g(0.0016%).

The odor of the concentrate was very similar to that of Jindalrae flower; it had a fresh Jindalrae flower-like aroma with an oily odor. All panelists evaluated it as having a desirable flavor without off-flavors. Since the whole volatile flavor concentrate is usually present in the form of the volatile mixture, the fractionation of the volatile mixture may be desirable. The concentrate was first fractionated hydrocarbon and OCC-fractions by silica gel column chromatography using nonpolar and polar eluents. The fractions were inferior in odor to the original whole volatile flavor concentrate. Nevertheless, the OCC-fraction retained to some extent the odor of Jindalrae flower, and hence was considered to be more important in establishing the floral pattern of Jindalrae flower based on their odors. The OCC-fraction was further separated into nine subfractions by column chromatography using gradient elution : only four sub-fractions(No-1, 4, 6 and 7), totalling to about 74% of the OCC-fraction, carried the floral flavor, and consisted mainly of aliphatic aldehydes, esters, terpene alcohols, oxides and phenolic compounds.

Table 2 lists the compounds identified from the whole volatile flavor concentrate and their fractions.

Sixy-one compounds from about eighty peaks resolved in the gas chromatogram of hydrocarbon fraction were identified by comparing the retention times and mass spectra of authentic specimen(manufactured by Sigma, Aldrich, Fluka, Soda Perfumary Co. Ltd and Hasegawa Perfumary Co. Ltd). These were composed of 20 alkanes(21%), 9 aromatic hydrocarbons(0.5%), 13 monoterpene hydrocarbons(48 %) and 19 sesquiterpene hydrocarbons(24%). β-Pinene(13.8%) and limonene(13.9%) were the major components of hydrocarbon fraction.

Fig. 1 shows gas chromatograms of the whole volatile flavor concentrate, hydrocarbon fraction and OCC-fraction. One hundred and one compounds from about two hundred peaks resolved in the gas chromatogram of OCC-fraction were identified by the same technique as mentioned above. These were composed of 18 aldehydes(17%), 18 esters(9 %), 41 alcohols(47%), 3 ketones(0.8%), 4 oxides(2%), 8 acids(2%), 6 phenols(3%) and 3 miscellaneous(0.5

Table 1. Yield and odor characteristics of whole volatile flavor concentrate and each fraction

Fraction	Yield*	Odor**	Main compounds identified
WVC	0.1116g	Jindalrae flower-like	All volatile components
HF	0.0541g	Woody or herbaceous	All hydrocarbons
OCCF	0.0575g	Jindalrae flower-like	All oxygen-containing compounds
No. 1	43%	Sweet-floral	Aldehydes, ketone, esters
No. 2	5%	Herbaceous	Aldehydes
No. 3	6%	Dried straw-like	Phenols, esters
No. 4	17%	Seohyang flower-like	Monoterpene alcohols, phenols
No. 5	6%	Woody or herbaceous	Mono and sesquiterpene alcohols
No. 6	11%	Sweet-floral	Alkanols, alkenols, monoterpene alcohols
No. 7	3%	Sweet-floral	Alkanols, aromatic alcohols
No. 8	9%	Rancidity or sweat	Carboxylic acids
No. 9	0%	Medicinal	Not detected

* Yield obtained from 7 kg of Jindalrae flower.
** The ethereal solution of each fraction was absorbed on a filter paper. And the filter paper was air-dried to remove the solvent and then subjected to the sensory test by 10 members of our laboratory.
WVC : Whole volatile flavor concentrate, HF : Hydrocarbon fraction, OCCF : Oxygen-containing compound fraction.

Table 2. Volatile components identified from Jindalrae flower oil

Peak No.	R. I*			Compounds	Peak area (%)			
	HP-20M	HP-101	HP-FFAP		WVC	HF	OCCF	(Sub-fractions)
2	686	418	716	Ethanal	0.0625		0.3007	(1)
3	800	800	800	Octane	0.4856	0.6309		
3′	803	530	833	Ethyl formate	0.1876		0.0377	(1)
4	862	602	897	Ethyl acetate	0.5877		1.0255	(1)
5	900	900	900	Nonane	0.1255	0.1424		
5′	901	485	933	Ethanol	0.2335		0.2123	(6)
5″	901	641	933	3-Methyl butanal	0.2438		0.1733	(1)
6	931	651	966	Benzene	0.0445	0.0055		
8	958	687	1000	Pentanal	0.0831		0.0735	(1)
11	1000	1000	1000	Decane	0.0538	0.0958		
12	1005	930	1030	α-Thujene	0.0997	0.0686		
13	1017	940	1044	α-Pinene	7.4013	9.6144		
14	1024	762	1068	Toluene	0.0270	0.0062		
17	1055	955	1095	Camphene	0.8379	1.0178		
18	1053	782	1105	Hexanal	0.4286		0.6401	(1,2)

