Research Article

# Identification of Volatile Flavour Compounds in *Moringa Oleifera* Powder and Soup Mixes

K Shunmugapriya[1*], P Vennila[2], S Kanchana[3] and S Vellaikumar[4]

[1]Department of Food Science and Nutrition, Home Science College and Research Institute, Madurai
[2]Post Harvest Technology Centre, Tamil Nadu Agricultural University, Coimbatore
[3]Department of Human development and Family studies, Home Science College and Research Institute, Madurai
[4]Department of Bio technology, Agricultural College and Research Institute, Madurai

**Abstract**

Drumstick powder and soup mixes from drumstick possessing some volatile compounds which is responsible for it's a unique characteristics aroma. In this present study, effort was taken to identify the volatile compounds present in drumstick powder and soup mixes from drumstick which establishing a critical baseline for further work. The drumstick powder was prepared by drying the pretreated drumstick in cabinet drier at $60^0$C till moisture content reaches to 4.0 per cent. Soup mixes from drumstick were prepared by adding the various ingredients *viz.,* thickening and flavouring agents to the drumstick powder. The prepared soup mixes which was stored for six months in metallised polypropylene packs and analysed for the presence of volatile compounds. The samples were extracted directly with hexane and volatile compounds were analysed in GC-MS while the mass spectra of the compounds found in the extract was matched with the National Institute of Standards and Technology (NIST) library. The results revealed that the existence of octadecanoic acid, 3-hexen 2-one and cyclopentanol, 1 - methyl in all the samples taken for the study.

**Keywords:** *Moringa oleifera*, Soup mixes, GC - MS, Volatile compounds

***Correspondence**
Author: Shunmugapriya
Email: priyakannan44@gmail.com

## Introduction

*Moringa oleifera* or sahijan is also called drumstick tree. It belongs to the plant family Moringaceae and genus moringa. The moringa plant originated initially in the Northern parts of India and soon moved into Southern parts, where it was known as "murungai keerai" (moringa leaves) and "murungai kaai" (moringa vegetable). The moringa tree had spread to most part of Asia, nearly the whole of Africa, South America, Southern part of North America and some parts in Europe. The plant is cultivated in the semi-arid, tropical and sub-tropical areas of the world [1].

Moringa trees are originated from India and now found in Ghana, the Philippines, Nigeria, Kenya, Rwanda, Niger, Mozambique, Cambodia and Haiti. Today, the moringa market globally is estimated at more than Rs 27,000 crore, which is expected to cross Rs 47, 250 crore by 2020, growing at a rate of nine per cent per year. In India, moringa tress are grown in about one lakh acre. It is grown in about 5,000 acres in Theni district in Tamil Nadu alone [2].

The acceptance or rejection of a foodstuff is its flavor, as this plays a very important role in palatability and is one of the key parameters determining the overall quality of a food product. [3]. Flavour is defined as the combined perception of odour, taste and mouthfeel (texture). The flavor of food is created by aromatic substances that are biosynthesized during normal metabolic processes in plants and animal possibly further modified by processing. A number of these flavours have been used in food industries as part of their key inputs [4]. Reactions leading to flavor development may include pyrolysis of amino acids and peptides, carbohydrate degradation, interaction of sugars with amino acids and peptides, breakdown of ribonucleotides and lipids [5]. Evidently, most non-volatiles are odourless and extremely hydrophilic and include compounds such as table salt, citric acid and sugar. These are known to impact significantly on the taste of substances and thus regarded as flavourants. A number of other non -volatiles such as amino acids, peptides, fats, carbohydrates and organic acids also provide and enhance tastes in food [6]. Although, generally odourless, these also generate characteristic volatiles. Their chemical interaction such as during hydrolytic cleavages usually leads to the formation of specific aromas [7].

To find out the retention of volatile flavouring compounds present in the prepared soup mixes from drumstick, qualitative analysis of flavoring compounds were carried out for dehydrated drumstick powder and processed soup

mixes both fresh and stored samples. The sample was extracted with suitable solvent based on the literature cited and the compounds were analysed by using Gas chromatography - Mass spectrometry (GC-MS).

## Materials and Methods

Fully mature, drumstick (*Moringa oleifera*) variety $PKM_2$ was purchased from Horticultural College and Research Institute, Periyakulam, Tamil Nadu Agricultural University, Tamil Nadu

### *Preparation of drumstick powder*

Two different drumstick powder was prepared by adopting two differents pretreatment procedure and which was denoted as $DP_1$ and $DP_1$.

### *Preparation of drumstick powder - $DP_1$*

The fresh drumstick ($PKM_2$) pieces were steam blanched and were soaked in 0.5 per cent potassium metabisulphite solution for 30 minutes to retain the colour and to increase the storage stability. The excess solution was drained out. The pieces were uniformly spread on the aluminium trays of the cabinet drier and dried at a temperature of $60^0$C till moisture content reaches to 4.0 per cent. The dried pieces was powdered by using mixie and passed through 40 mesh sieve to get uniform particle size of drumstick powder.

