

RESEARCH NOTE

Volatile Composition of Fourteen Species of Fresh Wild Mushrooms (*Boletales*)

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Abstract

Forty-five volatile substances of fourteen species of fresh wild mushrooms (*Boletus aereus*, *Boletus calopus*, *Chroogomphus rutilus*, *Gomphidius glutinosus*, *Leccinum aurantiacum*, *Leccinum lepidum*, *Leccinum pulchrum*, *Leccinum quercinum*, *Leccinum versipelle*, *Paxillus atrotomentosus*, *Suillus bovinus*, *Suillus collinitus*, *Suillus granulatus*, *Suillus variegatus*) have been identified by GC/MS. The main components of the fruit bodies were 1-octen-3-ol, (E)-2-octenol, 1-octen-3-one, octanol, 3-octanone, 3-octanol, N(2-phenylethyl)acetamide, benzaldehyde, limonene, geranyl acetone, farnesyl acetone and (E,E)-farnesol. Camphene and germacrene D were identified for the first time in mushrooms.

Key Word Index

Mushroom, *Boletus aereus*, *Boletus calopus*, *Chroogomphus rutilus*, *Gomphidius glutinosus*, *Leccinum aurantiacum*, *Leccinum lepidum*, *Leccinum pulchrum*, *Leccinum quercinum*, *Leccinum versipelle*, *Paxillus atrotomentosus*, *Suillus bovinus*, *Suillus collinitus*, *Suillus granulatus*, *Suillus variegatus*, *Boletales*, *Basidiomycetes*, 1-octen-3-ol, 3-octanone, 3-octanol, (E)-2-octenol, limonene, geranyl acetone, cyclohexyl isothiocyanate, (E,E)-farnesol.

Mushroom Name)

Boletus aereus Bull.:Fr., *Boletus calopus* Pers.:Fr., *Chroogomphus rutilus* (Sch.:Fr.) O.K. Miller, *Gomphidius glutinosus* (Sch.:Fr.) Fr., *Leccinum aurantiacum* (Bull.) S.F. Gray, *Leccinum lepidum* (Bouchet ex Essette) Quadraccia, *Leccinum pulchrum* Lannoy & Estades, *Leccinum quercinum* Pilat & Dermek, *Leccinum versipelle* (Fr.) Snell, *Paxillus atrotomentosus* (Batsch:Fr.) Fr., *Suillus bovinus* (L.:Fr.)

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Table I. Percentage* of volatile compounds identified in fresh mushrooms

Compound	RI	Mushroom type									
		1	2	3	4	5	6	7	8	9	10
4-hexen-3-one**	811	-	-	-	-	-	-	-	-	0.7	-
γ -butyrolactone	870	-	0.4	-	-	-	0.5	-	-	-	-
γ -valerolactone	918	-	0.8	-	-	-	-	-	-	-	-
α -pinene	927	-	-	-	-	-	-	-	-	-	3.4
benzaldehyde	935	-	-	-	-	-	0.2	-	0.1	3.0	-
camphene	941	-	-	-	-	-	-	-	-	-	3.4
1-octen-3-one	948	-	-	-	-	-	0.2	2.0	1.1	1.5	-
3-octanone	950	-	-	-	2.0	-	6.3	-	47.0	-	-
δ -valerolactone	953	-	-	-	-	-	4.0	-	-	-	-
1-octen-3-ol	965	92.0	89.0	75.0	75.0	75.0	52.0	20.0	15.0	8.7	6.4
β -pinene	967	-	-	-	-	-	-	-	-	-	9.4
3-octanol	979	-	-	-	12.0	-	6.2	-	27.0	-	-
myrcene	980	-	-	-	-	-	-	-	-	-	2.4
2-octanone	983	-	-	0.4	-	-	-	-	-	-	-
dipropylene glycol- methylether†	995	-	-	-	-	-	-	-	-	5.4	-
6-oxa-2,4,4-trimethyl- cyclohex-2-enone	1015	-	-	-	-	-	7.8	-	0.7	3.6	-
limonene	1026	-	-	-	-	-	-	-	3.6	3.6	16.6
benzyl alcohol	1029	-	-	-	-	-	0.2	-	-	-	-
octanol	1050	4.0	2.8	1.6	2.0	-	-	-	-	-	-
2-phenylethanol	1095	-	-	-	-	-	0.3	-	-	-	-
2,5-dihydroxycyclohexa- 2,5-diene-1,4-dione	1125	-	-	-	-	-	-	8.0	-	-	-
(E)-2-octenol	1153	2.0	2.8	4.0	-	13.0	16.2	-	1.2	11.0	6.0
2,4,4-trimethylcyclo- hex-2-enone	1165	-	-	-	-	-	-	-	-	0.7	-
4-oxooctan-2-ol	1171	-	-	-	-	-	-	-	0.3	-	-
benzothiazole	1180	-	-	-	-	-	-	-	0.2	3.6	3.0
cyclohexyl isothio- cyanate	1182	-	-	-	-	-	-	-	-	28.0	-
4-thiomethylphenol	1198	-	-	-	-	-	-	-	-	0.2	-
2-phenoxyethanol	1219	-	-	-	-	-	0.7	-	-	-	-
bornyl acetate	1262	-	-	-	-	-	-	-	-	-	1.0
indole	1293	-	-	-	-	-	-	-	0.2	-	-
eugenol	1325	-	-	-	-	-	-	-	-	0.5	-
geranyl acetate	1353	-	-	-	-	-	-	7.0	-	-	-
β -caryophyllene	1410	-	-	-	-	-	-	-	-	-	6.4
4-pyridine carboxamide	1415	-	-	-	-	-	-	2.0	-	-	-
α -humulene	1435	-	-	-	-	-	-	-	-	-	2.2
1-phenyloctene	1443	-	-	-	-	-	-	-	-	1.5	-
geranyl acetone	1450	-	-	0.4	-	-	-	16.0	-	-	2.4
N(2-phenylethyl)acetamide	1463	-	-	-	2.0	-	-	-	0.3	0.8	-
4-methyl-5-thiazoethanol	1465	-	-	-	-	-	0.9	-	-	-	-
germacrene D	1470	-	-	-	-	-	-	-	-	-	2.0
2-methylthiobenzothiazole	1477	-	-	-	-	-	-	-	-	0.4	-
8-heptadecene	1685	-	-	-	-	-	-	-	-	2.5	-
(E,E)-farnesol	1720	-	2.4	-	-	-	-	16.0	-	-	-
(E,E)-farnesyl acetate	1844	-	-	-	-	-	-	6.0	-	-	-
farnesyl acetone	1865	-	0.5	1.0	-	-	-	-	-	-	-