Table 2. (continued)

Peak No.	R. I*			Compounds	Peak area (%)			
	HP-20M	HP-101	HP-FFAP		WVC	HF	OCCF	(Sub-fractions)
21	1100	1100	1100	Undecane	0.0818	0.1829		
21′	1101	980	1138	β-Pinene	10.4998	13.7629		
22	1105	663	1145	1-Butanol	0.0713		0.0551	(6)
23	1108	975	1145	Sabinene	0.0648	0.0489		
23′	1109	859	1157	Ethyl benzene	0.1021	0.0268		
24	1116	866	1165	p-Xylene	0.0130	0.0243		
25	1122	687	1161	1-Penten-3-ol	0.1245		0.1853	(4)
25′	1122	870	1172	m-Xylene	0.0169	0.0315		
27	1144	984	1176	Myrcene	1.2163	1.9056		
28	1150	1006	1191	α-Phellandrene	0.0542	0.0920		
30	1164	885	1209	Heptanal	1.6729		2.6598	(1,2)
30′	1164	907	1209	Methyl caproate	0.0460		0.0731	(1)
31	1165	1018	1209	α-Terpinene	0.0943	0.1713		
31′	1165	893	1221	o-Xylene	0.0065	0.0118		
32	1172	732	1209	2-Pentanol	0.1700		0.2116	(6)
32′	1172	736	1209	3-Methyl-1-butanol	0.2710		0.3374	(6)
33	1187	1033	1228	Limonene	8.7293	13.9398		
34	1196	1033	1240	β-Phellandrene	0.9320	1.4883		
34′	1196	836	1250	(E)-2-Hexenal	0.2031		0.3688	(1,2)
34″	1196	1031	1240	1,8-Cineole	0.0163		0.0296	(1)
34‴	1200	1200	1200	Dodecane	0.0261	0.1397		
38	1218	763	1255	1-Pentanol	0.0189		0.0164	(6)
38′	1218	982	1250	2-Pentylfuran	0.2847		0.2466	(1)
40	1230	1058	1273	γ-Terpinene	2.0514	3.8166		
40′	1230	971	1277	3-Octanone	0.4815		0.4783	(1)
43	1252	1022	1301	p-Cymene	0.9292	1.3838		
45	1261	895	1320	2-Heptanol	0.0371		0.0193	(4)
46	1265	1088	1311	Terpinolene	0.1265	0.6757		
46′	1265	987	1311	Octanal	0.4534		0.4564	(1,2)
53	1300	1300	1300	Tridecane	0.0248	0.1325		
53′	1300	940	1360	(E)-2-Heptenal	0.0639		0.0972	(2)
56	1311	971	1363	6-Methyl-5-hepten-2-one	0.0937		0.1611	(1)
57	1318	865	1360	1-Hexanol	0.6010		1.1325	(6)
59	1349	859	1398	(Z)-3-Hexenol	0.2366		0.4082	(6)
60	1361	990	1398	3-Octanol	0.0933		0.1818	(4,5)
62	1370	870	1417	(E)-2-Hexenol	0.0254		0.0556	(6)
62′	1372	1091	1421	Nonanal	2.6020		5.6954	(1)
62″	1372	1108	1404	Methyl caprylate	0.0123		0.0269	(1)
67	1400	1400	1400	Tetradecane	0.0249	0.1327		
68	1402	1044	1450	(E)-2-Octenal	0.0651		0.1667	(2)
69	1405	710	1469	Acetic acid	0.1219		0.1959	(7,8)
71	1416	1072	1469	(Z)-Linalool oxide(furanoid)	0.0626		0.1536	(5)
71′	1416	978	1456	1-Octen-3-ol	0.8188		2.0096	(4,5,6)
71″	1416	1183	1450	Ethyl caprylate	0.0137		0.0337	(1)
72	1419	969	1450	1-Heptanol	0.2042		0.5309	(6)
73	1426	990	1469	6-Methyl-5-hepten-2-ol	0.0782		0.1927	(6)
74	1429	845	1507	2-Furfural	0.2716		0.4377	(1,4)
76	1441	1091	1497	(E)-Linalool oxide(furanoid)	0.1999		0.9057	(5)
77	1446	1359	1476	α-Cubebene	0.0233	0.1019		
78	1449	1200	1497	(E)-2-Hexenyl butyrate	0.1033		0.2734	(4)
79	1455	1027	1497	2-Ethyl-1-hexanol	0.5467		1.3607	(5,6)

