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Physico-chemical Changes in African Mango (*Irvingia gabonensis*) during Normal Storage Ripening

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ABSTRACT

*Some physical and chemical measurements were applied to mature green African mango fruits (*Irvingia gabonensis *Baill) during a 7-day storage ripening period at tropical ambient conditions (27–30°C and 68–70% relative humidity). Changes in fruit weight, texture and colour reflected the most significant chemical changes in the fruit such as starch degradation, formation of sugars and increase in total carotenoids. The post-harvest ripening changes observed are discussed and compared with similar changes in other mango varieties.*

INTRODUCTION

African or bush mango (*Irvingia gabonensis* Baill) is one of the edible tropical fruits which has largely been unexploited by the local fruit products industry. This semi-wild fruit, commonly found in the Nigerian lowland forest zone, is often available between the months of July and October. The highest degree of commercial development is found in the southeast of Nigeria, but the fruit enjoys wide acceptance on account of its juiciness and pleasing flavour and for its oil-rich seed cotyledons which are relished as soup condiments.

Two varieties of the fruit have been distinguished: namely, 'gabonensis', with a sweet edible scantily fibrous pulp and 'excelsa', with bitter and very fibrous pulp (Okafor, 1975*a*). The nutritional importance and dietary contributions of the seed kernels have been reported (Eka, 1980; Okafor, 1975*b*; Okigbo, 1977; Abaelu & Akinrimisi, 1980). The economic potentials

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of the sweet variety (var. 'gabonensis') for the production of table jelly, wine and fruit juice have also been highlighted (Okafor, 1983; Aina, 1986).

Production of African mangoes in Nigeria has increased rapidly in recent years following its successful vegetative propagation by the Forestry Commission (Okafor, 1978), which has drastically reduced fruiting age from 10 to about 3 years. As agricultural production of this indigenous fruit increases, it becomes increasingly important to have a comprehensive knowledge of the composition of the fruit and the attendant chemical changes that accompany its ripening. Information on post-harvest chemical changes has been reported for a wide variety of mango fruits (Hulme, 1971; Elahi & Khan, 1973; Morga *et al.*, 1979). Knowledge of such changes has been employed in the development of improved processing and post-harvest handling methods for optimum fruit utilization. This study was, therefore, undertaken in an attempt to provide basic information on some physico-chemical changes in African mango during normal storage ripening.

MATERIALS AND METHODS

Procurement of fruits

The more common sweet variety of African mango (*Irvingia gabonensis* Baill var. gabonensis) was used in this study which was conducted over a period of two growing seasons, August–September 1985 and 1986. Commercially mature, hard green fruits (i.e. pre-climateria stage) were randomly picked from several trees located on different farms at Fiditi near Ibadan. Commercial maturity was determined with the help of a local farmer who could make the assessment by visual inspection. The fruits are considered mature when they are just turning olive green. The fresh fruits were transported to the laboratory in plastic baskets within 2 h of harvest.

Fruit sampling and storage

On arrival at the laboratory, the fruits were immediately cleaned with moist cotton wool to remove extraneous materials as well as fruit latex which may impart dark coloration. Unblemished samples were then randomly grouped into two batches of 100 fruits each. They were kept in perforated open-top plastic baskets under prevailing laboratory conditions (27–30°C day/night and 68–70% relative humidity) until they ripened. The first sample was taken as soon as possible on the day of harvest and analysed. Thereafter ten fruits were randomly selected from each batch for chemical analysis at daily intervals.

Physical analysis

Samples were selected in groups of fruits of almost identical size and weight. Daily fruit weights were determined gravimetrically using a top-loading Mettler balance (model P 11 N). Fruit colour was assessed visually using a 0 to 5 rating (Hulme, 1971) as follows: 0 = green; 1 = olive green; 2 = olive green with yellow areas; 3 = equal portions of green and yellow; 4 = yellow with some areas of green and 5 = full yellow. Colour observed on the unpeeled fruit for a given day represented the mean of ten fruit samples.

