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Changes in Physical and Chemical Composition during Maturation of Yellow Mombin (*Spondias mombin*) Fruits

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ABSTRACT

*Yellow mombin (*Spondias mombin *L.) fruits were analyzed for some physical and chemical changes during various stages of maturity. The fruit was found to be ellipsoidal to ovoidal in shape, being, on average, 3·47 cm long and 2·65 cm in width. The weight of the pulp increased during ripening from green mature (40·67%) to the ripe stage (59·67%). The weight of the seeds and skin did not show any significant difference in green mature and half-ripe fruits. °Brix/acidity ratio increased with the advance in maturity. Half-ripe fruits had significantly higher (6·02%) reducing sugars than green mature (4·81%) and ripe (5·21%) fruits.*

INTRODUCTION

A large number of exotic tropical fruits are found in the north and northeast regions of Brazil. Fruits such as mango (*Mangifera indica*), cashew (*Anacardium occidentale*) and those belonging to the genus *Spondias*, pertain to the family of Anacardiaceae which is known to represent almost 40 species in Brazil (Schultz, 1963). The genus *Spondias* possesses 8 to 12 species from tropical regions of the world and is renowned for its tasty edible fruits (Bailey, 1950; Adams, 1972). In Brazil, the genus *Spondias* has many representatives such as cajarana (*Spondias dulcis* L.), siriguela (*Spondias purpurea* L.) and umbu (*Spondias tuberorosa* Arruda Camara) commonly

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referred to in English as ambarella, red mombin and imbu, respectively, and the yellow mombin (*Spondias mombin* L.), sometimes also referred to as *Spondias lutea* (Gomes, 1985), which is locally known as 'Caja', 'Caja-mirim' or 'Tapereba'.

Contrary to the report of Morton and Morton (1946) that most of the yellow mombin trees yield fruits of low quality which seldom appear in the market, Gomes (1985) described the fruit to be very rich in flavour, refreshing and appropriate for making jellies, drinks and ice cream. In the northeast region of Brazil which has a large cultivation of the yellow mombin, the fruit is very much cherished by the local population, and is utilized principally in the form of drinks and also in the production of liquors. In spite of the availability of, and demand for, this fruit, its commercial exploitation by the fruit processing industry is limited due to lack of information such as yield, shelf life, optimum maturity of the fruit, and to the non-existence of systematic plantations.

Scientific information about this fruit is generally scanty but the chemical composition has been reported (Winton & Winton, 1935; Sturrock, 1959; Leung & Flores, 1961; Morton, 1987). However, no detailed study exists on the physical and chemical characteristics of the yellow mombin fruit at different stages of maturity.

The objective of the present study was to determine the physical, physico–chemical and chemical characteristics during various stages of maturation of the fruit.

MATERIALS AND METHODS

The yellow mombin (*Spondias mombin* L.) fruits were obtained from the municipality of Itabaiana, Paraiba, Brazil. After harvest, the fruits were classified into three apparent maturities as described in Table 1.

TABLE 1
Classification of the Yellow Mombin Fruit based on Fruit Characteristics

Characteristic	*Stages of maturity*		
	Green mature	*Half-ripe*	*Ripe*
Skin colour	Green	Greenish–yellow	Yellow
Stains on skin (Fine black dots)	Present	Present	Almost absent
Skin feel	Rough	Slightly rough	Smooth and suave
Skin brilliance	Absent	A little shiny	Shiny
Fruit texture	Hard	Firm	Soft

Physical analysis

Fifty fruits of each maturity were individually analyzed for physical characteristics. Length and diameter were measured with a vernier calliper, and volume by the displacement of the liquid. The measurement of length was made in the polar axis of fruit, i.e. between apex and stem. The maximum width of the fruit, measured in the direction perpendicular to the polar axis, is defined as diameter.

Chemical analysis

The edible portion of the fruit was separated manually from the seed using a stainless steel knife, and triturated in a domestic mixer at its maximum velocity for 3 min. Moisture, titratable acidity, ash, crude fibre, sugars, starch, pectin, tannin, ascorbic acid, iron, calcium and phosphorus were determined according to the methods described by Ranganna (1977). The protein was determined by the method of Lowry, modified by Schacterle and Pollack (1973). Five samples of each maturity were analyzed in triplicate.

Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences (Nie *et al.*, 1975). Tukey's studentized range test (Steel & Torrie, 1980) was performed to compare all the mean differences.

RESULTS AND DISCUSSION

The dimensions of the yellow mombin fruit and its components are shown in Table 2. The fruit is ellipsoidal to ovoidal in shape, being $3{\cdot}47 \pm 0{\cdot}84$ cm (mean $\pm$ three times standard deviation covering 99·97% of all determinations) long and $2{\cdot}65 \pm 0{\cdot}87$ cm in diameter. Gomes (1985) reported the yellow mombin fruit to be a drupe of maximum 6 cm in length, ovoid, oblong and flat at the base, having thin and smooth skin, pulp of little thickness, yellow–orange in colour and acidic in flavour, and possessing a large white fibrous and wrinkled seed. Bailey (1950) and Campbell and Sauls (1980) have also reported the fruit to be a drupe with tough skin and scant flesh surrounding a large oblong seed. In general, the length and diameter of the fruit, and the thickness of the pulp were highest in half-ripe mature fruits and lowest in the green mature fruits. There was no significant difference between green mature and half-ripe fruits with respect to the length and diameter of the seeds.