Table 2. (continued)

Peak No.	R. I*			Compounds	Peak area (%)			
	HP-20M	HP-101	HP-FFAP		WVC	HF	OCCF	(Sub-fractions)
79′	1455	1137	1503	Cironellal	0.0087		0.0217	(1)
82	1470	1385	1523	α-Ylangene	0.0782	0.1525		
83	1473	1192	1526	Decanal	0.2956		0.7770	(1,2)
83′	1473	1097	1522	2-Nonanol	0.1028		0.2702	(4,5)
84	1479	1390	1534	α-Copaene	0.2203	0.3964		
86	1490	983	1582	Benzaldehyde	0.1285		0.2764	(1)
87	1500	1500	1500	Pentadecane	0.0635	0.2371		
88	1505	1146	1573	(E)-2-Nonenal	0.2355		0.4945	(1,2)
89	1513	1100	1555	Linalool	6.4409		14.5002	(4,5)
90	1521	1068	1566	1-Octanol	0.4358		1.0285	(6)
92	1535	1245	1576	Linalyl acetate	0.1096		0.2512	(1)
93	1540	1152	1610	Isopulegol	0.1830		0.4257	(4,5)
94	1549	1123	1610	α-Fenchyl alcohol	0.0916		0.1964	(4)
95	1552	1429	1580	Longifolene	0.0491	0.1304		
96	1558	1284	1623	Bornyl acetate	1.1326		3.3660	(1,2)
96′	1558	1427	1623	Isocaryophyllene	0.0627	0.1665		
98	1570	1182	1637	Terpinen-4-ol	0.3853		0.7381	(4)
100	1573	1400	1630	β-Bourbonene	0.5311	0.7028		
101	1579	1072	1627	(E)-2-Octenol	0.1401		0.2684	(6)
103	1582	1438	1654	β-Caryophyllene	2.5255	6.2868		
106	1600	1600	1600	Hexadecane	0.1208	0.1616		
108	1607	1044	1700	Phenylacetaldehyde	0.4967		0.8640	(3)
112	1622	1152	1700	(E)-Pinocaveol	0.4170		0.7254	(4)
112′	1623	1169	1668	1-Nonanol	0.4762		0.9084	(6)
112″	1624	921	1685	Isovaleric acid	0.0612		0.1168	(8)
113	1627	1478	1701	Alloarmadendrene	0.1049	0.1567		
114	1636	1163	1720	Ethyl benzoate	0.1518		0.1764	(1)
115	1641	1463	1725	(Z,E)-α-Farnesene	0.1766	0.2121		
116	1648	1212	1682	Phellandral	1.2816		3.4109	(1)
117	1651	1200	1682	p-Cymen-8-ol	0.4108		1.7596	(5)
117′	1651	1471	1728	α-Humulene	0.5970	0.7755		
118	1658	1197	1728	α-Terpineol	2.4219		5.2926	(5,6)
120	1668	1487	1738	γ-Muurolene	0.6477	1.5842		
121	1672	1174	1728	(E)-2-Nonenol	0.3356		0.1416	(5,6)
122	1682	1394	1739	Dodecanal	0.2662		0.2801	(1,2)
123	1689	1497	1767	Germacrene D	1.1739	1.5772		
125	1700	1700	1700	Heptadecane	0.1275	0.3267		
125′	1700	1505	1786	α-Muurolene	1.7529	4.4913		
126	1704	1513	1788	(E,E)-α-Farnesene	1.5753	4.1774		
126′	1704	1195	1824	Naphthalene	0.1142	0.2143		
129	1718	1269	1771	1-Decanol	0.3572		0.7114	(6,7)
130	1724	1366	1777	Geranyl acetate	0.0410		0.0779	(1)
130′	1724	1230	1777	Citronellol	0.4962		0.9431	(6)
131	1736	1529	1806	δ-Cadinene	0.8112	1.8679		
132	1739	1200	1450	Methyl salicylate	0.0500		0.2264	(1,3)
132′	1739	1525	1816	γ-Cadinene	0.4518	0.7710		
134	1751	1212	1834	Myrtenol	1.0902		2.5752	(5,6)
135	1760	1234	1821	Nerol	0.1001		0.3040	(5,6)
135′	1760	1542	1839	β-Sesquiphellandrene	0.2643	0.1389		
137	1770	1547	1847	Cadina-1,4-diene	0.1479	0.1440		

