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## Identification of the volatile components of the multi-floral honey by ultrafast E-nose chromatography

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### Abstract

The study is focused on the identifying the volatile components of multifloral honey through ultra-fast GC chromatography E-nose. Volatile Components obtained for this honey can be grouped as aldehydes, ketones, terpenoids, alcohols and esters and the components reported in this multifloral honey are widely distributed as it is collected from the variety of flower nectar utilised by the bees for creating this honey. Though the volatile marker can be pointed out for the multifloral, it has limitations such as variations in composition due to the season, botanical source, geographical origin.

**Keywords:** Multifloral, Volatile components, E-nose

### 1. Introduction

Bees can produce multi-floral honey by gathering nectar from various kinds of flowers. The botanical source and the region where the honey was collected have a considerable influence on the composition of the hive. The botanical source of honey is very important in terms of its chemical volatile content that directly affects its organoleptic properties. Because of this, the volatile component profile may be utilised as a fingerprint for honey verification, allowing for the determination of a honey's source of origin (Machado *et al.* 2020) [3].

Methods such as gas chromatography are frequently used in determining the quality of honey requires the complex sample preparation. (Wang *et al.* 2010) [6]. The benefit of the electronic nose device is its high degree of dependability, low cost, and considerable flexibility for in-situ and online measurements. It is especially useful for looking at the headspace of solid or liquid food samples (Ragazzo *et al.* 2008) [4]. Thus, the current study is focused on the study of volatile components of multifloral honey collected from the Tamil Nadu region.

### 2. Materials and Methods

#### 2.1 Sample collection

The sample is collected from the Senthamangalam, Madurai district, Tamil Nadu. The collected multifloral honey is stored in the dark place at room temperature.

#### 2.2 Melissopalynology

The Melissopalynology technique proposed by the Louveaux *et al.* (1978) is used for the identification of pollens in the multifloral honey. The pollen identification of multifloral honey was done by the CBRTI, Pune.

#### 2.3 Electronic nose

The ultra-rapid gas chromatography method (Heracles Alpha M.O.S., Toulouse) with headspace analysis is indeed the E-nose employed for the analysis. The gas chromatograph has two flame ionisation detectors (FID) and two simultaneous metallic columns of opposite polarities, allowing it to analyze a test sample that has been divided in half while simultaneously displaying two chromatograms.

### 3. Results and discussions

#### 3.1 Pollen analysis

The collected honey evaluated from the CBRTI, Pune contained the various pollen species of *Cocos nucifera*, *Brassica Eucalyptus*, *parthenium*, and it is termed as "Multifloral honey" as it does not contain any predominant pollen.

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### 3.2 Volatile components of Multifloral honey

The volatile compounds obtained for the multifloral honey is listed in the Table-1 (MXT- FID-1) and Table-2 (MXT-FID-2) and the chromatogram from the column 1 (MXT- FID-1) and the column 2 (MXT-FID-2) is represented as Figure1 and Figure 2 respectively. Aldehyde such as hexanal, (E, E)-2, 4-hexadienal, undecanal, 2-Heptenal, (E, E) - 2,4 Heptadienal, 12-methyltridecanal, 2-Heptenal, Epoxy-2-nonenal is reported in the multifloral honeys. These aldehydes are common honey aroma compounds because they have been found in a variety of honey types (Karabagias *et al.* 2019) [2]. Sulphurous compounds such as dimethyl disulphide, dimethyl sulfoxide, bis (2-methyl-3-furanyl) disulphide also presented in this volatile profile.

In this multifloral honey, the terpene compound called 1R-(+)-alpha-pinene is reported in the both columns of the honey. Terpenoids are a major class of volatiles found in many natural based products, and they add a distinct note to the aroma of honey (Karabagias *et al.* 2019) [2]. Ethyl 2-methylbutyrate, Butyl pentanoate, (Z)-3-Hexenyl isobutyrate, Methyl undecanoate, gamma-nonalactone, Ethyl hexadecanoate are some of the esters found in this multifloral

honey. 2-Heptanone, gamma-nonlactone, 2-Hydroxy-3,4-dimethyl-2-cyclopenten-1-one, delta-decalactone, 4(4-hydroxy-3-methoxyphenyl)-2-butanone are the ketones present in the honey. Gamma-nonlactone adds the coconut, creamy characteristic flavour in this honey. Silici (2011) [5] reported the 2-Heptanone in the pine honeys volatile compounds. Alcohols such as 1-octanol, citronellol, and phenol such as 2, 6-dimethyl phenol are also presented in the honey.

