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Characterization of aroma components of sap from different Indian mango varieties

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Abstract

Saps (latex) from seven Indian mango varieties were collected immediately after destalking the mature fruit. The amount of sap so collected varied from variety to variety. Sap was separable into two phases, aqueous and nonaqueous, and their ratio was different for each variety. GC-MS analysis of the nonaqueous phase of saps revealed that they mainly consisted of monoterpenes viz, β-myrcene, *trans*-/*cis*-ocimene and limonene being major. There were however, differences in the composition and concentrations of these terpenoid compounds.

Keywords: *Mangifera indica*; Anacardiaceae; Mango sap; Nonaqueous phase of sap; Aroma components; Terpenes

1. Introduction

The mango, commonly referred to as the 'king of fruits' in Asia, is one of the most important tropical fruits of the world. India is the world's largest producer of mango and a major portion of the produce is consumed locally as fresh fruit (Mukherjee, 1997). During harvest, when the mango is severed from the pedicel at the abscission zone, sap (latex) contained within the fruit ducts (lactifers), spurts out. When the sap comes in contact with the fruit, it causes sap-injury, a superficial damage characterized by darkening of the peel, with injured areas becoming particularly susceptible to pathogenic infections. One way to reduce sap-injury is by careful desapping of mangoes after harvesting them with their stems intact. A significant amount of sap, which has a raw mango aroma, accumulates as a by-product. In the present study, the nonaqueous phase of saps from seven Indian mango varieties were separated and their chemical composition was characterized by GC-MS analysis.

2. Results and discussion

Sap collected from different mango varieties viz, *Badami, Banganapalli, Malgoa, Raspuri, Seedling, Mallika, Totapuri* was a viscous liquid with a pH of 3.5–4.0 and aroma characteristic of the raw fruit. The sap yield varied in different varieties. *Malgoa, Seedling, Mallika* and *Banganapalli* varieties yielded 25.2, 22.5, 21.0 and 18.5 ml of sap per 10 kg of fruit respectively (Table 1) whereas much lower amounts were obtained from *Badami, Raspuri* and *Totapuri* varieties (10–11 ml per 10 kg of fruit). The collected sap had a tendency to separate into two phases — an upper light, pale-yellow coloured, nonaqueous layer and a lower viscous, colourless, aqueous layer. Centrifugation of the sap was performed to accelerate the process of its separation into the constituent phases as in the case of *Kensington* and *Irwin* varieties by Loveys, Robinson, Brophy and Chacko (1992). The ratio of the nonaqueous phase to the aqueous phase was found to be different in different varieties (Table 1). The *Seedling* and *Totapuri* varieties had nonaqueous to aqueous ratios of about 1:2, and *Mallika* and *Badami* had about 1:3 and 1:4 respectively, indicating the presence

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Table 1
Nonaqueous and aqueous phases of mango sap

S. No.	Variety	Volume (ml/10 kg mango)			Ratio (nonaqueous/aqueous)
		sap	nonaqueous phase	aqueous phase	
(1)	*Totapuri*	11.0	3.7	7.3	1:2.0
(2)	*Seedling*	22.5	6.8	15.7	1:2.3
(3)	*Mallika*	21.0	5.4	15.7	1:3.0
(4)	*Badami*	10.0	2.0	8.0	1:4.0
(5)	*Raspuri*	11.0	1.4	9.6	1:7.0
(6)	*Banganapalli*	18.5	1.5	17.0	1:11.0
(7)	*Malgoa*	25.2	1.8	23.4	1:13.0

of relatively large amounts of nonaqueous phase in these varieties, whereas *Malgoa, Banganapalli* and *Raspuri* varieties yielded very little nonaqueous phase with ratios of 1:13, 1:11 and 1:7 respectively. It is interesting to note that the varieties like *Banganapalli, Malgoa* and *Raspuri*, that are popularly used as ripe fresh fruit, had less nonaqueous phase content compared to less popular varieties like *Totapuri* and *Seedling* which are, in fact, either consumed as raw mango preparations or are pickled.

