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# Volatile components of mangaba fruit (*Hancornia speciosa* Gomes) at three stages of maturity

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**Abstract**

The effect of stage of maturity on the volatile components of mangaba fruit (*Hancornia speciosa* Gomes) growing at Sergipe State, Brazil, was investigated at three different stages. The volatile profile obtained by hydrodistillation, using a Clevenger-type apparatus, was analysed by GC–FID and GC–MS. It was possible to identify 33 compounds in the immature fruits, such as 1-octen-3-ol (2.8%), (*Z*)-linalool oxide (9.1%), (*E*)-linalool oxide (6.3%), linalool (16.1%), 2-phenylethanol (4.5%), α-terpineol (5.5%), geraniol (3.1%), hexadecanal (2.5%) and octadecanol (2.7%); 34 compounds in the fruits at the intermediate stage, such as ethyl propanoate (4.1%), *n*-propyl acetate (11.1%), 3-methyl-3-buten-1-ol (6.8%), 2-methyl propyl acetate (2.5%), furfural (18.6%), (*Z*)-3-hexenol (3.2%), 1-hexanol (2.4%), 3-methyl-3-buten-1-yl acetate (5.4%), (*Z*)-3-hexen-1-yl acetate (2.9%), *n*-hexyl acetate (3.3%), (*Z*)-linalool oxide (3.9%), (*E*)-linalool oxide (2.4%), linalool (3.8%), 2-phenylethanol (2.8%) and α-terpineol (2.5%); and 32 components in the mature fruits, such as 3-hydroxy-2-butanone (9.1%), 2,4,5-trimethyl-1,3-dioxolane (6.8%), 3-methyl-3-buten-1-ol (12.1%), 3-methyl-1-butanol (5.2%), furfural (8.3%), 3-methyl-1-butanyl acetate (8.8%) and 3-methyl-3-buten-1-yl acetate (28.2%).


*Keywords:* Mangaba; *Hancornia speciosa* Gomes; Apocynaceae; Volatile compounds

## 1. Introduction

Brazil has a natural abundance of tropical fruits with distinctive exotic flavours appealing to the foreign consumer. The northeastern region of Brazil has a natural diversity of fruits, many of them are considered exotic, presenting different flavours and aromas. The enormous diversity of fruits represents a promising area for research on aromas, with unusual sensory properties, and also for attracting the attention of consumers worldwide. Fruits with a high market potential, such as mango and guava, and also many others, are so far only regionally important (Pino & Marbot, 2001). There is also great potential for the manufacture of juices, desserts and other processed products. However, the flavours and aromas of most of these fruits have not yet been characterised.

Mangaba (*Hancornia speciosa* Gomes, Apocynaceae) is a Brazilian tropical fruit from these regions with an exotic flavour and aroma. The fruit is an ellipsoid or spherical berry, 2.5–6 cm in length, with white pulp, sweet, acid, and viscous. The pulp is eaten fresh or consumed as juice. It is also consumed as ice cream, jellies, confectionery and liquor, and is greatly appreciated by the local population (Vieira Neto, 2002). The latex in the fruits is an advantage for the preparation of ice-creams and jellies. In traditional medicine, this latex is used to protect against gastric disorders and tuberculosis. When unripe, fruits have high contents of latex, which decrease according to the maturity stage.

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Volatile compounds are responsible for the aroma and flavour of foods. However, the chemical composition, including the distribution of aroma compounds, is dependent on the species, environmental conditions and stage of maturity of the fruit. Substantial qualitative and quantitative differences in volatile compounds have been identified in many different fruits, depending on the stage of development (Vendramini & Trugo, 2000; Visai & Vanoli, 1997). The aim of this work was to analyse the chemical composition of the aroma of mangaba fruits from the northeastern region of Brazil at three stages of maturity. To the best of our knowledge, there are no previous reports on *Hancornia speciosa* volatile composition.

## 2. Material and methods

### 2.1. Plant material

Mangaba (*Hancornia speciosa* Gomes) fruits were harvested from different trees in the region of Abaís, Sergipe State, Brazil, between October, 2002 and June, 2003. Fresh fruits were picked at three different stages of maturity, based on the colour of the peel (Alves, Carnelossi, Silva, & Figueiredo, 2003). For the present study, green colour of the peel was chosen as the initial stage (immature fruit), green-yellow colour of the peel as the intermediate stage and yellow colour of the peel as the mature fruit.