### *Preparation of drumstick powder - $DP_2$*

The fresh drumsticks were steam blanched for 5 minutes. Then the pieces were soaked in 0.5 per cent potassium metabisulphite solution for 30 minutes. The excess solution was drained out and the edible portion (pulp) of the pretreated pieces was scooped out by using stainless steel spoon. The collected pulp was uniformly spread on the aluminium trays of the cabinet drier and dried at a temperature of $60^0$C till moisture content reaches to 4.0 per cent. The dried pulp was powdered by using mixie and passed through 40 mesh sieve to get uniform particle size of drumstick powder.

### *Preparation of soup mix from drumstick powder*

The soup mix prepared from drumstick powder - $DP_1$and $DP_2$ was denoted as $DSM_1$ and $DSM_2$ respectively. The soup mix $DSM_1$ consisted of drumstick powder 20g and corn flour 35g whereas $DSM_2$ had 15g of drumstick powder and 40g of corn flour. The other ingredients *viz.*, thickening and flavouring agents added to each soup mix were skimmed milk powder (5g), soy flour (8g), pepper powder (4g), cumin seed powder (5g) and onion powder (5g). In addition to this, taste improvers such as citric acid (0.5g), salt (8g) and sugar (12g) were mixed. All the ingredients were stirred thoroughly and sieved (BS 40 sieve) for uniform mixing.

### *Sample preparation for GC - MS analysis*

Fresh drumstick powder and soup mixes were ground separately and an aliquot of 250 ml was extracted with 500 ml of hexane for 24 h on a shaker (250 rpm). The sample was filtered, rinsed with hexane and evaporated under reduced pressure to a volume of 30 ml [8].

### *GC - MS Instruments and chromatographic conditions*

Gas chromatography - Mass spectrometry analysis was carried out on GC-MS-QP2020 Shimadzu system comprising a gas chromatograph interfaced to a mass spectrometer instrument employing the following conditions : column VF-5 MS fussed silica capillary column (30.0m x 0.25mm x 0.25µm, composed of 5 per cent phenyl / 95 per cent dimethyl polysiloxane), operating in electron impact mode at 70ev; helium (99.999%) was used as carrier gas at a constant flow of 1.0 ml/min and an injection volume of 0.5µl was employed (split ratio of 10:1) injector temperature $240^0$C ion-source temperature $200^0$C. The oven temperature was programmed from $70^0$C (isothermal for 3 min), with an increase of $10^0$C/minutes to $240^0$C, ending with a 9 minutes isothermal at $280^0$C. Mass spectra were taken at 70ev; a scan interval of 0.5 seconds and fragments from 40 to 440Da. Total GC running time was 30 min [9].

## Results and Discussion

### *Identification of Components*

Interpretation on mass spectrum GC-MS was conducted using the database of National Institute Standard and Technology (NIST) having more than 62,000 patterns. The spectrum of the unknown component was compared with the spectrum of the known components stored in the NIST library. The Name, Molecular weight and Structure of the components of the test materials were ascertained. The chromatogram obtained from GC-MS with the extract of all the samples were presented in **Figures 1-6**.