The nonaqueous portions of all the 7 mango varieties were analysed by GC-MS and found to contain mostly monoterpene hydrocarbons, viz. β-myrcene, *cis*-/*trans*-ocimene and limonene. The major constituent of the sap from *Totapuri, Raspuri, Seedling* and *Malgoa* was β-myrcene (50–80%) whereas in *Banganapalli* and *Badami* -ocimene (around 90%) and in *Mallika*, limonene (61%) were the major constituents. α-Pinene, *trans*-alloocimene were present in considerable amounts in certain varieties. β-Pinene, τ-terpinene, α-copaene, β-caryophyllene and α-humulene were present in these varieties as minor components (0.20 to 2.96). Incidentally, Gholap and Bandhyopadhyay (1977) have reported the presence of only *cis*-ocimene in the latex of *Alphonso* (synonymous with *Badami*) and β-myrcene in the *Batali* varieties. Loveys et al. (1992) have reported the presence of terpinolene (83.7%) and car-3-ene (89.8%) in Australian *Kensington* and *Irwin* varieties respectively, as major components. But neither of these compounds was detected in any of the Indian mango varieties here studied.

Monoterpene hydrocarbons were reported to be the major aroma constituents of mango (Bandhyopadhyay & Gholap, 1979; Hunter, Bucek & Radfort, 1974; Idstein & Schrier, 1985; Macleod, Macleod & Snyder, 1988; Macleod & Troconis, 1982). Bandhyopadhyay and Gholap (1979) reported the presence of *cis*-ocimene and β-myrcene in the pulps of *Alphonso* and *Totapuri* mango varieties respectively. Interestingly, in the present study the saps of these two varieties were found to contain *cis*-ocimene and β-myrcene as the major aroma components (Table 2). Previous report by MacLeod et al. (1988)

Table 2
Percentage composition of terpene components in saps from different mango varieties

RT (min)	Compound	Variety							KI^{cal}
		Badami	*Banganapalli*	*Malgoa*	*Raspuri*	*Seedling*	*Mallika*	*Totapuri*	
5.13	α-pinene	–	1.07	23.58	1.03	16.53	22.29	16.80	937
6.44	β-pinene	–	–	2.43	–	1.46	2.34	1.95	975
7.17	β-myrcene	2.07	0.32	58.89	66.17	77.57	10.38	49.42	987
8.32	limonene	–	–	–	–	0.25	61.04	0.39	1025
9.53	*cis*-ocimene	82.83	1.37	10.68	–	–	–	–	1044
9.87	*trans*-ocimene	–	90.95	1.21	22.28	0.54	–	22.78	1049
9.98	τ-terpinene	2.54	–	–	1.63	0.21	–	1.24	1055
13.95	*transallo* ocimene	11.56	–	0.90	1.53	–	–	2.53	1125
28.68	α-copaene	–	–	0.28	0.22	1.20	–	0.28	1378
31.01	β-caryophyllene	1.50	2.96	1.49	2.03	0.37	2.67	0.87	1414
32.54	α-guaiene	–	–	–	–	–	–	0.27	1441
32.98	α-humulene	–	1.65	0.83	1.11	0.20	1.29	0.55	1448
34.56	*allo*-aromadendrene	–	–	–	–	–	–	0.22	1474
34.85	τ-gurujunene	–	–	–	–	–	–	0.35	1479
35.86	δ-cadinene	–	–	–	–	–	–	0.20	1495

indicated the presence of terpinolene as the major aroma component of the pulp of *Kensington* variety of mango and subsequently, Loveys et al. (1992) reported terpinolene in the sap of the same variety. These studies indicate that the pulp and sap of a particular mango variety share similar terpenoid compounds.

