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# Aroma Changes in Mango Juice during Processing and Storage

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## *ABSTRACT*

*Mango juice was analysed after bottling and during storage for 2 and 4 months, in order to follow the changes in aroma constituents which have an adverse influence on the juice quality. Heat processing at 85°C/10 min caused the reduction of all volatile fractions due to evaporation and, in addition, the formation of acetyl furan, 5-methyl furfural, β-terpineol, terpinen-4-ol and butyl-3-hydroxy butanoate, which were not found in fresh juice. These compounds were attributable to degradation reactions and especially to ascorbic acid. Storage of bottled mango juice at room temperature resulted in the appearance of ethyl fatty acids and seline-11-ene-4-ol, in addition to a decrease in hydrocarbons and oxygenated components; these very important factors affected the flavour of mango juice.*

*According to these findings, the furan derivatives, α- and β-terpineol, terpinen-4-ol and ethyl fatty acids, are detrimental factors resulting from heat-processing and storage of bottled mango juice.*

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## INTRODUCTION

The volatile components of fruit juices play a very important role in influencing the sensory quality of juices, particularly following heat-processing and storage. Among fruit products, mango juice has been extensively investigated (Hunter *et al.*, 1974; Diaz, 1980; Abd El-Baki *et al.*, 1981; Engel & Tressl, 1983; Gholap & Bandyopadhyay, 1984; Sakho *et al.*, 1985*a*; El-Nemr & Askar, 1986).

The results obtained by most of these authors concern the identification and distribution of the volatile components among the varieties and between the pulp and serum of mango juice. Little information regarding the changes of aroma volatile constituents during heat-processing and storage of mango juice is available. Sakho *et al.* (1985*b*) studied the change in mango volatile components during heating. Aboul-Enein *et al.* (1983) investigated the effect of gamma irradiation on the mango volatiles during ripening. Jain *et al.* (1959) studied the nutritive value and flavour of mango juice during storage in cans. Also the effect of different processing conditions on physical and chemical characteristics of mango juice was studied by Muhammad *et al.* (1965). On the other hand, Bielig & Askar (1974) investigated the aroma deterioration during the manufacture and storage of orange juice in bottles. They found an increase in carbonyl compounds during the first two months of storage and they proposed α-terpineol as an index for predicting the storage time.

Kirchner & Miller (1957) studied the volatile constituents of fresh, freshly canned and stored California Valencia orange juice. The major changes were the loss of total volatile oil, conversion of part of the hydrocarbons to alcohols and loss of esters, aldehydes and terpene aliphatic alcohols.

The objective of the present study was to determine the effect of processing and storage on aroma volatile constituents of bottled mango juice.

## MATERIALS AND METHODS

An Egyptian commercial variety of mango, Zebda, was selected. This kind is recognized for its late ripening with a relatively large size and delicate aroma. The juice was extracted using the method described by Askar *et al.* (1981), and analyzed (i) fresh, (ii) after bottling at 85°C/10 min, and (iii) after storage of the bottled juice for 2 and 4 months at room temperature (20–25°C). Three hundred grams of mango juice were homogenized with 500 ml of a phosphate buffer solution at pH 6·8; tridecane and 1-heptanol were added as internal standards. The volatile aroma compounds were extracted using fresh distilled pentane-diethylether (1:1) in a modified Likens and Nickerson apparatus (Schultz *et al.*, 1977).

The aroma extracts were dried over anhydrous $Na_2SO_4$ and then concentrated using a vigreux column over a water bath at 42–45°C to a volume of 0·3 ml. The aroma compounds were then separated by adsorption chromatography to hydrocarbon and oxygenated fractions (Engel & Tressl, 1983).

The fractions were analyzed by capillary GLC and capillary GLC–mass spectrometery. The conditions of Carlo Erba Fractovap 2900 capillary GLC were: 50 m glass column (0·25 mm-i.d.) coated with carbowax 20M and the column was programmed from 70 to 180°C at 2°C/min; the helium flow rate was 2 ml/min, a flame ionization detector was used and set at a temperature of 250°C. For the capillary GLC–mass spectrometery, a 50 m glass column (0·32 mm-i.d.) coated with UCON (LB-1715, Hewlett-Packard, FRG) was connected to a double-focusing mass spectrometer CH5-DF (Varian MAT, FRG). The column temperature program was 70–180°C at 2°C/min, ionization voltage 70 eV, ion source temperature 200°C and resolution 2000 (10% Valley). The volatiles were characterized and identified according to the component retention time (*Rt*). Kovats index ($I_K$) and mass spectra in comparison to authentic samples.