Mushroom type: 1 = *Suillus collinitus*, 2 = *S. bovinus*, 3 = *S. granulatus*, 4 = *S. variegatus*, 5 = *Boletus aereus*, 6 = *Leccinum quercinum*, 7 = *Chroogomphus rutilus*, 8 = *Boletus calopus*, 9 = *Leccinum aurantiacum*, 10 = *Gomphidius glutinosus*

*relative percentage of the identified volatile based on the GC/MS chromatographic area; **correct isomer not identified;

RI = Retention indices; †tentative identification

O. Kuntze, *Suillus collinitus* (Fr.) O. Kuntze, *Suillus granulatus* (L.:Fr.) Roussel, *Suillus variegatus* (Sw.:Fr.) O. Kuntze (3).

Source

Fourteen species of wild fresh mushrooms (*Boletales*) were collected in South of France in October 1994.

Mushrooms

Basidiocarps previously cubed were investigated for volatiles in dichloromethane. The tissue destruction was then performed by sonication.

Previous Work

None of the fourteen wild species has been previously investigated for volatiles. Studies on volatiles in the *Boletales* were reported for *Hygrophoropsis aurantiaca* (1), *Xerocomus badius* (21) and *Boletus edulis* (2,4,6,8,12,14,15,18,20).

Present Work

Qualitative analysis was performed on a Hewlett-Packard GC/MS system. The chromatograph was fitted with a 25 m x 0.25 mm polydimethylsiloxane DB-1 fused (film thickness: 0.25 μm) silica capillary column. The carrier gas was helium with a flow rate of approx. 0.9 mL/min. The injector and detector temperatures were 200°C and 220°C, respectively. The column temperature was programmed as follows: 60°-200°C (4°C/min).

The mass spectra were recorded on a mass selective quadrupole-type detector of the HP 5970A class. Ionization was obtained by electronic impact under a potential of 70 eV. Volatile compounds were identified by their MS spectra and retention indices. The quantitative analysis was conducted on a Delsi F30 gas chromatograph fitted with a flame ionization detector. The column and the conditions of use were the same as above, although nitrogen was used as the carrier gas.

This research was undertaken to determine the major volatile constituents of fourteen fresh wild *Boletales* species by combined gas chromatography-mass spectrometry. The GC/MS analysis of the dichloromethane extracts obtained from eleven Boletes and three gilled related species revealed differences in the components of the volatiles. There is no volatiles in *L. verstipelle*, *L. lepidum*, *L. pulchrum* and *P. atrotomentosus*. Forty-five constituents were identified in the other ten mushrooms. Table I lists the relative percentage of the identified volatiles based on the areas of chromatographic peaks. The ten mushrooms were classified according to the percentage of 1-octen-3-ol.

The eight tubulate and the two lamellate *Boletales* contained 1-octen-3-ol. A relative high level of this compound (>50%) was measured in 6 out of 8 tubulate fungi, i.e., *S. collinitus*, *S. bovinus*, *S. granulatus*, *S. variegatus*, *B. aereus* and *L. quercinum*.

Compounds related to 1-octen-3-ol [1-octen-3-one, (E)-2-octenol, octanol, 2-octanone, 3-octanol, 3-octanone] were demonstrated to be present in all *Boletales* species as already reported for fresh mushrooms (5,7,13,15,22), i.e., *B. edulis* (6,14,20). Only C-8 derivatives were observed in *B. aereus* and *S. collinitus*. There is a general agreement that C-8 compounds are decisive contributors to the flavor of mushrooms (1,2,9,10,11,13,15,17,19).

The percentage of volatile substances other than C-8 components ranged from 1.4% to 55%. The highest values were found in *C. rutilus*, *L. aurantiacum* and *G. glutinosus*. Some *Boletales* were composed of methyl ketones such as geranyl acetone in *G. glutinosus*, *C. rutilus* and *S. granulatus*, and farnesyl acetone in *S. granulatus* and *S. bovinus* as already reported for *S. grevillei* and *S. luteus* (16). (E,E)-Farnesol was found in the fruiting bodies of *S. bovinus* and *C. rutilus*, and in the latter species, (E,E)-farnesyl acetate was also identified. Monoterpenes and sesquiterpenes, i.e., α -pinene, β -pinene, β -caryophyllene, α -humulene, myrcene and bornyl acetate were only identified in the gilled mushroom *G. glutinosus* as described for some fresh mushroom species (1,22). Benzaldehyde was positively

identified in *L. aurantiacum*, *L. quercinum* and *B. calopus*. Camphene and germacrene D have not been previously observed in mushrooms.

This paper demonstrates the broad spectrum of volatile compounds from basidiocarps of *Boletales*. The biotechnological production of flavors could represent an advantageous alternative to previous sources. Further screenings of volatiles from *Suillus* cultures are in progress.

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