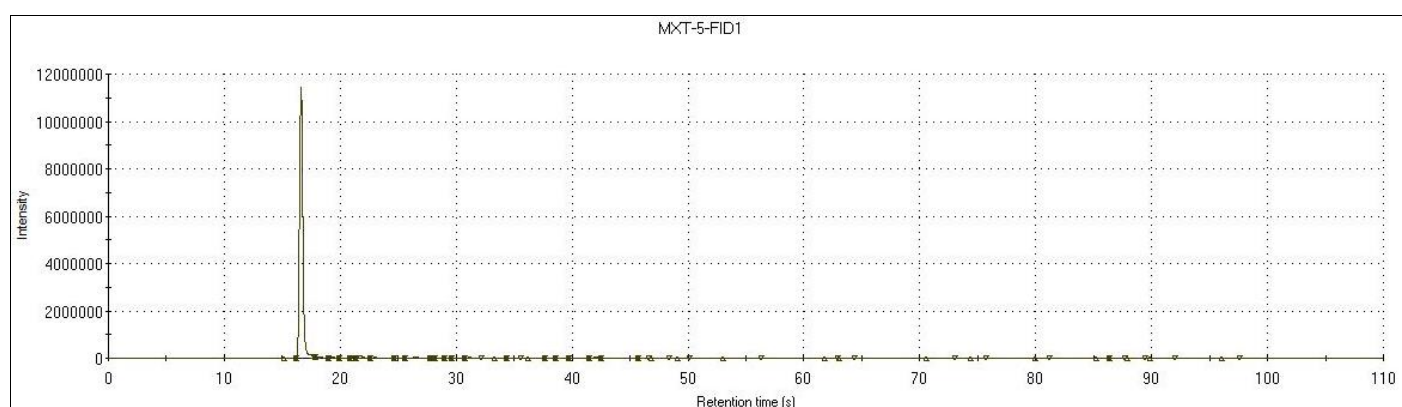
The peaks with highest concentration (in terms of area) reported were dimethyl disulphide, dimethyl sulfoxide, 2-Heptanone, (E, E)-2, 4-hexadienal, 1R-(+)-alpha-pinene, 2-Heptenal, 1-Methyl-4-isopropenyl-1-cyclohexene, methyl undecanoate. Multifloral honeys have a more complex volatile composition than unifloral honeys because of their blend of botanical sources and hence forecasting the floral markers for multifloral honeys is complicated. (Devi *et al.* 2018) [1]. However, the compounds such as 4(4-hydroxy-3-methoxyphenyl)-2-butanone, 2-Hydroxy-3,4-dimethyl-2-cyclopenten-1-one are exclusively present in this honey, and it can be used as floral marker for this particular collected honey.