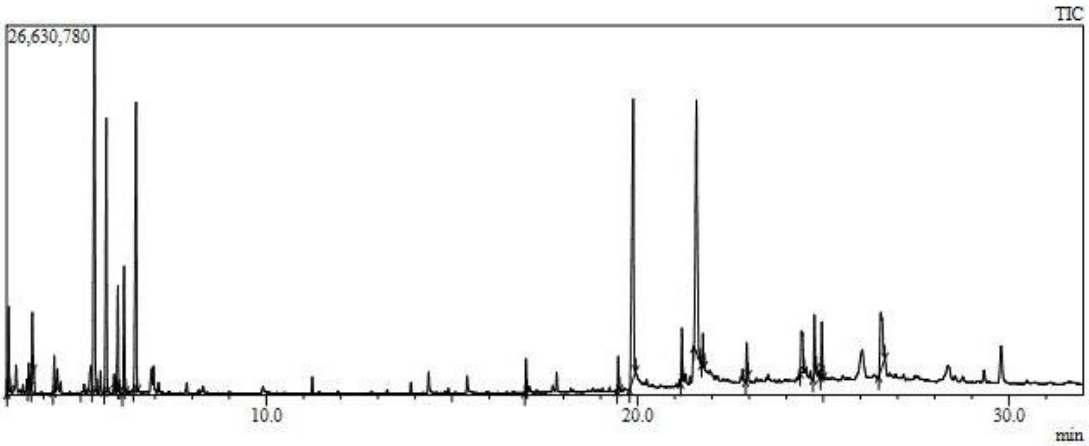


**Figure 1** Chromatogram obtained from GC-MS with the extract of drumstick powder ($DP_1$)

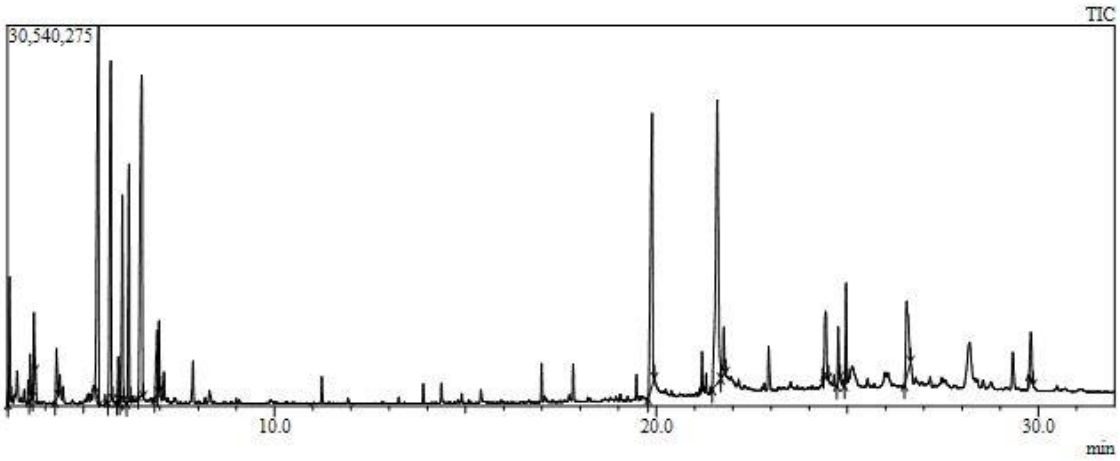


**Figure 2** Chromatogram obtained from GC-MS with the extract of drumstick powder ($DP_2$)

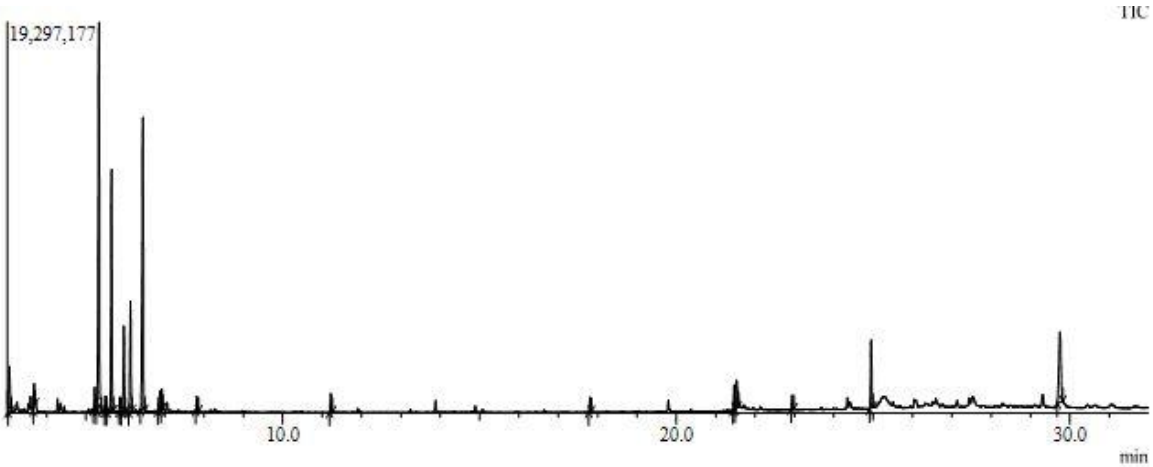


**Figure 3** Chromatogram obtained from GC-MS with the extract of soup mix from drumstick ($DSM_1$)

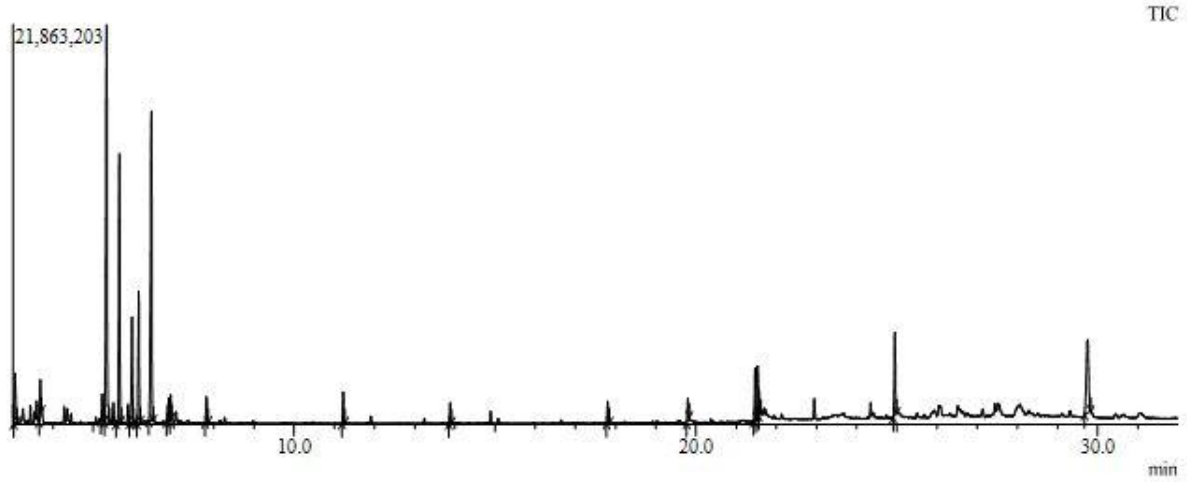


**Figure 4** Chromatogram obtained from GC-MS with the extract of soup mix from drumstick ($DSM_2$)

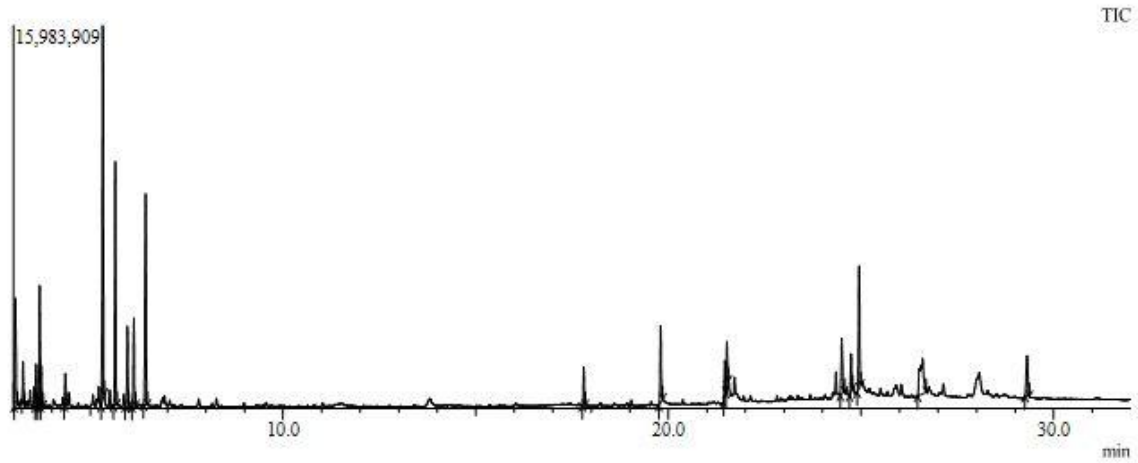


**Figure 5** Chromatogram obtained from GC-MS with the extract of stored soup mix from drumstick ($DSM_1$)

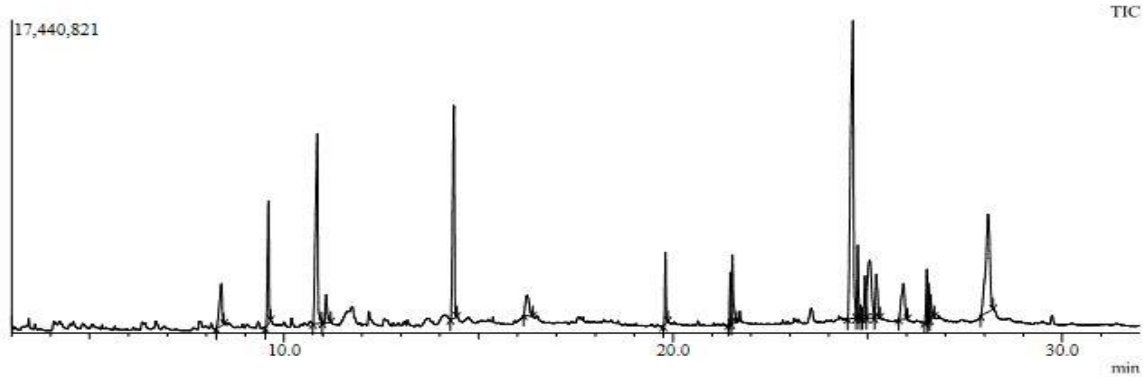


**Figure 6** Chromatogram obtained from GC-MS with the extract of stored soup mix from drumstick ($DSM_2$)

The GC- MS Chromatogram of the volatile flavour constituents present in the samples are displayed in Figures 1-6. The results showed that the presence of volatile flavor compounds in each sample varied in number and peak area. The study is concluded based upon the percentage of peak area. The major