A Preliminary Study on the Flavor and Aroma Components of Four Mango Varieties[1, 2]

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ABSTRACT

Mango varieties Edward, Palmer, Keitt and Zill were selected to study the possible relation between the flavor and aroma components or their precursors in the mature green fruit at harvest and in the same fruit ripened under controlled conditions. Flavor quality was also evaluated.

The fruits were hand picked from trees at the Fortuna Substation and stored at 70° F (21° C) and 80% relative humidity. After 7 to 10 days in storage, good eating quality mangoes were attained. Sensory evaluation for flavor scored from 5.3 to 5.6 in a (1-poor to 6-good) 6-point hedonic scale.

The gas chromatographic analysis showed differences in the number and concentration of certain components among varieties and within the same depending on their stage of ripeness. Green fruits showed a larger number of components than ripe fruit in general.

Varieties Palmer and Zill seem to be richer in flavor and aroma components than varieties Edward and Keitt.

The identity of 15 flavor and aroma components of mango essence, including alcohols, aldehydes, ketones and terpenes, was established by gas chromatography-mass spectrometry and comparison with reference spectra.

INTRODUCTION

The commercial production of mango (*Mangifera indica* L). becomes more attractive because of its economical importance in some of the tropical and subtropical regions of the world. There is plenty of information on the production, storage, preservation and processing of the fruit (1, 5–7, 14), but there is still a lack of information on flavor and aroma components which are valuable guides for the selection, propagation and processing of certain varieties.

Angelini et al. (2), identified some aroma bearing compounds on ripe mango pulp. Gholap and Bandyopadhyay (8) correlated changes in fatty acids in ripening mango pulp (varieties Alphonso and Totapuri) with developing pulp aroma and flavor. Baragaño de Mosqueda (4) classified some tropical fruits on the basis of their aroma and taste. Hunter, Bucek and Radford (11) identified 39 components qualitatively and discussed their possible significance to flavor and found that no single compound was characteristic. The recovery of some volatile components from mango and guava from a water distillate was reported by Kunishi and Seale (13). Work on odor concentrates and identification of odorous ingredients in

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mango and guava were reported by Pattabhiraman and coworkers (15). A preliminary study of the aromatic principles isolated from ripe pulp of Alphonso and Langra mangoes was reported by Gholap and Bandyopadhyay (9), who also worked on the characterization of green aroma of raw mango varieties Alphonso and Batali (10). These reports are so far the only references found on the flavor and aroma constituents of mangoes.

The objective of this preliminary work is to study the possibility that there might be a relationship between the composition of mango essences or their precursors in the mature green fruit at harvest, in the fruit ripened under controlled temperature and relative humidity conditions with the flavor quality of the mango as fresh whole fruit.

MATERIALS AND METHODS

Four mango varieties (Edward, Palmer, Keitt and Zill) were selected on the basis of flavor, appearance and other attributes which make them highly acceptable.

Fifty fruits of each variety were gathered in the Fortuna Substation grove at the mature green stage. The weight of each fruit was recorded. The fruits were immersed in water at 52° C for 10 min in order to minimize losses due to anthracnose. To 2 kg of pulp extracted from each variety 4 L of water were added in order to perform vacuum distillation of the essences for 3 h. The remaining whole fruits were stored at 21° C and 80% relative humidity until they became ripe thus developing desirable color, texture and flavor for consumption. Sensory evaluation was conducted on each variety using the 6-point hedonic scale reported by Kramer and Ditman (12).

The flavor and aroma distillates were concentrated to a volume of 1 ml. The individual components were separated by gas chromatography and the identity of some of them was established by interpretation of their mass spectra by comparison with reference spectra.

The chromatograms obtained in this work were performed with a Perkin-Elmer 900 gas chromatograph equipped with a hydrogen flame detector. A column packed with 3% OV 101 on Chromosorb W 80-100 mesh 4 m × 2 mm I.D. was used. The temperature was programmed from 90° C to 200° C at a rate of 6° C/min and a helium flow of 30 ml/min.

Mass spectra were performed at the Finnigan Corporation laboratories using a Finnigan 4000 Model mass spectrometer-gas chromatography system operated at an electron energy of 70 eV and 100 μA with a source temperature of 150° C.