The macerate of fresh mangaba fruit (500 g of each sample according to stage of maturity) was mixed with distilled water (1000 ml) and submitted to hydrodistillation for 3 h, using a Clevenger-type apparatus. The volatile compounds were extracted from the distillation water with dichloromethane, dried over anhydrous sodium sulphate and carefully concentrated under $N_2$ to a final volume <0.5 ml. Two extraction of each sample were performed and then analysed by GC–FID and GC–MS.

### 2.2. GC–FID and GC–MS analysis

#### 2.2.1. GC–FID

Analyses were carried out using a Shimadzu 17A gas chromatograph instrument equipped with J&W Scientific DB-5 fused silica capillary column (30 m × 0.25 mm i.d. × 0.25 μm film thickness); column temperatures were programmed from 40 °C for 2 min, raised to 220 °C at 4 °C/min, then raised to 280 °C at 20 °C/min. Injector and detector temperatures were 250 and 280 °C, respectively. Hydrogen was used as carrier gas at a flow rate 1.5 ml/min in the split mode, with an injection volume of a 1.5-μl solution in ethyl acetate. The percent composition of each component was determined from the area of the component divided by the total area of all components isolated under these conditions.

#### 2.2.2. GC–MS

Mass spectra were obtained using a Shimadzu QP5050A gas chromatograph–mass spectrometer. The carrier gas was helium and the programme was the same as that for the GC–FID experiments. The MS were taken at 70 eV with a scanning speed of 0.5 scan/s from *m/z* 40–550. The retention indices were obtained by co-injecting the oil sample with a $C_{10}$–$C_{24}$ linear hydrocarbon mixture (retention index in 700–999 range was obtained by extrapolation).

The volatile components were analysed by GC–FID and GC–MS, and identification was by comparison of retention indices (Van den Dool & Kratz, 1963) as well as by computerised matching of the acquired mass spectra with those stored in the NIST mass spectral library of the GC/MS data system and other published mass spectra (Adams, 1995).

## 3. Results and discussion

The volatile compositions obtained by hydrodistillation of mangaba fruits at three stages of maturity, are listed in Table 1. Replicate analyses revealed no significant changes in chemical composition, only a small variation in relative abundance. Thus, it was possible to identify 33 compounds in the immature fruits, such as 1-octen-3-ol (2.8%), (*Z*)-linalool oxide (9.1%), (*E*)-linalool oxide (6.3%), linalool (16.1%), 2-phenylethanol (4.5%), α-terpineol (5.5%), geraniol (3.1%), hexadecanal (2.5%) and octadecanol (2.7%); 34 compounds in the fruits at intermediate stage, such as ethyl propanoate (4.1%), *n*-propyl acetate (11.1%), 3-methyl-3-buten-1-ol (6.8%), 2-methyl propyl acetate (2.5%), furfural (18.6%), (*Z*)-3-hexenol (3.2%), 1-hexanol (2.4%), 3-methyl-3-buten-1-yl acetate (5.4%), (*Z*)-3-hexen-1-yl acetate (2.9%), *n*-hexyl acetate (3.3%), (*Z*)-linalool oxide (3.9%), (*E*)-linalool oxide (2.4%), linalool (3.8%), 2-phenylethanol (2.8%) and α-terpineol (2.5%); and 32 components in the mature fruits, such as 3-hydroxy-2-butanone (9.1%), 2,4,5-trimethyl-1,3-dioxolane (6.8%), 3-methyl-3-buten-1-ol (12.1%), 3-methyl-1-butanol (5.2%), furfural (8.3%), 3-methyl-1-butanyl acetate (8.8%) and 3-methyl-3-buten-1-yl acetate (28.2%).