twenty volatile flavour compounds present in each sample are presented in **Tables 1-6**. Drumstick powder ($DP_1$) had major flavouring compounds namely 2-pentanethiol, 2-methyl and 3-hexen 2-one. It was noted that in drumstick powder - $DP_2$ major compounds are 3-hexen2-one, 5-hydroxymethylfurfural, benzeneacetonitrile, 4-hydroxyl and 2- dimethyl trimethylsilylmethyl. The fresh soup mix $DSM_1$ had 2-pentanethiol, 2-methyl, 1-pentanol, 2, 2-dimethyl, 3-hexen2-one and piperine as major compounds. Fresh soup mix sample $DSM_2$ contained 2-pentanethiol, 2-methyl, pentane, 3 - ethyl -3-methyl, 3-hexen2-one and piperine as major compounds. The soup mixes stored in metallised polypropylene packaging material

was taken for analysis of volatile flavouring compounds in GC - MS for comparison before and after storage. The soup $DSM_1$ stored after 180 days had 2-pentanethiol, 2-methyl, 3-hexen2-one, n- hexadecanoic acid and oleic acid as major compounds. In the case of stored soup mix $DSM_2$ butanoic acid, 2 - ethyl-2-methyl, pentane, 3-ethyl-3-methyl, 3-hexen2-one, n-hexadecanoic acid and oleic acid were major compounds based on percentage of peak area.