RESULTS AND DISCUSSION

Figure 1 represents a reconstructed gas chromatogram of ripe Zill mango essence obtained form the Finnigan 4000 mass spectrometer system.

The identification of some of the components shown in figure 1 was attained using reference spectra published in the "Registry of Mass Spectral Data" (17). A list of the identified components and their corresponding chromatographic fraction from the Zill mango variety is presented in table 1.

Among the constituents found in this work are the following: hydrocarbons γ-terpinene, δ-carene, isopropyl-bicycloheptane, 2-methylheptadecane, 9-n-octylheptadecane, phytane, 2, 6, 11, 15-tetramethylhexadecane and 2, 6, 10, 15-tetramethylheptadecane; the alcohols ledol and hexadecanol; the aldehyde tetradecanal; and the ketone 9-heptadecanone.

Table 2 shows the results of some chemical analyses and flavor evaluation of the four mango varieties.

A comparison between the essence of mango varieties Edward, Palmer, Keitt and Zill at their mature green and at the ripe stages showed

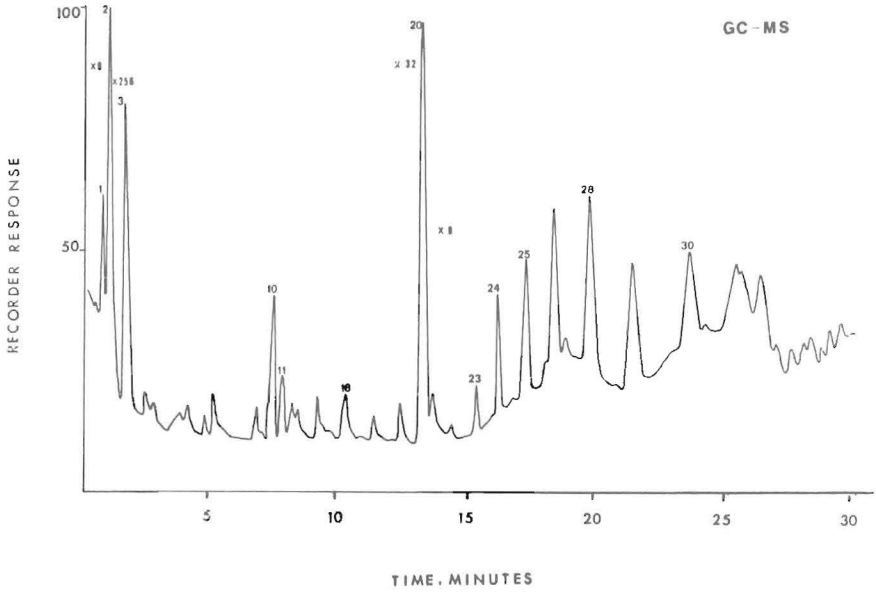

FIG. 1.—Gas chromatogram of ripe Zill mango essence.

differences among varieties not only in the number of components but also in their concentration. Zill and Palmer varieties showed the highest number of constituents.

KEITT VARIETY

The concentration of δ-carene and of isopropyl-bicycloheptane in the ripe fruit showed to be twice as compared to the mature green fruit. The major difference is the increase of hexadecanol and 9-heptadecanone in the ripe fruit at almost eightfold that of the green fruit. The concentration

of 2, 6, 10, 15-tetramethylheptadecane remained almost constant during ripening.

PALMER VARIETY

It was observed that in the ripe fruit the relative concentrations of isopropyl-bicycloheptane, hexadecanol, 9-heptadecanone and *trans*-caryophyllene were thirty two, two, eight and four times the concentration

TABLE 1.—*Flavor and aroma constituents identified qualitatively from ripe Zill mango essence*[1]

Compound	GC Peak No.
γ-Terpinene	1
δ-Carene	2
Isopropyl-bicycloheptane	3
Trans-Caryophyllene	10
Humulene	11
Ledol	16
TMS-TMS-Oxyacetate	17
Tetradecanal	18
Hexadecanol	20
2-Methylheptadecane	22
9-n-Octylheptadecane	23
2,6,10,14-Tetramethylhexadecane (phytane)	24
2,6,11,15-Tetramethylhexadecane	25
9-Heptadecanone	28
2,6,10,15-Tetramethylheptadecane	30

[1] Identification based on GC-MS and reference spectra.