TABLE 2
Dimensions of the Yellow Mombin Fruit and its Components

Parameter	*Statistical description*	*Apparent maturity*			*All the fruits*
		Green	*Half-ripe*	*Ripe*	
Number of fruits	*n*	*50*	*50*	*50*	*150*
Length of fruit	Mean (cm)	3·33[a]	3·70[b]	3·47[c]	3·50
	SD	0·17	0·22	0·29	0·28
Diameter of fruit	Mean (cm)	2·52[a]	2·89[b]	2·62[a]	2·68
	SD	0·13	0·23	0·27	0·29
Length of seed	Mean (cm)	2·95[a]	2·90[a]	2·64[b]	2·83
	SD	0·16	0·20	0·29	0·26
Diameter of seed	Mean (cm)	1·87[a]	1·89[a]	1·70[b]	1·82
	SD	0·15	0·17	0·24	0·21
Thickness of pulp	Mean (cm)	0·33[a]	0·50[b]	0·46[b]	0·43
	SD	0·01	0·01	0·01	0·01
Length/Diameter of fruit	Mean	1·32[a]	1·28[b]	1·33[a]	1·31
	SD	0·05	0·06	0·08	0·08

Means in each row followed by different superscript letters were significantly different ($P < 0·05$).
Standard Deviation (SD) < 0·01 is reported as 0·1.

The distribution of the various components of the fruit is presented in Table 3. Taking into consideration the fruits of all three maturities, it was observed that, on average, the pulp, seed and skin constituted 52·29, 31·88 and 15·83% of the whole fruit, respectively. Morton (1987) reported 48% of flesh in the fruit although no mention was made for the maturity of the fruit. A higher (59·67%) pulp content in the ripe fruit was observed in the present study. The flesh was found to be yellow, fibrous, soft and juicy. The total weight, volume and density of the fruit also increased from green mature fruits to half-ripe fruits, being maximum at this stage. The lower weight of ripe fruits as compared to those of half-ripe fruits could be attributed to the metabolic changes during the ripening of the fruits. The weight of the seeds and skin did not show any significant difference in green mature and half-ripe fruits.

The physico-chemical parameters of the pulp of the yellow mombin are presented in Table 4. The pH of the fruits increased with the advance in maturity, being 3·25 for green mature, 3·31 for half-ripe and 3·56 for ripe fruits. These relatively lower pH values characterized the acidic flavour of the pulp. Barbosa *et al.* (1981) reported still lower pH (2·1) for yellow mombin fruits. The titratable acidity decreased with advance in maturity. Ripe fruits were significantly less acidic (1·49%) than green mature fruits

TABLE 3
Weight of Various Components and Volume of the Yellow Mombin Fruit

Parameter	*Statistical description*	*Apparent maturity*			*All the fruits*
		Green	*Half-ripe*	*Ripe*	
Number of fruits	*n*	50	50	50	150
Weight of fruit	Mean (g)	11·99[a]	15·10[b]	13·10[a]	13·40
	SD	1·80	3·17	3·17	3·06
	Mean (%)	100·00	100·00	100·00	100·00
Weight of seed	Mean (g)	4·68[a]	4·31[a]	3·57[b]	4·18
	SD	0·66	0·91	1·02	0·99
	Mean (%)	39·59	29·70	29·15	32·81
Weight of skin	Mean (g)	2·34[a]	2·35[a]	1·37[b]	2·02
	SD	0·78	0·49	0·32	0·72
	Mean (%)	19·74	16·04	11·18	15·66
Weight of pulp	Mean (g)	4·97[a]	8·44[b]	8·16[b]	7·19
	SD	1·21	2·20	1·98	2·15
	Mean (%)	40·67	54·26	59·67	51·53
Volume of fruit	Mean (cm^3)	12·84[a]	15·72[b]	14·56[b]	14·37
	SD	2·29	3·18	3·69	3·31
Density of fruit	Mean (g/cm^3)	0·94[ab]	0·96[b]	0·91[a]	0·94
	SD	0·10	0·09	0·09	0·09

Means in each row followed by different supercript letters were significantly different ($P < 0·05$).