In addition to terpenoids, mango fruit also contain several esters, alcohols and lactones (Bandhyopadhyay & Gholap, 1979; Hunter et al., 1974; Idstein & Schrier, 1985; Macleod & Troconis, 1982; Macleod et al., 1988). The raw mango flavour is essentially due to terpenoids, the aroma of the ripe fruit is due to the other aroma components. It is probable that esters, alcohols and lactones develop during the ripening process whereas sap imparts the raw mango aroma to the unripe fruit.

The aroma components of the ether extract of whole sap were also subjected to GC-MS analysis. The results indicated that there is no significant difference between the composition of the nonaqueous phase and that of the ether extract. This implies that simple centrifugation is sufficient to extract all the aroma components present in sap. Sap nonaqueous phase can thus be used directly in various confectionery items, bakery products and beverages, to impart the raw mango aroma. Certain terpenoids such as β-myrcene, ocimene, limonene, α- and β-pinene are being used in low concentrations (ppm) as aroma components in various processed foods like baked goods, frozen dairy products, meat products, condiments, relish, soft candies, gelatin, puddings, nonalcoholic and alcoholic beverages, cheese, chewing gum etc. (Burdock, 1995). Besides this, the individual components of sap can be used as raw materials for nature-identical aroma chemicals. Preliminary studies carried out in our laboratory (Saby John, Ramana, Bhat & Prasada Rao, 1997) and the results of Joel, Marbach and Mayer (1978) indicate that the aqueous phase of mango sap contains oxidative enzymes like polyphenol oxidase, peroxidase. Thus, the mango sap which is a potential source of natural food aroma and enzymes may be considered as a valuable agri-horticulture by-product.

3. Experimental

3.1. Plant materials

Mango varieties *Badami, Totapuri, Raspuri, Malgoa, Seedling* grown in CFTRI campus, Mysore, Karnataka, *Mallika* variety grown in Kolar, Karnataka and *Banganapalli* variety grown in Chirala Andhra Pradesh were used in this study.

3.2. Collection of mango sap

Mango fruits were harvested with pedicels (about 2 inches long) intact. Subsequently, the pedicel was detached from the fruit at the abscission zone, the fruit was immediately inverted over a glass tube and the sap was allowed to flow into the glass tube for about 1 min.

3.3. Separation of aroma components

Two methods were used to obtain aroma components from sap:

1. Centrifugation: mango sap was separated into upper nonaqueous and lower aqueous phase by centrifugation at $3000 \times g$ for 5 min at room temperature (Loveys et al., 1992). The nonaqueous layer was stored at $-20^{\circ}C$ whereas the aqeous layer was stored at $4^{\circ}C$.
2. Extraction: to the freshly obtained whole sap taken in a separating funnel, two equal volumes of peroxide free distilled diethyl ether were added. This was shaken well and then allowed to settle. The upper ethereal layer containing the extracted aroma components was removed, distilled and the distillate was stored at $-20^{\circ}C$ until use.

3.4. GC-MS analysis

The aroma components of the sap from different varieties were analysed using a Schimadzu 17A-GC chromatograph equipped with a QP-5000 (quadrapole) mass spectrometer. The samples were diluted 15 times with acetone and 1 μl was injected. A fused silica capillary column SPB-1 (30 m × 0.32 mm i.d., film thickness 0.25 μm), coated with polydimethyl siloxane, was used. Helium was the carrier gas at a flow rate of 1 ml/min; injector temperature was $250^{\circ}C$; detector temperature was $250^{\circ}C$ and initial oven temperature $50^{\circ}C$ for 3 min. The temperature was later increased to $250^{\circ}C$ at the rate of $2^{\circ}C$/min. This temperature was maintained for 5 min; splitting ratio 1:50; ionization voltage, 70 eV. Retention indices for all the compounds were determined according to the Kovats method using n-alkanes as standards (Jennings & Shibamoto, 1980). The compounds were identified by comparison of Kovats indices and by co-injection with an authentic specimen; and also by matching their fragmentation patterns in mass spectra with those of NIST library and published mass spectra. (Adams, 1989; Jennings & Shibamoto, 1980).

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