**Table 1** Volatile flavouring compounds present in drumstick powder ($DP_1$)

| Retention time (min) | Name of the compound | Molecular Formula | Molecular weight (g/mol) | Peak area (%) |
|---|---|---|---|---|
| 3.05 | 2, pentanol-2,methyl | $C_6H_{14}O$ | 102 | 3.97 |
| 3.25 | 3, pentanol-3,methyl | $C_6H_{14}O$ | 102 | 1.49 |
| 3.59 | 2 Hexanone | $C_6H_{12}O$ | 100 | 1.53 |
| 3.68 | Cyclopentanol,1-methyl | $C_6H_{12}O$ | 100 | 3.27 |
| 4.35 | Cyclopentanol, 3-methyl | $C_6H_{12}O$ | 100 | 1.31 |
| 5.32 | 2-Pentanethiol, 2-methyl | $C_6H1_4S$ | 118 | 11.58 |
| 5.67 | 1 pentanol, 2,2 di methyl | $C_7H1_6O$ | 116 | 0.24 |
| 5.96 | Hexane, 2-nitro | $C_6H_{13}NO_2$ | 131 | 2.43 |
| 6.12 | Pentane 3 ethyl 2,4 dimethyl | $C_9H_{20}$ | 128 | 2.44 |
| 6.43 | 3 - Hexen 2 - one | $C_6H_{10}O$ | 98 | 6.38 |
| 19.80 | n Hexadecanoic acid | $C_{16}H_{32}O_2$ | 256 | 2.75 |
| 21.46 | 9,12 Octadecanoic acid | $C_{18}H_{32}O_2$ | 280 | 1.99 |
| 21.51 | cis-9-Hexadecenal | $C_{16}H_{30}O$ | 238 | 3.26 |
| 21.71 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 | 1.99 |
| 24.50 | 2,dimethyl(trimethylsilylmethyl) silyloxymethyltetrahydrofuran | $C_{11}H_{26}O_2Si_2$ | 246 | 2.68 |
| 24.74 | Hexadecanoic acid 2 hydroxyl | $C_{19}H_{38}O_4$ | 330 | 2.28 |
| 24.95 | Bis (2-ethylhexyl) phthalate | $C_{24}H_{38}O_4$ | 390 | 4.95 |
| 25.03 | Ergost-5-en-3-ol, (3 beta) | $C_{28}H_{48}O$ | 400 | 1.59 |
| 26.55 | 2 methyl hexacosane | $C_{27}H_{56}$ | 380 | 2.31 |
| 29.31 | Tetrapentacontane | $C_{54}H_{110}$ | 758 | 2.18 |

**Table 2** Volatile flavouring compounds present in drumstick powder ($DP_2$)

| Retention time(min) | Name of the compound | Molecular formula | Molecular weight (g/mol) | Peak area (%) |
|---|---|---|---|---|
| 3.70 | Cyclopentanol, 1-methyl | $C_6H_{12}O$ | 100 | 0.03 |
| 6.41 | 3 - Hexen 2 - one | $C_6H_{10}O$ | 98 | 6.15 |
| 7.86 | Pentyl phenylacetate | $C_{13}H_{18}O_2$ | 206 | 0.21 |
| 9.60 | 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl | $C_6H_6O_3$ | 126 | 3.25 |
| 10.85 | 5-Hydroxymethylfurfural | $C_6H_6O_3$ | 126 | 6.93 |
| 11.08 | 1,2,3-Propanetriol, 1-acetate | $C_5H_{10}O_4$ | 134 | 1.16 |
| 11.63 | Cyclopentane carboxylic acid | $C_8H_{12}O_3$ | 156 | 1.21 |
| 11.74 | Butanoic acid | $C_8H_{16}O_2$ | 144 | 0.04 |
| 14.13 | Galacto-heptulose | $C_7H_{14}O_7$ | 210 | 1.28 |
| 14.36 | Benzeneacetonitrile, 4-hydroxyl acetonitrile | $C_8H_7NO$ | 133 | 6.53 |
| 16.25 | Quinic acid | $C_7H_{12}O_6$ | 192 | 2.82 |
| 18.40 | Myo-inositol | $C_6H_{12}O_6$ | 180 | 0.39 |
| 21.52 | cis-9-Hexadecenal | $C_{16}H_{30}O$ | 238 | 2.90 |
| 23.55 | Salicin | $C_{13}H_{18}O_7$ | 286 | 1.17 |
| 24.61 | 2-dimethyl trimethylsilylmethyl | $C_{11}H_{26}O_2Si_2$ | 246 | 13.60 |
| 24.75 | Hexadecanoic acid, 2-hydroxy | $C_{16}H_{32}O_2$ | 256 | 2.45 |
| 25.05 | Ergost-5-en-3-ol, (3.beta.) | $C_{28}H_{48}O$ | 400 | 4.24 |
| 25.22 | beta.-l-Rhamnofuranoside, 5-O-acetyl | $C_{16}H_{30}O_5S$ | 334 | 2.63 |
| 25.72 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 | 0.26 |
| 25.92 | Ergosta-7,22-dien-3-ol | $C_{28}H_{46}O$ | 398 | 2.92 |