Table 2. (continued)

Peak No.	R. I*			Compounds	Peak area (%)			
	HP-20M	HP-101	HP-FFAP		WVC	HF	OCCF	(Sub-fractions)
138	1772	1288	1878	Ethyl salicylate	0.0425		0.1924	(1,3)
143	1800	1051	1864	Caproic acid	0.0503		0.0953	(8)
143′	1800	1800	1800	Octadecane	0.0787	0.0869		
144	1802	1259	1864	Geraniol	0.0942		1.7132	(5,6)
145	1808	1550	1892	Calamenene	0.1693	0.1319		
147	1817	1306	1940	α-Methylnaphthalene	0.2021	0.1299		
149	1826	1091	1925	Benzyl alcohol	0.8511		1.6076	(6,7)
153	1851	1323	1981	β-Methylnaphthalene	0.2331	0.0863		
157′	1880	1509	1943	BHT	0.1320		0.1678	(4)
161	1900	1900	1900	Nonadecane	0.4954	0.2683		
161′	1900	1484	2000	β-Ionone	0.1716		0.1161	(1)
162	1903	1146	1970	Enanthic acid	0.2836		0.3079	(8)
164	1915	1245	2049	Benzothiazole	0.1227		0.0837	(7)
169	1950	1140	2041	o-Cresol	0.3131		0.7113	(3,4)
169′	1950	1110	2049	Phenol	0.5746		1.3054	(3,4)
170	1954	1601	2067	Caryophyllene oxide	0.3726		0.8868	(2)
171	1959	1321	2049	Perilla alcohol	0.2442		0.4019	(5,6)
177	2000	2000	2000	Eicosane	0.0132	0.0673		
178	2004	1562	2053	(E)-Nerolidol	0.4071		0.8650	(4,5)
180	2010	1230	2076	Caprylic acid	0.1936		0.4390	(7,8)
182	2026	1182	2125	p-Cresol	0.4347		1.0022	(3,4)
186	2050	1321	2145	Cuminic alcohol	0.1332		0.3731	(3,4)
193	2092	1256	2191	2,3-Xylenol	0.0265		0.0741	(3,4)
195	2100	2100	2100	Heneicosane	0.1061	0.5413		
198	2110	1321	2183	Pelargonic acid	0.3997		0.3376	(8)
198′	2110	1385	2218	Eugenol	0.0754		0.0637	(3)
201	2129	1517	2248	2,3-Dimethyl-2-none-4-olide	0.0459		0.1571	(6)
202	2141	1655	2273	β-Eudesmol	0.1124		0.3444	(5)
210	2189	1911	2232	Methyl palmitate	0.1563		0.4663	(1)
212	2200	2200	2200	Docosane	0.1334	0.6810		
215	2250	1409	2286	Capric acid	0.0291		0.0298	(8)
218	2260	1978	2265	Ethyl palmitate	0.1619		0.4137	(1)
227	2300	2300	2300	Tricosane	2.9132	7.4290		
228	2301	1722	2373	(E,E)-Farnesol	0.0633		0.4928	(5)
236	2400	2400	2400	Tetracosane	0.3431	1.7511		
240	2447	2075	2513	Methyl linoleate	0.1425		1.1490	(1)
242	2484	2139	2543	Ethyl linoleate	0.0843		0.3955	(1)
244	2500	2500	2500	Pentacosane	2.3357	6.9504		
245	2510	2081	2583	Methyl linolenate	0.2759		0.9124	(1)
248	2545	2145	2614	Ethyl linolenate	0.0943		0.3089	(1)
250	2600	2600	2600	Hexacosane	0.0491	0.1460		
253	2700	2700	2700	Heptacosane	0.2827	0.9269		
256	2850	1991	2930	Palmitic acid	0.0295		0.3551	(8)
Total					91.6345	93.5182	81.9683	
Unknown					8.3655	6.4818	18.0317	

* R.I : Retention index. HP-20M. HP-101 & HP-FFAP : Columns used.