TABLE 4
Physico-Chemical Parameters of the Yellow Mombin Pulp

Parameter	*Statistical description*	*Apparent maturity*			*All the fruits*
		Green	*Half-ripe*	*Ripe*	
pH	Mean	3·25[a]	3·31[a]	3·56[b]	3·38
	SD	0·13	0·02	0·14	0·17
Degree Brix	Mean	11·04[a]	12·50[b]	11·66[a]	11·73
	SD	0·37	0·50	0·32	0·72
Titratable acidity	Mean (%)	1·87[a]	1·76[a]	1·49[b]	1·71
(as anhydrous citric acid)	SD	0·10	0·09	0·15	0·20
°Brix/Titratable acidity	Mean	5·92[a]	7·10[b]	7·91[b]	6·98
	SD	0·32	0·38	0·93	1·02

Means in each row followed by different supercript letters were significantly different ($P < 0·05$).

TABLE 5
Chemical Composition of Yellow Mombin Fruit per 100 g of Edible Portion

Constituent	*Statistical description*	*Apparent maturity*			*All the fruits*
		Green	*Half-ripe*	*Ripe*	
Moisture	Mean (g)	87·28[a]	88·14[a]	87·15[a]	87·52
	SD	0·97	4·38	0·52	2·46
Protein	Mean (g)	0·26[a]	0·26[a]	0·24[a]	0·25
	SD	0·02	0·02	0·02	0·02
Crude fibre	Mean (g)	1·17[a]	1·27[a]	1·11[a]	1·10
	SD	0·26	0·16	0·10	0·17
Total sugars	Mean (g)	5·06[a]	6·32b	5·40[a]	5·60
	SD	0·12	0·14	0·36	0·59
Reducing sugars	Mean (g)	4·81[a]	6·02[b]	5·21[c]	5·35
	SD	0·17	0·20	0·29	0·56
Non-reducing sugars	Mean (g)	0·25[a]	0·30[a]	0·19a	0·25
	SD	0·10	0·06	0·19	0·13
Starch	Mean (g)	0·89[a]	0·25[b]	Traces	0·56[d]
	SD	0·02	0·01	—	0·04[d]
Pectin (as calcium pectate)	Mean (g)	0·09[a]	0·06[a]	0·05[a]	0·07
	SD	0·01	0·01	0·01	0·01
Tannin	Mean (g)	0·40[a]	0·43[a]	0·43[a]	0·42
	SD	0·10	0·10	0·03	0·08
Ascorbic acid	Mean (mg)	25·70[a]	23·21[b]	13·49[c]	20·80
	SD	1·51	1·26	1·55	5·61

Means in each row followed by different superscript letters were significantly different ($P < 0·05$).
Standard Deviation (SD) < 0·01 is reported as 0·01.
[d] excluding data for ripe fruits.

(1·87%) and half-ripe fruits (1·76%). The soluble solids (Brix) content was highest (12·5%) in the half-ripe fruits. The Brix/acid ratio increased from 5·92 for green mature to 7·91 for ripe fruits.

The chemical analysis of yellow mombin fruits is shown in Table 5. On average, the yellow mombin fruit pulp has a moisture content of 87%. There was no significant difference among the three maturities for moisture, protein, fibre, non-reducing sugars, and pectin content. Half-ripe fruits contained significantly higher reducing sugars (6·02%) than green mature (4·81%) and ripe (5·21%) fruits. The protein content of the fruit was found to be low (0·25%) as compared to the reported values of 0·8% (Leung & Flores, 1961) and 1·28–1·38% (Winton & Winton, 1935; Morton, 1987). Starch content decreased with the advance in maturity and was found only in traces in ripe fruits. The average ascorbic acid content for all three maturities of the fruit was 20 mg/100 g. However, the data reported for ascorbic acid content

TABLE 6
Mineral Content of Yellow Mombin Fruit per 100 g of Edible Portion

Constituent	*Statistical description*	*Apparent maturity*			*All the fruits*
		Green	*Half-ripe*	*Ripe*	
Ash	Mean (g)	0·65[a]	0·60[a]	0·73[a]	0·66
	SD	0·06	0·12	0·12	0·11
Iron	Mean (mg)	1·40[a]	1·00[b]	1·00[b]	1·20
	SD	0·01	0·01	0·01	0·01
Calcium	Mean (mg)	32·53[a]	27·50[a]	23·50[a]	28·60
	SD	0·12	0·14	0·36	0·60
Phosphorus	Mean (mg)	27·20[a]	24·50[a]	26·21[a]	26·35
	SD	0·17	0·20	0·29	0·56

Means in each row followed by different supercript letters were significantly different ($P < 0·05$).
Standard Deviation (SD) < 0·01 is reported as 0·01.

of this fruit vary widely (11 to 166 mg/100 g); a relatively higher value (166 mg/100 g) has been reported by Keshinro (1985).

The ash, phosphorus and calcium contents (Table 6) are in good agreement with the reported values by Winton and Winton (1935), Sturrock (1959), Leung and Flores (1961) and Morton (1987). There was no significant difference among the three maturities for calcium, phosphorus and ash content. The iron content was found to be low (1·2 mg/100 g) as compared to 2·2 mg/100 g reported by Leung and Flores (1961).

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