**Table 3** Volatile flavouring compounds present in soup mix from drumstick ($DSM_1$)

| Retention time(min) | Name of the compound | Molecular formula | Molecular weight (g/mol) | Peak area (%) |
|---|---|---|---|---|
| 3.68 | Cyclopentanol, 1-methyl | $C_6H_{12}O$ | 100 | 1.15 |
| 5.22 | 2-Pentanone, 5-(1,2-propadienyloxy) | $C_8H_{12}O_2$ | 140 | 1.22 |
| 5.32 | 2-Pentanethiol, 2-methyl | $C_6H_{14}S$ | 118 | 17.90 |
| 5.50 | Pentane 3 ethyl-2,4-dimethyl | $C_9H_{20}$ | 128 | 0.65 |
| 5.64 | 1-Pentanol, 2,2-dimethyl | $C_7H_{16}O$ | 116 | 9.90 |
| 5.96 | Hexane, 2-nitro | $C_6H_{13}NO_2$ | 131 | 3.68 |
| 6.12 | 2-Pentanone, 3-ethyl-3-methyl | $C_8H_{16}O$ | 128 | 4.24 |
| 6.44 | 3-Hexen 2- one | $C_6H_{10}O$ | 98 | 13.38 |
| 6.87 | Cyclopropane, 1,1,2,2-tetramethyl | $C_7H_{14}$ | 98 | 1.28 |
| 7.06 | 1-Nonen-4-ol | $C_9H_{18}O$ | 142 | 0.41 |
| 11.22 | Benzaldehyde, 4-(1-methylethyl) | $C_{10}H_{12}O$ | 148 | 0.74 |
| 16.64 | 1-Naphthalenol, 1,2,3,4,4a,7,8,8a-octa | $C_{15}H_{26}O$ | 222 | 2.05 |
| 21.46 | 9,12-Octadecadienoic acid | $C_{18}H_{32}O_2$ | 280 | 1.13 |
| 21.53 | cis-9-Hexadecenal | $C_{16}H_{30}O$ | 238 | 1.81 |
| 21.57 | 3H-Indazol-3-one, 1,2-dihydro | $C_{13}H_{10}N_2O$ | 210 | 0.88 |
| 23.68 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 | 0.07 |
| 24.95 | Bis(2-ethylhexyl) phthalate | $C_{24}H_{38}O_4$ | 390 | 2.92 |
| 25.27 | 2,6-Dihydroxybenzoic acid | $C_{16}H_{30}O_4Si_3$ | 370 | 2.50 |
| 26.33 | 2,6-Dimethyl-3,4-bis(trimethylsilyloxymethyl) pyridine | $C_{15}H_{29}NO_2Si_2$ | 311 | 0.82 |
| 29.74 | Piperine | $C_{17}H_{19}NO_3$ | 285 | 7.08 |

**Table 4** Volatile flavouring compounds present in soup mix from drumstick ($DSM_2$)

| Retention time (min) | Name of the compounds | Molecular formula | Molecular weight (g/mol) | Peak area (%) |
|---|---|---|---|---|
| 3.05 | 2-Pentene, 2,4-dimethyl | $C_7H_{14}$ | 98 | 1.84 |
| 3.43 | Toluene | $C_7H_8$ | 92 | 0.77 |
| 3.59 | 2-Hexanone | $C_6H_{12}O$ | 100 | 0.85 |
| 3.68 | Cyclopentanol, 1-methyl | $C_6H_{12}O$ | 100 | 1.37 |
| 5.33 | 2-Pentanethiol, 2-methyl | $C_6H_{14}S$ | 118 | 15.42 |
| 5.65 | Pentane, 3-ethyl-3-methyl | $C_8H_{18}$ | 114 | 8.94 |
| 5.96 | Hexane, 2-nitro- | $C_6H1_3NO_2$ | 131 | 3.63 |
| 6.13 | Ethanone, 1-(3ethyloxiranyl)- | $C_6H_{10}O_2$ | 114 | 4.08 |
| 6.44 | 3-Hexen-2-one | $C_6H_{10}O$ | 98 | 11.71 |
| 6.87 | Cyclopropane, 1,1,2,2 tetramethyl | $C_7H_{14}$ | 98 | 1.27 |
| 7.81 | 3-Hexene-2,5-diol | $C_6H_{12}O_2$ | 116 | 1.00 |
| 11.01 | Cyclohexane, decyl- Decane | $C_{16}H_{32}$ | 224 | 1.83 |
| 11.22 | Propanal, 2-methyl-3-phenyl | $C_{10}H_{12}O$ | 148 | 0.98 |
| 13.88 | Caryophyllene | $C_{15}H_{24}$ | 204 | 0.87 |
| 19.79 | n-Hexadecanoic acid | $C_{16}H_{32}O_2$ | 256 | 0.95 |
| 21.72 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 | 1.27 |
| 24.95 | Bis(2-ethylhexyl) phthalate | $C_{24}H_{38}O_4$ | 390 | 2.94 |