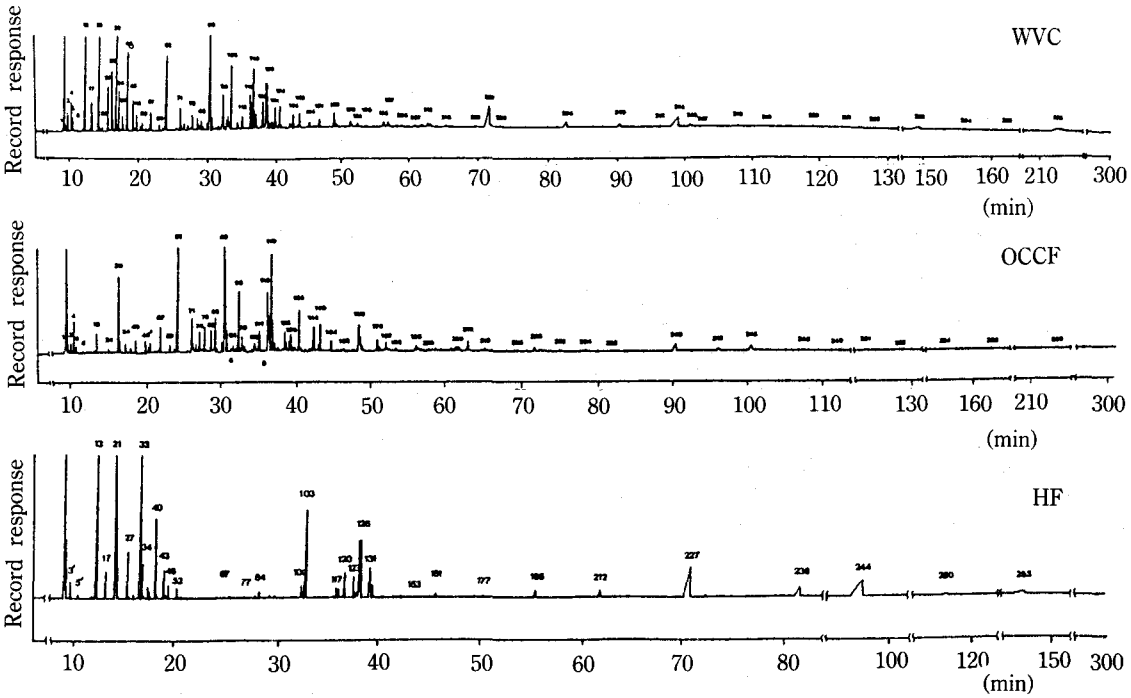

Fig. 1. Gas chromatograms obtained from whole volatile concentrate, hydrocarbon and oxygen-containing compound fractions.
Column : HP-20 M(50 m×0.25 mm i.d.), Column oven temperature : 60→190℃(3℃/min), Injection port and detector temperature : 230℃, Detector : FID, WVC : Whole volatile flavor concentrate, OCCF : Oxygen-containing compound fraction, HF : Hydrocarbone fraction

%).

Aldehydes were composed of 9 alkanals(11%), 4 alkenals(1%), 3 aromatic aldehydes(2%) and 2 terpene aldehyes(3%). Nonanal(5.7%), a major component of alkanals, is supposed to be formed through enzymatic breakdown of oleic acid.[5] Alkenals present in the OCC-fraction at low concentration were probably formed through the enzyme-induced oxidative breakdown of unsaturated fatty acids such as linoleic and linolenic acid.[6,7]

Esters were composed of 12 aliphatic esters(4.8 %), 3 aromatic esters(0.6%) and 3 terpene esters(3.7 %). Methyl linoleate and bornyl acetate were the major components of aliphatic and terpene esters, repectively. Esters were probably formed from alcohols and fatty acids within the cells of Jindalrae flower during the flowering time.[8]

Alcohols, the most predominant constituents in the OCC-fractions, were composed of 22 aliphatic alcohols(10%), 2 aromatic alcohols(2%) and 18 terpene alcohols(34%). The identified aliphatic alcohols were mostly the degradation products of unsaturated fatty acids and present at relatively high concentrations. In the case of terpene alcohols, the content of monoterpene alcohols was larger than that of sesquiterpene alcohols. These terpene alcohols may play an important role as the main aroma constituents of Jindalrae flower oil.