Chemical analysis

For moisture and constituents which deteriorate on freezing, such as ascorbic acid, determination was carried out on fresh pulp slices. For other determinations, pulp slices from each fruit batch were bulked together in separate polythene bags and stored in a refrigerator until the relevant analysis could be accomplished. Appropriate weights of pulp slices were homogenized with distilled water (1:2 w/w) in a Waring blender and, after filtration through glass wool, aliquots were taken to determine total soluble solids (Abbe refractometer at 20°C). Titratable acidity (expressed as per cent anhydrous citric acid) was determined by titration with 0·1N sodium hydroxide to pH 8·1 using phenolphthalein as indicator (AOAC, 1975).

Total carotenoids was estimated by extracting the mango purée with hexane–acetone (3:2 v/v) mixture containing 0·2% (w/v) magnesium carbonate and measuring absorbance of the extract at 436 nm in a Beckman spectrophotometer (AOAC, 1975). Total tannin was determined on a 25 g homogenized and clarified sample solution by titrating with 0·1N potassium permanganate using indigo solution as indicator (Ruck, 1969). Pectin was determined on the blended pulp following the modified Carre and Haynes' method (Ruck, 1979). Ascorbic acid, starch and moisture content were determined following standard methods of analysis (AOAC, 1975). A metrohm Herisau pH meter (model E520) was used for pH measurement.

RESULTS AND DISCUSSION

Mature, hard green African mangoes used in this study ripened 7 days after harvest. By this time the fruits had softened, the peel turned yellow and the pulp changed from creamy-white to orange. The attendant physico-chemical changes accompanying the storage ripening of African mango at tropical ambient conditions are presented in Table 1. Yellow colour development in African mango was due to chlorophyll degradation and the

TABLE 1
Changes in Physico-Chemical Properties of African Mangoes during Storage Ripening at Tropical Ambient Conditions (28 ± 1°C)

Physico-chemical properties[a]	*Year*	*Days of storage*						
		1	*2*	*3*	*4*	*5*	*6*	*7*
Pulp								
Starch (%)	1985	11·3[a]	9·8	6·04	3·75	1·24	0·68	0·25
	1986	11·3	8·6	2·82	1·20	0·82	0·34	0·18
Refractometric	1985	4·0	5·2	6·2	8·0	9·2	9·8	10·2
solids (%)	1986	4·8	6·5	7·5	9·1	9·8	10·2	10·8
Total carotenoids	1985	4·42	0·75	0·94	1·24	1·82	2·00	2·25
(mg %)	1986	0·56	0·86	1·02	1·52	2·04	2·15	2·18
Pectin (%)	1985	0·35	0·48	0·55	0·67	0·80	0·75	0·63
	1986	0·42	0·53	0·61	0·78	0·92	0·84	0·72
Moisture (%)	1985	78·65	78·50	76·23	79·05	79·32	79·50	79·80
	1986	79·10	78·62	78·46	79·34	80·50	80·82	81·25
Total tannin (mg %)	1985	53·2	53·3	53·6	54·0	54·5	54·8	55·0
	1986	51·4	52·0	53·4	53·8	54·0	54·6	54·8
Ascorbic acid (mg %)	1985	28·8	36·8	45·6	58·2	52·4	51·5	49·8
	1986	32·4	42·4	50·3	61·5	55·5	53·8	52·3
Total acidity (%)	1985	2·1	2·0	1·5	1·0	0·8	0·5	0·32
	1986	1·9	1·8	1·2	0·7	0·6	0·4	0·30
pH	1985	3·4	3·5	3·6	3·8	4·0	4·3	4·5
	1986	4·0	4·1	4·2	4·4	4·6	4·8	5·0
Peel								
Colour index	1985	1·0	2·0	2·6	3·2	4·1	4·5	5·0
	1986	1·2	2·3	2·9	3·4	4·3	4·6	5·0
Colour of peel	1985	Olive green	Olive green	Yellowish green	Yellowish green	Greenish yellow	Greenish yellow	Full yellow
	1986	Olive green	Olive green	Yellowish green	Yellowish green	Greenish yellow	Greenish yellow	Full yellow
Fruit								
Mean weight loss	1985	0·32	1·10	2·11	4·14	5·62	8·74	10·8
(%)	1986	1·06	3·15	3·24	4·32	5·25	7·57	8·42