**Table 1:** Volatile components of multi-floral honey obtained in the column MXT-5-FID-1

S.no	RI	RT	Compound Name	Sensory description	Area	Relative Area
1	15.68	708	Heptane	Alkane; Fruity; Gasoline; Sweet	7173	0.176
2	16.63	745	Dimethyl disulfide	Cabbage; cheese (ripened); Garlic; Onion; Putrid; Sulfurous; Vegetable	3844335.9	94.12
3	18.03	799	hexanal	Acorn; Aldehydic; Fatty; Fishy; Fresh; Fruity; Grassy; Green; Herbaceous; Leafy; Sharp; Strong; Sweaty; Tallowy; vinous	40609	0.994
4	19.28	847	Dimethyl Sulfoxide	Alliaceous; Fatty; Garlic; Mushroom; Oily; Sulfurous	22717.9	0.556
5	20.18	882	2-Heptanone	Banana; Cheese; Coconut; Fruity; Gaseous; Gravy; ham (cured); Musty; Nutty; pear drop; Soapy; Spicy; Sweet; Toasted; Woody	10968.9	0.269
6	21.17	913	(E,E)-2,4-hexadienal	Citrus; Floral; Green; Spicy; Sweet; Vegetable	13125.7	0.321
7	21.71	926	1R-(+)-alpha-pinene	Aromatic; Harsh; Minty; Pine; Terpenic	47612.3	1.17
8	22.98	956	2-Heptenal, (E)	Almond; Earthy; Fatty; Fresh; Fruity; Grassy; Green; Mushroom; Onion; Pesticide; Plastic; Pungent; Soap; Soapy; Sulfurous; Tallowy; Vegetable; Vinegar	22411.8	0.549
9	24.74	998	(E,Z)-2,4-Heptadienal	Fried	2875.4	0.0704
10	26.48	1036	1-Methyl-4-isopropenyl-1-cyclohexene	Citrus; Etheral; Fruity; Green; Lemon; Licorice; Orange; Pleasant	23040.9	0.564
11	27.94	1069	1-Octanol	Aldehydic; bread (toasted); Burnt matches; Chemical; Fatty; Floral; Fresh; Green; Herbaceous; Metallic; Mushroom; Orange; Rose; Sulfurous; Waxy	923.8	0.0226
12	28.32	1077	2,4-Hexadienoic acid	Odorless	1198.2	0.0293
13	29.38	1100	Butyl pentanoate	Apple; Etheral; Fruity; fruity (sweet); Green; Pineapple; Raspberry; Sweet; Tropical	824.8	0.0202
14	29.96	1114	2,6-dimethyl phenol	Coffee; Medicinal; Phenolic; Rooty; Sweet	1002.1	0.0245
15	31.16	1141	(Z)-3-Hexenyl isobutyrate	Apple; Etheral; Fruity; Green; leaf (tomato); Mango; Minty; Nutty; Orange; Pear; Sweet; Tomato; Tropical; Violet; Winey	9143.4	0.224
16	33.74	1201	2,6-dimethoxy-phenol	Balsamic; Medicinal; Phenolic; Powdery; Smoky; Woody	187.3	0.00458
17	34.64	1224	Citronellol	Floral; Fresh; Rose	535.1	0.0131
18	36.92	1282	Tridecane	Alkane; Citrus; Fruity; Fusel; hydrocarbon	1743.3	0.0427
19	37.82	1305	Undecanal	Fresh; Fruity; Waxy	275.1	0.00674
20	38.84	1336	gamma-nonalactone	Coconut; Creamy; Fruity; Oily; Peach; Strong; Sweet; Waxy; Woody	52.9	0.0013
21	40.84	1395	Tetradecane	Alkane; Fusel; herbaceous (mild); Sweet	599.2	0.0147
22	42.04	1432	Methyl undecanoate	Brandy; Fatty; Fruity; Oily; Sweet; Waxy; Winey	19808.1	0.485
23	42.76	1455	Methyl undecanoate	Brandy; Fatty; Fruity; Oily; Sweet; Waxy; Winey	10934.1	0.268
24	46.16	1553	12-methyltridecanal	Broth; Citrus; Fatty; Fruity; meat (cooked); Meat broth; Meaty; Sweaty; Tallowy; Waxy	114.9	0.00281
25	47.24	1582	12-methyltridecanal	Broth; Citrus; Fatty; Fruity; meat (cooked); Meat broth; Meaty; Sweaty; Tallowy; Waxy	112.7	0.00276
26	49.46	1641	4(4-hydroxy-3-methoxyphenyl)-2-butanone	Fruity; Phenolic; Pungent; Spicy; Strong; Sweet; Vanilla; Woody	124.4	0.00305
27	53.66	1754	Benzoic acid, 2-amino, pentyl ester	Ester; Floral; Weak	495.5	0.0121
28	62.38	1987	eicosane	Alkane; Fruity; Odorless; Sweet; Woody	220	0.00539
29	63.42	2015	Ethyl hexadecanoate	Creamy; Fruity; Mild; Milky; sweet (mild); Waxy; waxy (mild)	78.6	0.00193
30	71.32	2226	docosane	Alkane; Odorless	599.3	0.0147
31	75.2	2330	tricosane	Alkane; Odorless	66.9	0.00164

