

Contribution of Lipid to Aroma of Ripening Mango (*Mangifera indica* L.)

A.S. GHOLAP and C. BANDYOPADHYAY Bhabha Atomic Research Centre,
Biochemistry & Food Technology Division, Trombay, Bombay - 400 085, India

ABSTRACT

Pulp lipid composition of two commercial varieties of mango, 'Alphonso' and 'Totapuri', with wide differences in aroma and flavor during ripening was studied. Ripening of Alphonso mango was found to be associated with a marked increase in glyceride content and a rapid change in aroma and flavor, while in case of 'Totapuri' there were no appreciable changes in these parameters. Although the same type of fatty acids were present in both varieties, a variation in the distribution of fatty acids during ripening was observed. The ratio of palmitic to palmitoleic acid, which was correlated with aroma and flavor characteristics, was higher in the 'Totapuri' mango.

INTRODUCTION

Organoleptic assessment of fully matured mango ripened at ambient temperature reveals that certain varieties develop their characteristic aroma in the ripe state, while the others are practically lacking in aroma although other physico-chemical changes associated with the ripening, such as color, sweetness, and texture, are similar. Besides sweetness and texture, the strength of the aroma primarily determines the quality of mango varieties. However, very little information is available regarding the volatile flavor components of mango. The aromatic principles of ripe 'Alphonso' mango, the choicest variety of Indian mango, were reported earlier (1) to consist of hydrocarbons, esters, alcohols, carbonyls, and lactones, and that a specific combination of these compounds represent the characteristic Alphonso aroma (2). Hunter, et al. (3) recently have analysed volatile components of canned 'Alphonso' mango puree. They observed that these compounds do not individually represent the characteristic mango aroma.

The role of lipids in food aroma and flavor, in general, has been the subject of many investigators. Forss (4) has reviewed the origin of flavor in lipids and suggested that the primary contribution of lipids to flavor is as precursors. Such studies with respect to fruits are scanty in the literature. A change in lipid composition in ripening banana fruit has been investigated by Goldstein and Wick (5). However, they could not derive any correlation between the aroma and lipid composition. With mangoes, on the other hand, a relationship between the aroma and flavor characteristic with fatty acid composition of the pulp has been ascertained (6,7). It was observed that the ripening of Alphonso mango was associated with concurrent changes in glyceride

content and fatty acid composition. The present paper deals with a comparative study on the lipid composition of the pulp of Totapuri and Alphonso mango during ripening at ambient temperature.

EXPERIMENTAL PROCEDURES

Two commercial varieties of mango, Alphonso and Totapuri, were selected. The former is recognized for its delicate aroma in the ripe state, while the latter, a cheaper variety, is recognized for its very mild aroma.

Fully matured unripe mangoes of these two varieties were purchased individually within 2 days after picking from a local market in two batches during the same season, and allowed to ripen at ambient temperature (25-30 C) in a well ventilated room. The samples were selected from each batch of the respective variety by a panel of 6 experienced judges according to the state of ripeness as raw, half ripe, and fully ripe, and these samples were subjected for flavor evaluation.

Each sample, representing 5 mangoes having uniform organoleptic scores, was peeled, and cut into small pieces, rejecting the seed. The pulp lipid of each sample was obtained by extracting the pulp repeatedly with peroxide free diethyl ether in a Waring Blendor (6). The residual pulp of each sample after ether extraction was freeze dried and after re-extraction with chloroform:methanol (2:1) gave rise to only a trace amount of lipid. Therefore, these were rejected.

Glyceride and phospholipid content of each lipid extract was determined according to the method of Van Handel and Zilversmit (8), and Fiske and Subbarow (9), respectively. Thin layer chromatographic (TLC) separation of lipid components of each sample was carried out on a silica gel plate using petroleum ether:diethyl ether:acetic acid (80:20:1 v/v) as solvent system according to the procedure detailed elsewhere (6). The triglyceride component of the pulp lipids was identified by comparing the R_f value of pure tripalmitin (Hormel Institute, MN). Each lipid extract was saponified with 1N alcoholic KOH. Nonsaponifiables were removed by repeated extraction of the diluted soap solution with a mixture of petroleum ether:diethyl ether (1:1, v/v), and the fatty acids were recovered by acidification of the soap solution with 1N H_2SO_4 followed by extraction with diethyl ether and finally methylated with diazomethane (6). The gas liquid chromatographic (GLC) analysis of fatty acid methyl esters of each sample was carried out on a BARC Model gas chromatograph equipped with a flame

TABLE I

Pulp Oil Extracts, Glyceride, and Phospholipid Content of Mango Pulp (Variety Alphonso' and Totapuri)^a in Different Ripening States of Mango Stored at 25-30 C.

Ripening state	Alphonso			Totapuri		
	Pulp oil extract (wt by % of wet pulp)	Glyceride (wt by % of pulp oil extract)	Phospholipid (wt by % of pulp oil extract)	Pulp oil extract (wt by % of wet pulp)	Glyceride (wt by % of pulp oil extract)	Phospholipid (wt by % of pulp oil extract)
Raw	0.15	41.7	1.7	0.12	40.0	1.9
Half ripe	0.29	66.0	1.7	0.12	41.8	2.3
Fully ripe	0.60	72.5	1.9	0.14	52.5	3.5

^aResults based on the average of 2 independent determinations.