[a] The results presented for each year are the averages of duplicate samples.

subsequent prominence of carotenoids, the major colour pigment in ripe fruits (Hulme, 1971). At harvest, total carotenoids of the fruit pulps were 0·42 and 0·56 mg% for the 1985 and 1986 crops, respectively. This increased significantly after the third day of ripening, reaching a maximum value at the edible ripe stage. Yellowness of the fruit was accompanied by a progressive sweetness of the fruit pulp due to formation of sugars resulting from starch

hydrolysis. As shown in Table 1, African mango had a starch content of about 11% at harvest, which is comparable to the starch levels reported for a wide variety of mango fruits (Hulme, 1971). At the completion of the ripening period, in about 1 week, the starch content had been drastically reduced with only 0·25% remaining in the edible ripe fruit. However, as shown in Figs 1 and 2, the different times at which the onset of rapid starch breakdown and increase in carotenoids were initiated were probably a reflection of differences in maturity or in the number of immature samples between the two batches of fruit crops. This observation is in accord with the findings on Philippine carabao mango and other mango varieties (Hulme, 1971; Morga *et al.*, 1979).

Sourness in fruits decreases with progressive yellowing due to increase in sugars and a decline in total acidity. According to Hulme (1971), the pH of ripening mangoes shows an increase from 3·0 to 5·2 and a decrease in total acidity from 0·71 to 0·13%. Total acidity in ripe edible pulps of some Florida grown mangoes (Beyer *et al.*, 1979) ranged between 0·4 and 0·24%. For Pakistani mangoes (Elahi & Khan, 1973), change in total acidity was from 2·96 to 0·003% while Morga *et al.* (1979) recorded a change from 1·9 to 0·3% in total acidity of Philippine mangoes. The comparable value found in African mango ranged on average from 2·0 to 0·3%, indicating that the fruit is mildly acidic like most other mango varieties.

Change in fruit colour was also accompanied by a progressive softening of

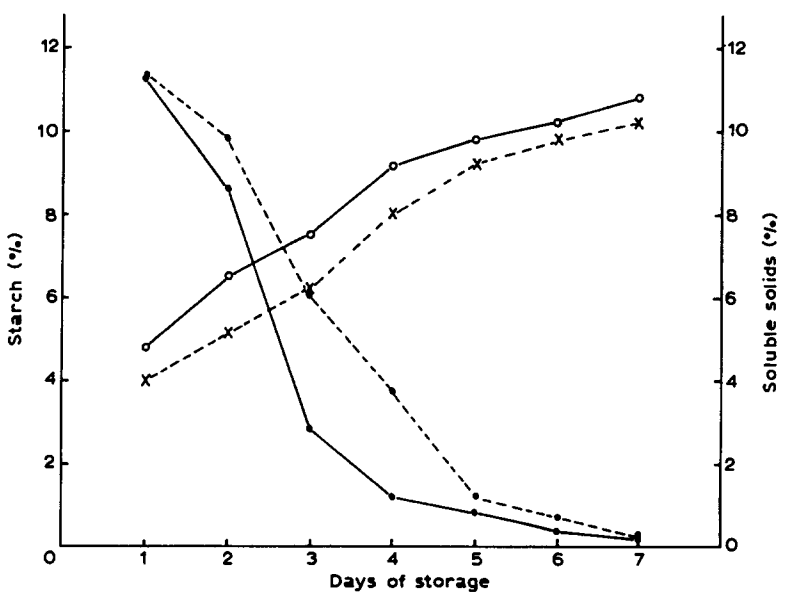

Fig. 1. Changes in starch and soluble solids of African mangoes during storage ripening (28°C, 68% rh). Starch (%): - - -●- - - 1985; ——●—— 1986. Soluble solids (%): - - - x - - - 1985; —○— 1986.