**Table 2:** Volatile components of multi-floral honey obtained in the column MXT-17-FID-2

S.no	RI	RT	Compounds	Sensory Description	Area	Relative Area
1	15.97	689	Heptane	Alkane; Fruity; Gasoline; Sweet	7982.1	0.186
2	18.14	769	Dimethyl disulfide	Cabbage; cheese (ripened); Garlic; Onion; Putrid; Sulfurous; Vegetable	4070478.9	94.69
3	20.43	839	Acetoin	Butter; Coffee; Creamy; Dairy; Fatty; Milky; Sweet; Woody	14758.7	0.343
4	21.53	868	Acetoin	Butter; Coffee; Creamy; Dairy; Fatty; Milky; Sweet; Woody	12493.4	0.291
5	22.01	881	ethyl 2-methylbutyrate	Apple; Blackberry; Cognac; Fruity; Green; Phenolic; Sharp; Strawberry; Sweet	29056.7	0.676
6	24.3	936	1R-(+)-alpha-pinene	Aromatic; Harsh; Minty; Pine; Terpenic	65889.1	1.53
7	26.11	978	2-Heptanone	Banana; Cheese; Coconut; Fruity; Gaseous; Gravy; ham (cured); Musty; Nutty; pear drop; Soapy; Spicy; Sweet; Toasted; Woody	5735.7	0.133
8	27.47	1009	Decane	Alkane; Fruity; Fusel; Sweet	1411.4	0.0328
9	28.37	1031	Pyridine, 2-pentyl	Fatty; Green; Green pepper; Mushroom; Pepper; Tallowy	1101.2	0.0256
10	29.11	1048	2-Heptenal, (E)	Almond; Earthy; Fatty; Fresh; Fruity; Grassy; Green; Mushroom; Onion; Pesticide; Plastic; Pungent; Soap; Soapy; Sulfurous; Tallowy; Vegetable; Vinegar	25433.1	0.592
11	31.03	1094	2-Octanol	Aromatic; Coconut; Earthy; Fatty; Fresh; Green; Mushroom; Oily; Rancid; Spicy; Walnut; Woody	1971.3	0.0459
12	32.57	1132	(E,Z)-2,4-Heptadienal	Fried	2110	0.0491
13	33.81	1163	Butyl pentanoate	Apple; Etheral; Fruity; fruity (sweet); Green; Pineapple; Raspberry; Sweet; Tropical	736.6	0.0171
14	35.05	1194	(Z)-3-Hexenyl isobutyrate	Apple; Etheral; Fruity; Green; leaf (tomato); Mango; Minty; Nutty; Orange; Pear; Sweet; Tomato; Tropical; Violet; Winey	13327.8	0.31
15	36.21	1226	2-Hydroxy-3,4-dimethyl-2-cyclopenten-1-one	Caramelized	1339.2	0.0312
16	38.17	1281	2,4-Hexadienoic acid	Odorless	1456.1	0.0339
17	38.71	1296	Phenol, 2,6-dimethyl	Coffee; Medicinal; Phenolic; Rooty; Sweet	1158.5	0.027
18	39.47	1319	2[(methylthio)methyl]furan	Alliaceus; Coffee; Meaty; Smoky	587.7	0.0137
19	40.43	1350	Citronellol	Floral; Fresh; Rose	640.8	0.0149
20	41.23	1375	Sotolon	Burnt; Burnt sugar; Caramelized; Coffee; Cotton candy; Curry; Maple; Mushroom; Seasoning; Spicy; Strong; Sweet	1070.7	0.0249
21	42.11	1403	ethyl maltol	Candy; Caramelized; Cotton candy; Jam; Strawberry; Sweet	453.6	0.0106
22	43.23	1438	epoxy-2-nonenal	Metallic	23166.7	0.539
23	44.19	1469	Methyl undecanoate	Brandy; Fatty; Fruity; Oily; Sweet; Waxy; Winey	12812.9	0.298
24	48.83	1581	gamma-nonalactone	Coconut; Creamy; Fruity; Oily; Peach; Strong; Sweet; Waxy; Woody	54.3	0.00126
25	49.67	1600	Hexadecane	Alkane; Fruity; Fusel; Odorless; Sweet	51.7	0.0012
26	50.49	1618	Skatole	Skatole	312.1	0.00726
27	51.37	1638	bis(2-methyl-3-furanyl)disulfide	meat (roasted); Meaty; Onion	255.8	0.00595
28	52.55	1664	12-methyltridecanal		136.1	0.00317
29	56.91	1760	delta-decalactone	Fruity; fruity (sweet); Peach; Sweet	51.6	0.0012
30	64.09	1919	4(4-hydroxy-3-methoxyphenyl)-2-butanone	Fruity; Phenolic; Pungent; Spicy; Strong; Sweet; Vanilla; Woody	62.4	0.00145
31	66.01	2008	eicosane	Alkane; Fruity; Odorless; Sweet; Woody	106.5	0.00248
32	68.09	2023	eicosane	Alkane; Fruity; Odorless; Sweet; Woody	57.5	0.00134
33	68.77	2041	Ethyl hexadecanoate	Creamy; Fruity; Mild; Milky; sweet (mild); Waxy; waxy (mild)	222.4	0.00517
34	69.61	2079	Ethyl hexadecanoate	Creamy; Fruity; Mild; Milky; sweet (mild); Waxy; waxy (mild)	682.7	0.0159
35	71.31	2174	docosane	Alkane; Odorless	95.2	0.00221
36	75.61	2203	docosane	Alkane; Odorless	54	0.00126
37	76.91	2285	tricosane	Alkane; Odorless	520.6	0.0121