Some of the compounds identified in the soup mixes also possessing biologically active properties like anti-bacterial, antioxidant, anti-inflammatory etc. Octadecadienoic acid have the property of antiinflammatory, hypocholesterolemic and antiarthritic activity which was reported by the earlier workers [10-12].

Piperine is used all over the world for various illnesses. Some health benefits that can be gained from using piperine may be helpful in reducing inflammation, improving digestion, the reduction of pain and the relief of Asthma. It has also been extensively evaluated antidepressant, anticonvulsant [13], antioxidant [14, 15], antimutagenic [16], hepatoprotective [17] endocrine and several other activities [18, 19].

The squalene (triterpene) is a phenolic compound a compound found in very smaller per cent peak area at the retention time of 28.065 min. But it possesses anti-microbial activity, chemopreventive activity against colon carcinogenesis [20]. In addition to antimicrobial activity, the squalene was also reported to have anticancer,

antioxidant, chemopreventive, gastropreventive and hepatoprotective effects, pesticide, anti-tumor and sunscreen properties [21-23].

**Table 5** Volatile flavouring compounds present in stored soup mix from drumstick ($DSM_1$)

| Retention time (min) | Name of the compound | Molecular formula | Molecular weight (g/mol) | Peak area (%) |
|---|---|---|---|---|
| 3.05 | 3-Dodecanol | $C_{12}H_{26}O$ | 186 | 1.91 |
| 3.68 | Cyclopentanol, 1-methyl | $C_6H_{12}O$ | 100 | 1.81 |
| 5.37 | 2-Pentanethiol, 2-methyl | $C_6H_{14}S$ | 118 | 10.79 |
| 6.00 | Hexane, 1-(3-butenyloxy) | $C_{10}H_{20}O$ | 156 | 2.40 |
| 6.16 | Pentane, 3-ethyl-3-methyl | $C_8H_{18}$ | 114 | 2.63 |
| 6.48 | 3-Hexen-2-one | $C_6H_{10}O$ | 98 | 7.77 |
| 19.87 | n-Hexadecanoic acid | $C1_6H_{32}O_2$ | 256 | 13.02 |
| 21.19 | 9-Octadecenoic acid, methyl ester | $C_{19}H_{36}O_2$ | 296 | 1.20 |
| 21.58 | Oleic Acid | $C_{18}H_{34}O_2$ | 282 | 14.37 |
| 21.75 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 | 2.02 |
| 21.93 | Hexadecanamide | $C_{16}H_{33}NO$ | 255 | 1.09 |
| 22.93 | Glycidyl palmitate | $C_{19}H_{36}O_3$ | 312 | 0.96 |
| 24.41 | Ethyl 6,9,12-hexadecatrienoate | $C_{18}H_{30}O_2$ | 278 | 1.15 |
| 24.43 | Glycidyl oleate | $C_{21}H_{38}O_3$ | 338 | 1.21 |
| 24.76 | Hexadecanoic acid, 2-hydroxy-1 (hydroxymethyl)ethyl ester | $C_{19}H_{38}O_4$ | 330 | 1.90 |
| 24.96 | Bis(2-ethylhexyl) phthalate | $C_{24}H_{38}O_4$ | 390 | 1.29 |
| 26.04 | Henicosanal | $C_{21}H_{42}O$ | 310 | 2.32 |
| 26.54 | E,Z-1,3,12-Nonadecatriene | $C_{19}H_{34}$ | 262 | 4.92 |
| 28.36 | 1-Hexacosanol | $C_{26}H_{54}O$ | 382 | 1.28 |
| 29.79 | Piperine | $C_{17}H_{19}NO_3$ | 285 | 1.76 |