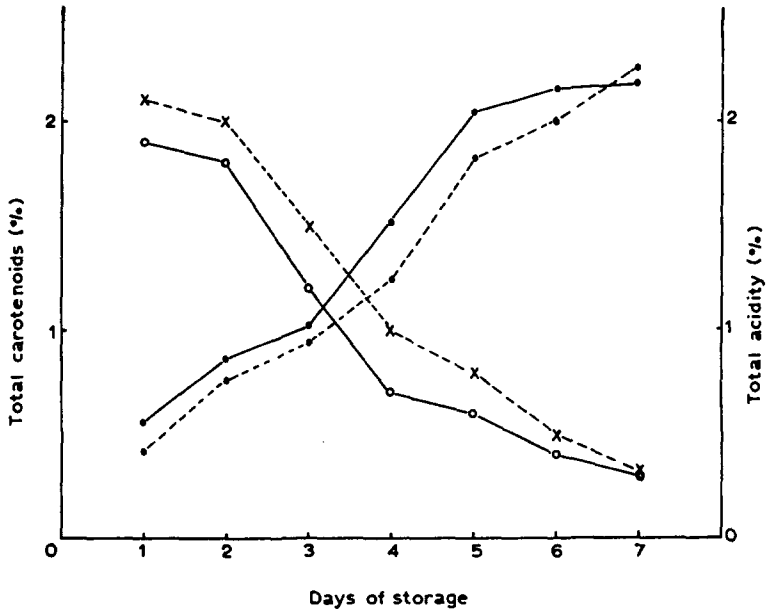

Fig. 2. Changes in total carotenoids and total acidity of African Mangoes during storage ripening (28°C, 68% rh). Milligrams per cent total carotenoids. - - - 1985; —— 1986. Total acidity (%) - - - × - - - 1985; —○— 1986.

the unpeeled fruit, which was due to degradation of pectin and other hydrocolloidal substances. Concomitant with changes in fruit colour and texture was the development of a characteristic pleasant flavour. This was due to the reduction in total acidity as well as an increase in extractable flavolans resulting from polymerization of tannins and other polyphenolic compounds, all of which contribute to fruit flavour (Hulme, 1971). However, unlike most other mango varieties, loss in astringency in ripening African mango was not accompanied by a reduction in total tannins (See Table 1) as has been reported for some astringent fruits (Goldstein & Swain, 1963).

Mangoes are a particularly good source of vitamin C. For African mango, Table 1 shows that the vitamin C level in the ripe pulp was 49·8 and 52·3 mg%, which compares with values reported in the literature for most mango varieties. However, the attendant diminution in vitamin C content of the fruit during ripening may be attributed to the susceptibility of ascorbic acid to oxidative destruction particularly at high ambient storage temperature (Thomas & Oke, 1980). Besides marked changes in fruit colour and texture, African mango underwent a reduction in fruit weight during the ripening process. Such change has been explained in terms of water loss resulting from both respiration and transpiration sources (Hulme, 1971). However, as shown in Table 1, water content of the fruit changed very little

throughout the ripening period. This may be due to moisture condensation resulting from hydrolysis of polymeric components such as starch and pectin.

CONCLUSION

African mango, one of the relished indigenous tropical fruits, changed from the green-mature to the yellow-ripe stage following a 7-day storage at ambient conditions. Besides the visual colour and texture changes, the most significant chemical change accompanying ripening was the hydrolysis of starch and the formation of soluble solids.

Although African mango is yet to attain its deserved prominence in the local fruit production system, chemical composition and attendant ripening changes show similarities to those of the common mango.

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