Ketones composed of 2 aliphatic ketones(0.7%) and an ionone derivative(0.1%). 3-Octanone would result from the thermal oxidation of 3-octanol naturally present in Jindalrae flower oil. 6-Methyl-5-hepten-2-one and β-ionone could arise from the oxdative breadown of lycopene and β-carotene pigments.[9]

The identified acids were composed of only 8 aliphatic acids. Caprylic acid appeared to be the major component, while capric acid was a minor component. In GC-MS analysis, the molecular ion peaks of these straight-chain monocarboxylic acids were weak but usually discernible. The most chara-

ctersitic peak at m/e 60 are presumably the result of McLafferty rearrangement. In the case of short chain acids, peaks of M-OH and M-COOH attributed to α-cleavage were prominent. In the case of long-chain acids, the spectrum consisted of two series of peaks resulting from cleavage at each C-C bond retaining charge either on the oxygen-containing fragment or on the alkyl fragment.

The results of GC-sniff evaluation are given in Table 3. The results of sniffing the effluents at the exit port of the gas chromatograph revealed the absence of an individual flavor compound having a characteristic Jindalrae flower-like aroma in this essential oil. Only 31 among 162 volatile components identified had somewhat floral aroma and were composed of 3 oxides, 5 esters, 4 alkanols, 2 alkenols, 9 monoterpene alcohols, 2 sesquiterpene alcohols, 1 aromatic alcohol, 1 alkanal, 2 monoterpene aldehydes, 1 phenol and 1 lactone. Therefore these 31 volatile components should deserve the most attention when the reconstruction of Jindalrae flower oil is conducted. However, other flavor com-

Table 3. Organoleptic characteristics of each volatile component by GC-sniff evaluation

Note	Compounds
Pungent	Ethanal, Ethyl formate, Ethyl acetate, 1-Butanol, 1-Penten-3-ol, 2-Pentanol, 3-Methyl-1-butanol, Acetic acid, Isovaleric acid, Caproic acid, Benzothiazole, Ethanol (12)
Fusel-like	Octane, Nonane, Decane, Undecane, Dodecane, 1-Pentanol, Tridecane, Tetradecane, Pentadecane, Hexadecane, Heptadecane, Octadecane, Nonadecane (13)
Herbaceous	3-Methyl butanal, Pentanal, 2-Heptanol, 3-Octanol, (E)-2-Nonenal, Isopulegol, β-Bourbonene, γ-Muurolene, δ-Cadinene, γ-Cadinene, Calamenene, β-Eudesmol, α-Cadinol, (E)-2-Octenal, 1-Octen-3-ol, Longifolene (16)
Solvent-like	Benzene, Toluene, Ethyl benzene, p-Xylene, m-Xylene, o-Xylene (6)
Woody	α-Thujene, α-Pinene, β-Pinene, Sabinene, Myrcene, Terpinolene, 6-Methyl-5-hepten-2-one, 6-Methyl-5-hepten-2-ol, α-Cubebene, α-Ylangene, Bornyl acetate, Isocaryophyllene, β-Caryophyllene, Alloaromadendrene, (Z, E)-α-Farnesene, α-Humulene, Germacrene D, α-Muurolene, (E, E)-α-Farnesene, β-Sesquiphellandrene, Cadina-1, 4-diene, α-Copaene, β-Ionone (23)
Camphoraceous	Camphene, 1, 8-Cineole, α-Fenchyl alcohol, Borneol (4)
Leafy	Hexanal, (E)-2-Hexenal, (E)-2-Heptenal, (Z)-3-Hexenol, (E)-2-Hexenol, 1-Hexanol, Phenylacetaldehyde (7)
Fruity	α-Phellandrene,Heptanal, Methyl caproate, α-Terinene, Limonene, β-Phellandrene, 2-Pentyl furan, γ-Terpinene, 3-Octanone, p-Cymene, Octanal, Nonanal, Methyl caprylate, Ethyl caprylate, 1-Heptanol, Decanal, 2-Nonanol, Benzaldehyde, Terpinen-4-ol, Ethyl benzoate, Benzyl alcohol, Caprylic acid, Cuminic acid (23)
Floral	(Z)-Linalooloxide(furanoid), (E)-Linalool oxide(furanoid), (E)-2-Hexenylbutyrate, 2-Ethyl-1-hexanol, Citronellal, Linalool, 1-Octanol, Linalyl acetate, (E)-2-Octenol, (E)-Pinocarveol, 1-Nonanol, Phellandral, p-Cymen-8-ol, α-Terpineol, (E)-Nonenol, Dodecanal, 1-Decanol, Geranyl acetate, Citronellol, Methyl salicylate, Myrtenol, Nerol, Ethyl salicylate, Geraniol, 2-Phenyl ethanol, Caryophyllene oxide, Perilla alcohol, (E)-Nerdidol, Eugenol, 2, 3-Dimethyl-2-nonen-4-olide, (E, E)-Farnesol (31)
Oily	2-Furfural, Methyl palmitate, Capric acid, Ethyl palmitate, Methyl linoleate, Ethyl linoleate, Methyl linolenate, Ethyl linolenate, Palmitic aicd (9)
Medicinal	Naphthalene, α-Methyl naphthalene, β-Methyl naphthalne, BHT, o-Cresol, Phenol, p-Cresol, 2, 3-Xylenol (8)
Odorless	Eicosane, Heneicosane, Docosane, Tricosane, Tetracosane, Pentacosane, Hexacosane, Heptacosane (8)
Rancidity	Enanthic acid, Pelargonic acid (2)