**Table 6** Volatile flavouring compounds present in stored soup mix from drumstick ($DSM_2$)

| Retention time (min) | Name of the compound | Molecular formula | Molecular weight (g/mol) | Peak area (%) |
|---|---|---|---|---|
| 2.02 | 3-Dodecanol | $C_{12}H_{26}O$ | 186 | 2.02 |
| 3.60 | 2-Hexanone | $C_6H_{12}O$ | 100 | 0.99 |
| 3.69 | Cyclopentanol, 1-methyl | $C_6H_{12}O$ | 100 | 2.09 |
| 4.29 | 2-Pentanone, 4-hydroxy-4-methyl | $C_6H_{12}O_2$ | 116 | 1.10 |
| 5.38 | Butanoic acid, 2-ethyl-2-methyl | $C_7H_{14}O_2$ | 130 | 10.30 |
| 5.71 | Pentane, 3-ethyl-3-methyl | $C_8H_{18}$ | 114 | 8.24 |
| 6.01 | Pentane, 3-ethyl-2,4-dimethyl | $C_9H_{20}$ | 128 | 3.80 |
| 6.52 | 3-Hexen-2-one | $C_6H_{10}O$ | 98 | 10.77 |
| 6.92 | Cyclopropane, 1,1,2,2-tetramethyl | $C_7H_{14}$ | 98 | 1.70 |
| 7.86 | 2-Pentene, 2,4-dimethyl | $C_7H_{14}$ | 98 | 0.76 |
| 19.88 | n-Hexadecanoic acid | $C_{16}H_{32}O_2$ | 256 | 9.25 |
| 21.59 | Oleic Acid | $C_{18}H_{34}O_2$ | 282 | 11.87 |
| 21.76 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 | 1.04 |
| 22.93 | Glycidyl palmitate | $C_{19}H_{36}O_3$ | 312 | 0.84 |
| 24.76 | Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester $$ Palmitin | $C_{19}H_{38}O_4$ | 330 | 2.32 |
| 24.88 | Docosanoic acid, methyl ester | $C_{23}H_{46}O_2$ | 354 | 0.10 |
| 25.12 | Ergost-5-en-3-ol, (3.beta.) | $C_{28}H_{48}O$ | 400 | 1.72 |
| 26.55 | E,Z-1,3,12-Nonadecatriene | $C_{19}H_{34}$ | 262 | 1.39 |
| 29.33 | Hexatriacontane | $C_{36}H_{74}$ | 506 | 4.29 |
| 29.80 | Piperine | $C_{17}H_{19}NO_3$ | 285 | 1.95 |

Oleic acid, a Steric acid found in the soup mixes have a property of Anti-inflammatory, anti-androgenic, anti-cancer, preservative and hypocholesterolemic effect and the phytol has Antinociceptive, Antioxidant, anticancer, anti-inflammatory, Diuretic, and chemopreventive properties [24]

In the present study, it was noticed that apparently, quite a number of volatiles found in the fresh drumstick, drumstick powder and soup mixes were absent in the end product while several volatiles compounds were generated *in situ*. These developments may be a function of thermal processing culminating perhaps in either the release of volatiles already existing in the ingredients or degradation of amino acids, sugars, nucleotides and /or maillard reactions occurring between amino acids and reducing sugars. The findings reported by Qin *et al.* [25] in the button mushroom soup mix were found to be similar to the present investigation.

The flavor quality of dehydrated lime was analysed by Ramesh Yadav *et al.* [26]. They reported that in the dehydrated lime fruit sample, all volatile components were found to be present, when compared with fresh fruit, though changes were noticed in their quantities. The overall flavor quality of the dried fruit changed accordingly.

Dev *et al.* [27] analysed the volatile compounds present in the *Moringa oleifera* pods and reported that the volatile compounds 2, 3- dihydro - 3, 5- dihydroxy - 6 - methyl - 4H -pyran - 4 - one, n-hexadecanoic acid and 9, 12 - octadecanoic acid present in the fresh sample and dehydrated samples. Similar picture was exhibited in the present study too.

**Table 7** depicts the comparative analysis of volatile flavour compound present in drumstick powder, fresh and stored soup mixes. The flavouring compounds octadecanoic acid, 3-hexen2-one and cyclopentanol, 1 -methyl was present in drumstick powder ($DP_1$ and $DP_2$) and soup mixes before and after storage ($DSM_1$ and $DSM_2$). The retention time and the percentage of peak area of the flavouring compounds retained were on par in all the samples taken for the study.

**Table 7** Comparative analysis of volatile flavour compounds present in drumstick powder, fresh and stored soup mixes

| S.No | Retention time (min) | Name of the compound | Molecular formula | Molecular weight (g/mol) |
|---|---|---|---|---|
| 1. | 3.69 | Cyclopentanol, 1-methyl | $C_6H_{12}O$ | 100 |
| 2. | 6.52 | 3-Hexen-2-one | $C_6H_{10}O$ | 98 |
| 3. | 21.76 | Octadecanoic acid | $C_{18}H_{36}O_2$ | 284 |

## Conclusion

The volatile flavouring compounds present in the drumstick powder, fresh soup mix from drumstick and stored soup mix from drumstick was analysed by using GC - MS. The compounds such as octadecanoic acid, 3-hexen2-one and cyclopentanol, 1 - methyl was found in all the samples taken for the study. Among the identified compounds, octadecanoic acid, n-hexadecanoic acid, squalene and piperine has role in antioxidant, antimicrobial, anticancer, antidiabetic and antiiflammatory effects.

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