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OBSERVATIONS ON PHYSICAL AND CHEMICAL PROPERTIES OF ACEROLA FRUIT AND PUREE

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SUMMARY

Ripe fruit of acerola (*Malphigia glabra*) had a mean total soluble solids content of 6·6% and a mean pH of 3·3. Mean vitamin C content of fruit ranged from 2,140 mg/100 g for green fruit to 1,160 mg/100 g for ripe fruit.

Puree recovery ranged from 36% (green fruit) to 63% (ripe fruit); comminution and finishing gave a better recovery than finishing alone, and large ripe fruit gave a higher recovery than small ripe fruit.

Mean total soluble solids content of puree ranged from 7·5% (green fruit) to 7·0% (ripe fruit) and pH was in the range 3·2–3·5. Mean vitamin C content varied from 2,140 mg/100 g in puree from small green fruit to 1,110 mg/100 g in puree from ripe fruit.

Since World War II there has been interest in the commercial production of acerola or West Indian cherry (*Malphigia glabra* L.) because of the exceptionally high ascorbic acid content of the fruit. Asenjo and de Guzman (1946) reported that the fully ripe fruit grown in Puerto Rico contained from 1,030 to 2,700 mg ascorbic acid per 100 g and that unripe fruit might contain as much as 3,300 mg/100 g. Fitting and Miller (1960) conducted investigations into the properties of acerola juice alone and combined with other fruit juices such as pineapple, passion-fruit and guava. After storage for 8 months, prepared frozen juices retained from 82 to 92% of ascorbic acid, while bottled juices retained 60-70%. The added acerola juice had very little effect on colour or flavour of the fortified juices. Bates (1964) reported on the suitability of acerola puree and other fruit purees such as pineapple, guava and passion-fruit for drying by the "foam-mat" process. The foaming characteristics of acerola juice were found to be similar to those of passion-fruit juice.

For several years the Kamerunga Horticultural Research Station in North Queensland has conducted trials on two plantings of seedling acerola trees raised from two Porto Rican clones in order to select the most suitable types for commercial propagation for processing. Investigations were undertaken on the physical and chemical properties of the fruit and their bearing on the commercial utilization of acerola.

Materials and Methods

Fruit.—The fruit ranged in size from ¼ in. to 1 in. diameter and weighed 2-10 g. The thin, smooth skin of the fruit varied from grass green (fruit unripe), through pale green (fruit beginning to ripen) and yellow to orange (fruit at half-ripe stage) to rust red to plum red (fruit fully ripe). The flesh of the fruit was whitish and had a firm texture of a pithy nature and a sour taste.

Preparation of puree.—For investigations of puree preparation, fruit was graded into green, half-ripe, and ripe. For physical and chemical analyses, fruit was graded also according to size range—large, greater than ½ in. diameter; small, less than ½ in. diameter.

In one method of puree preparation (method A), the fruit was subjected to a comminution treatment to fragment the raw material, then passed through a finisher, and puree obtained. The juice in the resultant pulp was then extracted by pressing.

In a second method (method b), the fruit was processed by finishing only, to produce puree.

Chemical analyses.—Total soluble solids were determined by refractometer. Vitamin C content was determined by the method of Kefford (1957), using 2, 6-dichloroindophenol dye. In order to achieve the critical final titration of approximately 2·0 ml of dye, the following procedure was adopted:—(a) for fruit, 30-40 g was weighed out and analysed; (b) puree from the finisher was centrifuged for 5 min at 2,500 r.p.m., then 4 ml of supernatant liquid used for analysis.

Total reducing sugars and total sugars were determined by the method of Ting (1956).

Results

The comminution method of extraction gave a consistent 60-65% recovery of puree from ripe fruit, 50-56% from half-ripe fruit, and 30-40% from green fruit. Typical extraction figures are presented in Table 1.

TABLE 1

TYPICAL PERCENTAGE RECOVERY BY COMMINUTION/FINISHING TREATMENT

Fruit Series	Percentage Recovery by Weight	
	Finisher (Puree)	Press (Juice)
A1–A33		
Green	35·7	19·0
Half-ripe	56·4	11·4
Ripe	63·0	9·3
B1–B31		
Green	38·5	9·9
Half-ripe	51·8	7·9
Ripe	61·1	8·5

It was found that the finishing method could be applied only to the ripe fruit, as green and half-ripe fruit was too firm for sufficient fragmentation to take place in the finisher alone. For more efficient pulping, the original brush attachment inside the gauze cylinder of the finisher was replaced by an $\frac{1}{8}$-in. thick rubber strip about 1 in. wide, set to clear the internal gauze cylinder by 1/16-1/32 in. at the top and 1/16-$\frac{1}{8}$ in. at the lower end. Typical results (Table 2) indicate that even after three separate passes of pulp through the finisher, total recovery by this method was not as high as in the comminution method.

TABLE 2

TYPICAL PERCENTAGE RECOVERY FROM RIPE FRUIT BY FINISHING TREATMENT ONLY

Fruit Series	Treatment	Percentage Puree Recovery by Weight
A1–A33	Pass 1	24·2
	Pass 2	15·9
	Pass 3	8·2
	Total	48·3
B1–B31	Pass 1	15·5
	Pass 2	17·6
	Pass 3	10·4
	Total	43·5

The final pulp from the comminution method after pressing constituted 25-30% by weight of the original fruit, and consisted of skin fragments, flesh and fragmented seed pips. The fragmentation of seed material was severe, but the effect of this is not known.