**Fig 1:** Chromatogram of Volatile components of multifloral honey in the Column MXT-FID-1

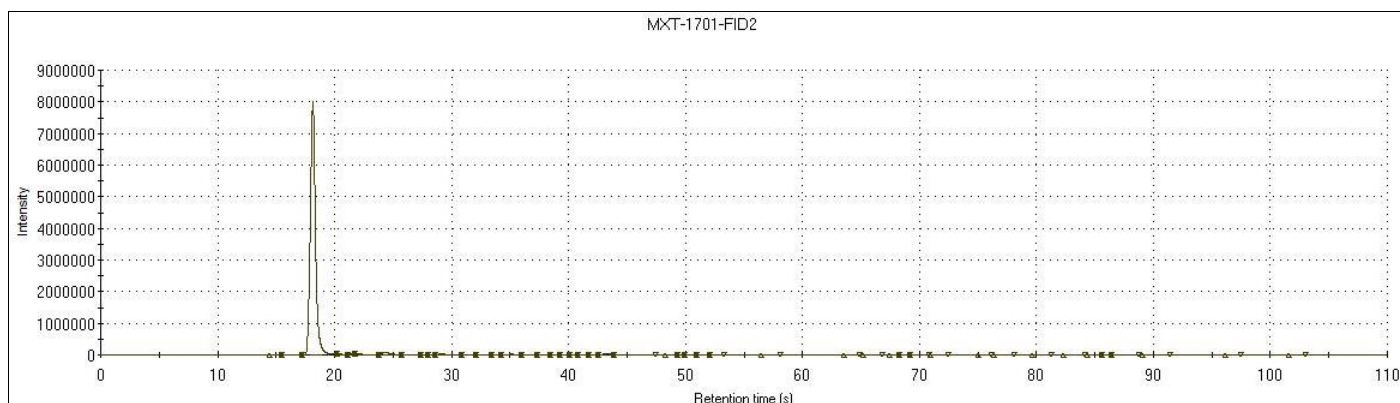


Fig 2: Chromatogram of Volatile components of Multifloral Honey in the Column MXT-FID-2

#### 4. Conclusion

It was discovered that multifloral honey included a wide range of volatile components, including ketone, furan, esters, alcohols, and terpenoids. It probably results from the variety of flower nectar utilised in the creation of multifloral honey. Though the volatile marker can be pointed out for the multifloral, it has limitations such as variations in composition due to the season, botanical source, geographical origin.

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