## RESULTS AND DISCUSSION

The changes in concentrations of the main volatile fractions in fresh material, after heat-processing and during storage of mango juice are shown in Fig. 1. There was a sharp decrease in all volatile fractions after processing, probably due to evaporation, especially of the ester fractions. All the volatile fractions were slightly increased with the time of storage, particularly alcohols and lactones compared with the fresh sample, which may be attributable to the conversion of hydrocarbons to alcohols. Similar trends were reported by Kirchner & Miller (1957).

Although the heating process caused the reduction of all aroma components which affected the juice quality, this treatment also resulted in the formation of some compounds which were not found in the fresh juice (Table 1). The production of acetyl furan and 5-methylfurfural was due to reactions between the reducing sugars and amino acids during the heat processing of mango juice as described by Scanlan *et al.* (1973), or was related to the degradation of ascorbic acid during the same treatment (Tatum *et al.*, 1969; Sakho *et al.*, 1985*b*). In addition, furfural was found in the fresh juice and increased after processing and during storage. The sweet, caramel-like notes exhibited by furfural and 5-methyl furfural also seem to

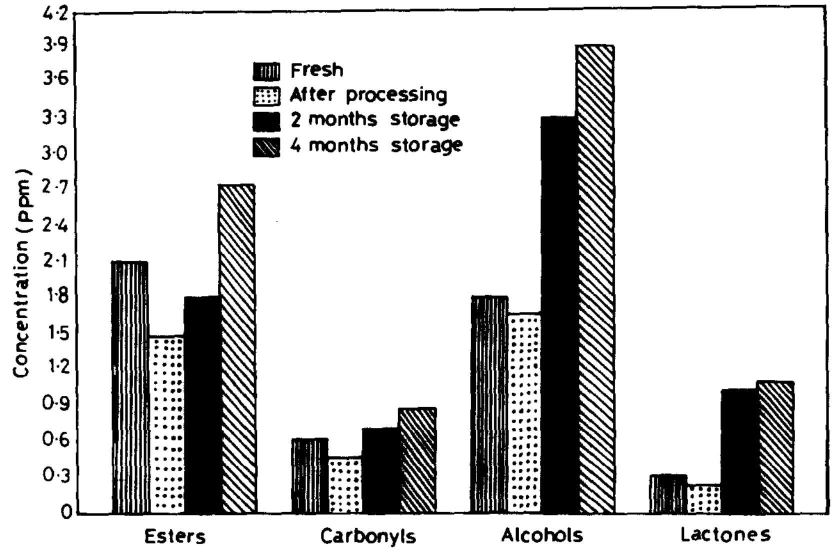

**Fig. 1.** Changes in concentration of the main volatile fractions in fresh, after processing and during storage of mango juice.

be essential to the overall flavour (Hunter *et al.*, 1974). Although α-terpineol was found in the fresh juice and gradually increased during storage, β-terpineol, terpinene-4-ol and butyl-3-hydroxy butanoate were identified after heat-treatment and during storage as shown in Table 1. All these compounds, which appeared after heating, were increased during the period of storage as the deterioration reactions continued. Furthermore, the

TABLE 1

Effect of Processing and Storage on the Formation of Aroma Compounds in Mango Juice

| *Aroma compounds* | *Concentration (ppm)* | | | |
|---|---|---|---|---|
| | *Fresh* | *After processing* | *Storage time (months)* | |
| | | | *2* | *4* |
| Acetyl furan | 0 | 0·015 | 0·03 | 0·03 |
| 5-Methyl furfural | 0 | 0·01 | 0·03 | 0·03 |
| Terpinene-4-ol | 0 | 0·01 | 0·025 | 0·035 |
| β-Terpineol | 0 | 0·01 | 0·035 | 0·035 |
| Butyl-3-hydroxy butanoate | 0 | 0·025 | 0·03 | 0·04 |
| Ethyl laurate | 0 | 0 | 0·01 | 0·01 |
| Ethyl myristate | 0 | 0 | 0·010 | 0·10 |
| Ethyl palmitate | 0 | 0 | 0·028 | 0·35 |
| Seline-11-ene-4-ol | 0 | 0 | 0·017 | 0·20 |

formation of ethyl laurate, ethyl myristate, ethyl palmitate and selin-11-ene-4-ol during storage also occurred; these components were derived mainly from the decomposition of fatty acids by autoxidation according to Bielig & Askar (1974) and El-Samahy *et al.* (1982). In order to follow conversions of the main volatile constituents which influence the aroma of mango juice, Fig. 2 shows the changes in the most important hydrocarbons during processing and storage. The predominant compound, α-terpinolene, decreased sharply after processing, then increased and slowly decreased during the storage period. The reduction in α-terpinolene caused the deterioration in aroma because this compound is considered as one of the main contributors to the odour quality of mango juice (El-Nemr & Askar, 1986). Also, a part of this component probably has been converted to α-terpineol and terpinene-4-ol which could lead to an unfavourable aroma and fishy flavour (Buttery *et al.*, 1969).