Chemical analyses presented in Table 3 indicate no detrimental effects on puree from ripe fruit after three passes through the finisher in the finishing only

treatment. There was a gradation in vitamin C content from 2,140 mg/100 g in puree made from green fruit down to 1,110 mg/100 g in puree made from ripe fruit. This is in accord with reports of Asenjo and de Guzman (1946) on ascorbic acid content of acerola. pH values of all purees were consistently in the range 3·2 to 3·5.

TABLE 3

CHEMICAL ANALYSES ON PUREES FROM GRADED FRUIT

Fruit Series	Type of Puree	T.S.S.	pH	Vitamin C Content (mg/100 g)
A1–A33	Green	7·4	3·3	2,140
	Half-ripe	7·4	3·2	1,710
	Ripe			
	(i)	7·0	3·3	1,230
	(ii)	7·1	3·3	1,110
	(iii)	7·1	3·3	1,160
B1–B31	Green	7·4	3·5	2,140
	Half-ripe	7·5	3·2	1,720
	Ripe			
	(i)	7·1	3·2	1,250
	(ii)	7·1	3·2	1,270
	(iii)	7·1	3·2	1,260

The puree showed a decrease in total soluble solids in ripe fruit (7·0%) compared with green and half-ripe fruit (7·5%), and there was a slight decrease in average total sugars from green to ripe fruit (Table 4).

TABLE 4

CHEMICAL ANALYSES ON PUREES FROM FRUIT SAMPLES IN TABLE 1

Fruit Series	Item	Large Fruit			Small Fruit			Average Analysis		
		G	H	R	G	H	R	G	H	R
A1–A33	Total soluble solids	6·7	6·7	6·4	7·2	6·6	6·9	7·0	6·7	6·7
	pH	3·15	3·20	3·20	3·25	3·15	3·10	3·20	3·18	3·15
	Vitamin C	1,875	1,535	1,120	2,150	1,810	1,230	2,015	1,675	1,175
	Total reducing sugars	4·6	4·5	4·6	4·7	4·4	3·7	4·7	4·5	4·1
	Glucose	..	..	1·4	..	..	1·0	..	..	1·2
	Fructose	..	..	3·1	..	..	2·6	..	..	2·9
	Total sugars ..	4·9	4·8	4·7	6·7	5·4	4·0	5·8	5·1	4·3
	Sucrose	0·4	0·3	0·1	1·9	0·9	0·3	1·1	0·6	0·2
B1–B31	Total soluble solids	7·4	6·6	6·9	7·4	6·9	7·0	7·4	6·8	7·0
	pH	3·10	3·00	3·15	3·20	3·10	3·15	3·15	3·05	3·15
	Vitamin C	2,190	1,685	1,335	2,475	1,780	1,255	2,335	1,735	1,295
	Total reducing sugars	4·1	4·0	3·5	4·6	4·5	4·7	4·4	4·3	4·6
	Glucose	..	..	1·6	..	..	1·2	..	..	1·4
	Fructose	..	..	3·0	..	..	3·5	..	..	3·2
	Total sugars ..	5·6	4·5	4·7	5·9	5·4	4·8	5·8	5·0	4·7
	Sucrose	1·4	0·5	0·1	1·3	0·8	0·1	1·3	0·7	0·1

Yamane and Nakasone (1961) reported the existence of both sweet and sour types of acerola, and Miller, Wenkam, and Fitting (1961) suggested the consumption of the fruit and puree in the raw state as well as in combination with other fruit juices. The fruit examined in the present examination was considered to be too tart for consumption in the fresh state, and this suggests that the trees from which it came were of the sour type.

Results in Table 5 and 6 indicate that the vitamin C content in fruit from seedling trees raised from one clone was higher throughout the maturity range than that in fruit from the other clone.

TABLE 5

AVERAGE ANALYSES OF FRUIT FROM FRUIT SERIES A1–A33

Fruit Grade	Vitamin C (mg/100 g)			Total Soluble Solids			pH		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Green	2,960	1,630	2,160	..	..	..	..	..	..
Half-ripe	1,990	975	1,545	..	..	..	..	..	..
Ripe	1,905	895	1,275	7·6	5·5	6·6	3·5	3·1	3·3

TABLE 6

AVERAGE ANALYSES OF FRUIT FROM FRUIT SERIES B1–B31

Fruit Grade	Vitamin C (mg/100 g)			Total Soluble Solids			pH		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Green	3,460	1,845	2,390	..	..	..	..	..	..
Half-ripe	2,660	1,390	1,895	..	..	..	..	..	..
Ripe	2,240	1,000	1,490	8·1	5·8	6·6	3·9	3·0	3·4

Total soluble solids and pH in ripe fruit from both sources showed close similarity, average values being 6·6% T.S.S. and pH 3·4 for ripe fruit.

Discussion

The exceptionally high vitamin C content and the relative ease of pulping make the fruit an attractive material as a juice supplement in fruit juices of low vitamin C content, provided problems of transportation and packaging can be overcome commercially.

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