TABLE II

Fatty Acid Composition of Pulp Oil Extract^a of Ripening Alphonso and Totapuri Mango during Storage at 25-30 C Ripening State

Fatty acids	Alphonso			Totapuri		
	Raw	Half ripe	Fully ripe	Raw	Half ripe	Fully ripe
C ₁₂ :0	0.3	0.2	0.3	0.3	0.3	2.8
C ₁₄ :0	2.0	1.3	1.7	1.7	2.4	11.6
C ₁₆ :0	29.0	29.4	28.9	30.7	25.5	21.9
C ₁₆ :1	21.8	26.5	30.7	12.9	15.8	16.4
Unknown	trace	trace	trace	---	---	0.5
C ₁₈ :0	1.3	0.8	1.5	1.5	1.3	1.0
C ₁₈ :1	29.5	29.7	24.5	37.1	40.2	31.4
C ₁₈ :2	10.5	3.0	3.1	10.4	9.2	5.7
C ₁₈ :3	5.6	9.1	9.3	5.4	5.3	8.7

^aResults based on the average of 2 independent determinations.

TABLE III

Flavor Evaluation of Ripening Alphonso and Totapuri Mango During Storage at 25-30 C in Relation to the Ratio of Palmitic to Palmitoleic Acid

Variety	Ripening state	Flavor Evaluation		C ₁₆ :0/C ₁₆ :1
		Aroma	Taste	
Alphonso	Raw	Green	Sour	1.33
	Half ripe	Mild fruity	Sweet-sour	1.11
	Fully ripe	Strong fruity	Sweet, estery, coconut-like	0.94
Totapuri	Raw	Green	Sweet-sour	2.34
	Half ripe	Sweet	Sweet	1.63
	Fully ripe	Very mild fruity	Sweet	1.34

ionization detector. A 0.25 in. outer diameter (OD) x 6 ft stainless steel column packed with 20% ethylene glycol succinate (Applied Science Lab, State College, PA) on 60/80 mesh chromosorb W (AW) was used. The oven and detector temperature was maintained at 185 C with a nitrogen flow of 25 ml/min. The fatty acids were identified by comparing the retention time of authentic reference samples (Analabs, Inc., North Haven, CT). Gas chromatographic peak areas were determined by multiplying peak ht by peak width at half ht.

RESULTS AND DISCUSSION

Pulp lipid, glyceride, and phospholipid content of the two varieties of mango during ripening at ambient temperature are presented in Table I. Both these varieties ripened after 12 days of storage, and they showed similar changes with respect to color, sweetness, and texture during this period. However, remarkable differences were observed in the development of their respective aroma in ripened state. For example, the Alphonso mango developed a strong pleasant aroma, while Totapuri gave only a very mild, bland aroma. With progressive ripening, the pulp lipid and glyceride content of Alphonso mango increased rather rapidly without any alterations in phospholipid content. These changes were not appreciable in the case of Totapuri. In fact, the pulp lipid content of Totapuri mango remained constant during the entire period of ripening.

TLC investigation of pulp lipid extracts of the respective samples revealed that the major constituent in all these samples was triglyceride. Mono- and diglycerides appeared to be minor constituents. Hence, an increase in pulp lipids in Alphonso mango, during ripening, could be attributed essentially to the increasing amount of triglycerides (Table I). In contrast, in Totapuri mango, no appreciable change was observed in glyceride and phospholipid contents.

Table II summarizes the fatty acid composition of the respective pulp lipids in various states of ripening of

Alphonso and Totapuri mangoes. Although the type of fatty acids were similar in both the varieties, considerable differences were observed in their quantitative distribution at different ripening stages. At the onset of ripening of Alphonso mango, unsaturated fatty acids appeared to change more than the saturated ones, as indicated by the increase in palmitoleic acid and linolenic acid contents, along with a simultaneous decrease in linoleic acid. In the case of Totapuri mango, however, the changes in fatty acids during ripening seemed to be random with appreciable increase in myristic acid. The distribution of palmitic and palmitoleic acid in both the varieties during ripening stages was of particular interest, because the ratio of these two fatty acids with a critical value of unity determines an index of aroma characteristics of mango (7).

Table III shows the organoleptic assessment of the aroma property of two mango varieties with reference to the ratio of palmitic to palmitoleic acid. It could be seen that development of aroma in the Alphonso mango was accompanied by decrease in the ratio of palmitic to palmitoleic acid from 1.3 to 0.9, whereas, Totapuri mango showed only a very mild aroma with a feeble fruity note at the ripened state, and the same ratio, though changes, was maintained above the critical value throughout the ripening period. Thus, the present data further support our previously reported findings (6,7) that the ripe mangoes have strong aroma only when this ratio is below the critical value of unity, and they have a very mild or bland aroma when it is above the critical value.

The foregoing results suggest that the lipid constituents, though occurring in small amount, could be correlated with aroma and flavor characteristics of mango varieties. The steep rise in glyceride content of Alphonso mango during ripening followed by a remarkable change in the ratio of palmitic to palmitoleic acid paralleled organoleptic scores of aroma and flavor. The marked increase in glyceride content during ripening of Alphonso mango has been attribu-

ted to the increasing activity of citrate cleavage enzyme in ripening mango (10), as the citrate is believed to be the immediate source of acetyl CoA required for fatty acid biosynthesis (11,12).

The recent evidence on the preponderance of various aliphatic lactones having coconut-like odor notes in aromatic principles of ripe Alphonso mango (2,3) suggests a role for lipids in mango aroma, because lactones are essentially of lipid origin (13). The presence of several lactones in volatile flavor components of Apricot (14) and coconut meat (15) has been suggested to be due to enzymatic delta oxidation of saturated fatty acids. Biochemical reactions of similar nature probably could be responsible for lactone formation in Alphonso mango.

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