The volatile analyses showed an obvious difference, both in qualitative and relative abundance, of major components, according to stage of maturity (Table 1, Fig. 1). Thus, it became apparent that fruits at the initial stage (immature) present oxygen-containing monoterpenes, such as (*Z*)-linalool oxide (35, Table 1), (*E*)-linalool oxide (36, Table 1) and linalool (38,

Table 1
Volatile composition of mangaba fruit (*Hancornia speciosa*) at three stages of maturity[a,b]

| | Compounds | RI[a] | Peak area (%) | | |
|---|---|---|---|---|---|
| | | | Immature | Intermediate | Mature |
| 1 | 3-Hydroxy-2-butanone | 721 | – | 1.6 | 9.1 |
| 2 | Ethyl propanoate | 726 | – | 4.1 | – |
| 3 | *n*-Propyl acetate | 728 | – | 11.1 | – |
| 4 | 2,4,5-Trimethyl-1,3-dioxolane | 745 | – | – | 6.8 |
| 5 | 3-Methyl-3-buten-1-ol | 746 | – | 6.8 | 12.1 |
| 6 | 3-Methyl-1-butanol | 747 | – | 1.2 | 5.2 |
| 7 | NI | 759 | – | – | 0.4 |
| 8 | NI | 776 | – | 0.4 | – |
| 9 | 2-Methyl propyl acetate | 786 | – | 2.5 | – |
| 10 | 3-Penten-2-ol | 789 | – | tr | – |
| 11 | 3-Methyl-2-butenal | 796 | – | 2.0 | 1.3 |
| 12 | Hexenal | 801 | – | 1.3 | – |
| 13 | *n*-Butyl acetate | 802 | – | – | 1.2 |
| 14 | Furfural | 834 | – | 18.6 | 8.3 |
| 15 | 2-Propryl furan | 845 | – | – | 0.4 |
| 16 | (*E*)-2-hexenal | 850 | – | 0.6 | – |
| 17 | (*Z*)-3-hexenol | 855 | 2.1 | 3.2 | 0.3 |
| 18 | 1-Hexanol | 867 | 1.7 | 2.4 | 0.3 |
| 19 | 3-Methyl-1-butanyl acetate | 874 | – | 1.0 | 8.8 |
| 20 | 3-Methyl-3-buten-1-yl acetate | 881 | – | 5.4 | 28.2 |
| 21 | 3-Methyl-2-buten-1-yl acetate | 919 | – | 0.5 | 1.1 |
| 22 | Isocitronellene | 926 | – | 0.4 | 0.4 |
| 23 | 5-Methyl-furfural | 964 | – | – | 0.2 |
| 24 | 2-Octanone | 984 | – | – | 0.1 |
| 25 | 1-Octen-3-ol | 985 | 2.8 | – | 0.4 |
| 26 | (*Z*)-3-hexen-1-yl acetate | 1007 | 1.8 | 2.9 | 0.2 |
| 27 | *n*-Hexyl acetate | 1014 | 1.1 | 3.3 | 0.5 |
| 28 | 2-Hexen-1-yl acetate | 1016 | – | 0.6 | – |
| 29 | 1,4-Cyclohex-2-enedione | 1024 | – | 1.4 | 0.5 |
| 30 | 2-Ethyl-1-hexanol | 1028 | 1.5 | – | – |
| 31 | Benzylalcohol | 1030 | – | – | 0.2 |
| 32 | NI | 1035 | 0.8 | – | – |
| 33 | Phenylacetaldehyde | 1040 | 0.6 | 0.9 | 0.4 |
| 34 | NI | 1049 | 0.5 | – | – |
| 35 | (*Z*)-linalool oxide | 1070 | 9.1 | 3.9 | 0.6 |
| 36 | (*E*)-linalool oxide | 1086 | 6.3 | 2.4 | 0.4 |
| 37 | Methyl benzoate | 1092 | – | – | 0.4 |
| 38 | Linalool | 1097 | 16.1 | 3.8 | 0.4 |
| 39 | Nonanal | 1101 | – | 0.8 | – |
| 40 | (*Z*)-2-hexenyl butanoate | 1103 | 1.9 | – | – |
| 41 | 2-Phenylethanol | 1109 | 4.5 | 2.8 | 0.2 |
| 42 | NI | 1120 | – | – | 0.3 |
| 43 | Benzyl acetate | 1162 | – | – | 0.2 |
| 44 | Ethyl benzoate | 1169 | – | – | tr |
| 45 | NI | 1183 | – | 0.9 | 1.2 |
| 46 | α-Terpineol | 1190 | 5.5 | 2.5 | 0.5 |
| 47 | Methyl salicylate | 1192 | – | 0.8 | 0.3 |
| 48 | *n*-Decanal | 1204 | 0.7 | – | – |
| 49 | Nerol | 1227 | 1.0 | – | – |
| 50 | 3-Phenoxy-1-propanol | 1244 | 1.7 | – | – |
| 51 | Geraniol | 1254 | 3.1 | 0.8 | – |
| 52 | (*E*)-2-decenal | 1260 | 1.4 | 0.7 | – |
| 53 | NI | 1280 | – | 0.5 | – |
| 54 | NI | 1281 | 1.8 | – | – |
| 55 | NI | 1308 | – | 0.4 | – |
| 56 | Vinylguaiacol | 1312 | 0.6 | – | – |
| 57 | (*E*,*E*)-2,4-decadienal | 1315 | 0.7 | 0.6 | – |
| 58 | Eugenol | 1357 | 0.7 | tr | – |
| 59 | 2-Undecenal | 1363 | – | 0.4 | – |
| 60 | (*E*)-β-damascenone | 1386 | 0.5 | tr | – |
| 61 | Tetradecane | 1400 | 1.2 | – | – |