The other two hydrocarbons, car-3-ene and *cis*-ocimene, demonstrated the same pattern as α-terpinolene but in low concentration and also, reduction in these compounds, means loss of flavour components. These

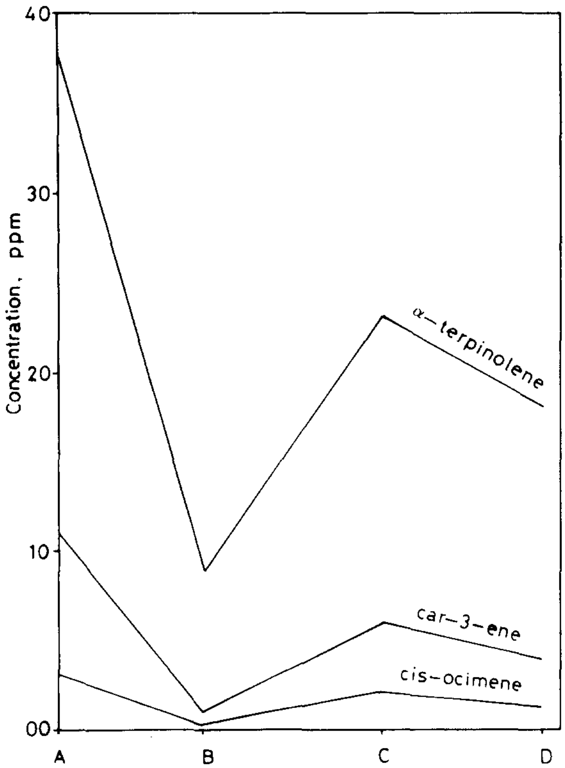

**Fig. 2.** Changes in the hydrocarbon compounds after processing and during storage of mango juice. A, Fresh; B, after processing; C, two months storage; D, four months storage.

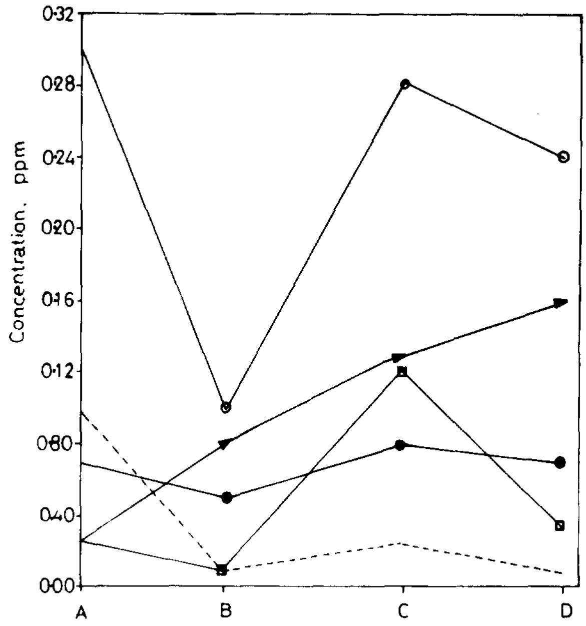

**Fig. 3.** Changes in the oxygenated compounds after processing and during storage of mango juice, A–D as in Fig. 2. ○, *trans,cis*-2,6-Nonadienal; ▶, α-terpineol; □, *trans*-2-nonenal; ●, γ-octalactone; -----, *trans*-2-hexenal.

results agree with those of Kirchner & Miller (1957), Blair *et al.* (1952) and Bielig & Askar (1974). Figure 3 illustrates the changes in oxygenated compounds of mango juice. All of these volatiles, which have been associated with the aroma of mango juice, decreased rapidly after heating, then increased after 2 months' and decreased during 4 months' storage, except α-terpineol which increased in a linear pattern, and contributed to the unpleasant flavour and the development of 'terebinthine-off-flavor' (Bielig & Askar, 1974).

In general, the changes in the aroma of mango juice after processing and storage were due mainly to the decrease in the principal aroma compounds, the formation of caramel flavour of furan derivatives and the appearance of some new components as a result of fatty acid autoxidation. Thus, furan derivatives, α- and β-terpineol, terpinene-4-ol and ethyl fatty acids are proposed as indices of heat-processing and storage periods of mango juice.

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