pound having slightly unpleasant odor would also be useful for the reconstruction of this oil, because they are also important parts of the whole volatile flavor concentrate obtained from Jindalrea flower. Furthermore, some unidentified volatile flavor components may contribute a share in the aroma of Jindalrae flower oil.

References

1. Ko, K. S. and Kim, Y. S. : Coloured wild plants of Korea, Academic Press,Seoul, p. 220(1988)
2. Hwang, H. S. : Korean Cookery Encyclopedia, Sam Jung Dang, Seoul, p. 470(1976)
3. Lu. Yichang and Xing. Jianping : Huaxue Xuebao, 40(60) : 531-8(1982); Chemical Abstracts, 97 : 1595 77t(1982)
4. Chinghai Sheng Institute of Biology, Academia Sinica and Institute of Botany : Chin Wu Hsueh Pao, 20(2) : 135-9(1978); Chemical Abstracts, 89 : 103895 h(1978)
5. Flath, R. A., Forrey, R. R. and Guadagni, D. G. : J. Agri. Food Chem., 21 : 948(1973)
6. Pyne, A. W. and Wick, E. L. : J. Food Sci., 30 : 192 (1965)
7. Kazeniac, S. J. and Hall, R. M. : J. Food Sci., 35 : 519 (1970)
8. Heath, H. B. : Source Book of Flavors, Avi, Connecticut, p. 97(1981)
9. Stevens, M. A. : J. Amer. Soc. Hortical. Sci., 95 : 461 (1970)

진달래꽃의 휘발성 성분에 관한 연구

정태영 · 이승은(부산대학교 식품영양학과)

초록 : 진달래꽃으로부터 얻어진 전휘발성 농축물은 column chromatography 수법으로 탄화수소 및 함산소 구분으로 분획되었으며, 함산소 구분은 column chron.atography에 의해서 9개의 sub-fraction으로 다시 분획되었다. 전휘발성 농축물, 탄화수소 구분, 함산소 구분 및 9개의 sub-fraction은 모두 GC 및 GC-MS에 의해서 분석되었다. 분석결과, 총 162 성분이 분리 동정되었으며 이들은 61개의 탄화수소, 18개의 aldehyde, 18개의 ester, 41개의 alcohol, 3개의 ketone, 4개의 oxide, 8개의 산, 6개의 phenol 및 기타 3 성분으로 구성되었다.