Table 1 (*continued*)

| | Compounds | RI[a] | Peak area (%) | | |
|---|---|---|---|---|---|
| | | | Immature | Intermediate | Mature |
| 62 | β-Caryophyllene | 1422 | 0.5 | – | – |
| 63 | γ-Decalactone | 1465 | – | – | 0.1 |
| 64 | NI | 1496 | 1.0 | – | – |
| 65 | Pentadecane | 1500 | 1.6 | – | – |
| 66 | Nerolidol | 1563 | 0.7 | – | – |
| 67 | Hexadecane | 1600 | 1.1 | – | – |
| 68 | NI | 1649 | 0.5 | – | – |
| 69 | Heptadecane | 1700 | 1.0 | – | – |
| 70 | NI | 1707 | 0.5 | – | – |
| 71 | NI | 1712 | 0.6 | – | – |
| 72 | Octadecane | 1800 | 1.1 | – | – |
| 73 | Hexadecanal | 1811 | 2.5 | – | – |
| 74 | Isopropyl miristate | 1816 | 1.7 | 1.6 | – |
| 75 | NI | 1858 | 1.6 | – | – |
| 76 | NI | 1923 | 0.7 | – | – |
| 77 | NI | 1937 | 0.6 | – | – |
| 78 | 2-Methyl-2-dodecanol | 2061 | 1.4 | – | – |
| 79 | Octadecanol | 2081 | 2.7 | – | – |
| | Total | | 89.5 | 95.1 | 91.0 |

[a] RI, retention indices on DB-5 column.
[b] tr, traces (mean value below 0.1%); NI, compounds not identified.