TABLE 2.—*Data on chemical composition and flavor evaluation of green and ripe mangoes*

Variety	Weight	Reducing sugars		Total sugars		Acidity (% citric acid)		pH		Brix		Sensory evaluation (flavor)
		G[1]	R[1]	G	R	G	R	G	R	G	R	
	G	%	%	%	%							
Edward	408	1.60	2.94	2.49	15.79	0.66	0.31	4.2	4.4	8.30	16.75	5.6
Palmer	453	3.76	4.01	4.98	15.30	0.64	0.28	4.0	4.5	8.50	18.90	5.5
Keitt	510	4.20	5.12	5.30	17.62	0.50	0.22	4.1	4.6	8.00	20.00	5.4
Zill	255	3.70	3.50	7.60	14.60	0.58	0.27	4.1	4.5	7.98	16.80	5.3

[1] G = green; R = ripe.

of the green mango. The concentration of 2, 6, 10, 15-tetramethylheptadecane in the green fruit was four times that of the ripe fruit.

EDWARD VARIETY

The relative concentrations of δ-carene and hexadecanol in the ripe mango were approximately 3.5 times that of the green fruit, and the concentration of 5, 6, 10, 15-tetramethylheptadecane showed to be about the same as in the green fruit.

ZILL VARIETY

Gamma-terpinene and δ-carene, are among the outstanding constituents of the ripe fruit. The most outstanding component was isopropylbicycloheptane followed by hexadecanol. *Trans*-caryophyllene seems to maintain a steady concentration in both green and ripe fruit. Among the outstanding components in the green fruit are: phytane, 2,6, 11,15-tetramethylhexadecane, 9-heptadecanone and 9-n-octylheptadecane. It seems possible that the presence of these and other constituents in the green fruit for which their identity needs to be confirmed is necessary to induce the development of good flavor quality when the fruit ripens.

CONCLUSIONS

Mature green mangoes of the Edward, Keitt, Palmer, and Zill varieties ripened in a period of 7 to 10 days under controlled conditions of 21° C and 80% relative humidity. Sensory evaluation of the ripe mangoes showed values for flavor attribute from 5.3 to 5.6 on a 6-point hedonic scale.

The gas chromatographic profiles showed differences in number of components as well as concentrations of some of them among varieties. Palmer and Zill varieties had the most. The green fruits showed more components than the ripe fruit in most cases.

According to the relative concentrations the outstanding components in the green mango varieties studied were: 2, 6, 10, 15-tetramethylheptadecane; phytane; 2, 6, 11, 15-tetramethylhexadecane; 9-heptadecanone; and 9-n-octylheptadecane. Some of the outstanding components identified in the ripe fruit were: δ-carene, isopropylbicycloheptane, hexadecanol, *trans*-caryophyllene and γ-terpinene.

RESUMEN

Se seleccionaron mangos de las variedades Edward, Palmer, Keitt y Zill con el propósito de estudiar la posible relación entre los componentes de sabor y aroma o sus precursores en la fruta verde, pero hecha y la misma madurada bajo condiciones controladas.

Las frutas procedentes de la Subestación de Fortuna se recolectaron a mano y se almacenaron a 21° C y 80% humedad relativa. Se obtuvieron frutas maduras de buena calidad entre 7 y 10 días bajo estas condiciones. La evaluación sensorial para sabor fluctuó entre los valores de 5.3 a 5.6 en una escala hedónica de 6 puntos (1-malo—6-bueno).

El análisis por cromatografía de gases mostró diferencias en el número y concentración de ciertos componentes entre variedades y aun en la misma variedad, dependiendo del estado de madurez. En general, la fruta verde contenia más compuestos que la madura. Las variedades Palmer y Zill fueron las más ricas al respecto comparadas con la Edward y Keitt.

Se estableció la identidad de 15 componentes de sabor y aroma a base de la comparación con los espectros de masas tipo. Entre los compuestos se encuentran alcoholes, aldehídos, cetonas y terpenos.

Según las concentraciones relativas los componentes que más se destacaron en la fruta verde fueron: 2,6,11,15-tetrametilhexadecano, 9-heptadecanona y 9-n-octilheptadecano. En la fruta madura se destacaron: δ-careno, isopropilbiciclohepta no, hexadecanol, *trans*-cariofileno y γ-terpineno.

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