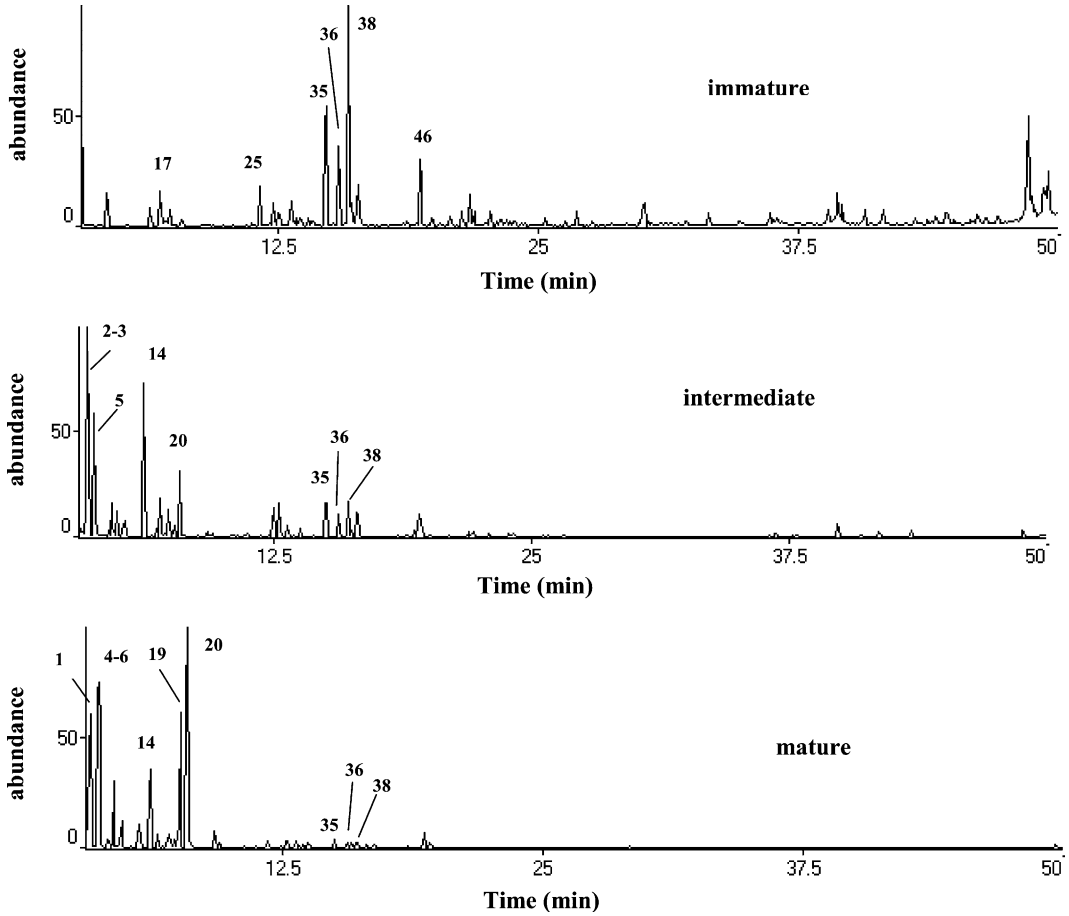


Fig. 1. Total ion chromatograms of the hydrodistilled volatiles of mangaba fruits (*Hancornia speciosa*) at three stages of maturity. Peak numbers corresponding to the identification of the compounds are cited in Table 1.

Table 1) in a higher relative percentage (51.5%), while esters (6.5%), alcohols (18.4%), aldehydes (5.9%) and ketones (0.5%) were detected at low percentages. Nonetheless, esters (40.9%) [mainly 3-methyl-1-butanyl acetate (19, Table 1), 3-methyl-3-buten-1-yl acetate (20, Table 1)], alcohols (18.4%) [mainly 3-methyl-3-buten-1-ol (5, Table 1), 3-methyl-1-butanol (6, Table 1)], aldehydes (10.2%) [such as furfural (14, Table 1)] and ketones (9.7%) [such as 3-hydroxy-2-butanone (1, Table 1)] predominated in the fruits at the final stage (mature) while the percentage of oxygen-containing monoterpenes was very reduced (1.9%). Finally, the volatile profile of the fruits at the intermediate stage showed esters (33.8%), alcohols (16.4%), aldehydes (25.3%) and ketones (3.0%) like those found in mature fruits, but at an intermediate percentage. In the same way, there was an intermediate percentage of oxygen-containing monoterpenes (13.4%) as was also observed in higher amounts in immature fruits. The analyses showed that ca. 80% of the compounds detected in the mature fruits were esters (40.9%), alcohols (18.4%), aldehydes (10.2%) and ketones (9.7%). These groups of compounds contribute markedly to the fruity note of fruits (Mathesis, Buchanan, & Fellman, 1992). Therefore, the composition of the volatile components at different stages of maturity studied in this work seems to be in accordance with analysis of other fruits in the literature (Alves & Jennings, 1979; Maia, Andrade, & Zoghbi, 2004; Vendramini & Trugo, 2000).

These results are the first reported on the volatile chemical composition of mangaba fruit and show that great changes occur in the volatile profile of this fruit during the maturation process. They can be used as an indicator of the maturation process of such fruits.

Further experiments are underway to investigate the influence of the extraction methods, such as headspace sampling using Porapak Q and SPME, on volatile profile of mangaba fruits.

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