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Extraction, Processing, Canning, and Keeping Quality of Acerola Juice

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INTRODUCTION

West Indian cherries (*Malpighia punicifolia* L), best known in Puerto Rico as "acerola," were shown by Asenjo, and Freire de Guzmán (1)[2] to contain from 1 to 3 gm. of ascorbic acid per 100 gm. of edible matter. This finding was confirmed by Mustard (4) who found the green fruit to contain about 4 gm. of the vitamin per 100 gm. of edible matter.

The high ascorbic acid content of the acerola suggested the possibility of using the juice as a source of the vitamin to enrich other juices and nectars (2). The possibility of using the acerola juice as such induced the author to study the canning and keeping quality of the juice. The present study deals chiefly with procedures for canning the juice and with the keeping quality of the product.

EXPERIMENTAL PROCEDURE

Ripe fruit from the trees grown at the Experiment Station Farm in Río Piedras were used. The fruit was picked when fully mature but still firm, and brought immediately to the laboratory. Whenever feasible, the fruit was processed immediately. When immediate processing was not feasible, the fruit was stored at 45°F. for no more than 3 days. During the peak of the season, when more fruit than could be processed in a reasonably short time was delivered to the laboratory, the excess was frozen solid and stored at 10°F. Frozen fruit was thawed overnight before processing.

The juice was extracted by pressing the whole fruit in a homemade cider press through white duck bags. When the fruit was too firm to give a high

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[2] Numbers in parentheses refer to Literature Cited, p. 183.

yield of the juice, it was broken into a mash by means of a high-speed stirrer before processing.

The extracted juice was centrifuged in a solid-basket centrifugal to remove the pulp in suspension. When the solids in suspension could not be completely removed by centrifugation, the juices were filtered in a frame-and-plate filter press using Hyflo Supercell.

The juices were flash-pasteurized in a tubular heat exchanger at 190°F. for 45 seconds, canned in No. 2 plain tin (1.25) or sanitary enameled containers, followed by 1-minute holding of the inverted cans and rapid cooling.

The canned juices were stored at 45°F. and at room temperature of 80°–85°F. for 1 year. Samples were regularly assayed for ascorbic acid, pH, total acidity, and reducing sugars. The ascorbic acid was determined by the iodometric titration of Ballantine (3). Total acidity was determined by electrometric titration with sodium hydroxide, using a glass and calomel electrode system. Reducing sugars were determined by the method of Santini (5).

RESULTS

YIELDS OF JUICE

The yields of juice obtained from several lots of fruits processed are given in table 1. As is seen from these figures, the average yield of juice when the fruit was pressed in the homemade hydraulic press varied from about 59 to 73 percent. This variation in the yield of juice can be attributed to the rather poor performance of the press. The pressure was applied by means of a 5-ton hydraulic jack and it was almost impossible to obtain uniform pressure in all the experiments. Variations in yields can also be attributed to the ripeness of the fruit being processed, mature fruit giving higher yields than greener fruit.

TABLE 1.—*Yields and ascorbic acid content of acerola juice*

Weight of fruit (pounds)	Weight of juice extracted	Juice in fruit	Ascorbic acid in juice
	Pounds	*Percent*	*Gm. per 100 ml.*
222.0	134.5	60.58	1.29
235.0	139.0	59.02	1.22
279.0	182.0	65.20	1.18
195.5	130.0	66.49	1.20
108.0	58.5	54.00	1.21
67.0	40.4	60.36	1.50
326.0	105.0	62.88	1.37
195.0	132.0	67.69	1.69
214.5	157.5	73.42	1.32

Although, as reported by Mustard (4), and later verified in this laboratory, the green fruit contains more ascorbic acid than the ripe, the processing of ripe fruit offers the advantage of higher yields of juice, and consequently, higher recovery of ascorbic acid. If the green fruit is to be processed, it is necessary to mash it in water in order to obtain a mash fluid enough for pressing. Pressing of green fruit without mashing in water could not be carried out with the equipment at our disposal.

The extraction of the juice by pressing the fruit in a screw press was attempted. A pulpy juice was obtained which could not be clarified easily. As will be shown later, the presence of pulp in the juice was found to be detrimental and, therefore, pressing in the screw press was abandoned.

The juice obtained from the hydraulic press was cherry red in color and fairly transparent. The ascorbic acid content varied from 1.18 to 1.69 gm. per 100 ml., as indicated in table 1. The recovery of ascorbic acid in the process in terms of the ascorbic acid present in the fruit was found to have an approximate average value of 75 percent.

EFFECTS OF PROCESSING

When the juice containing pulp in suspension was heated, the pulp coagulated and a yellowish precipitate appeared. When the juice was clarified, the formation of this precipitate could be prevented. The juice from the press which contained a fairly small quantity of pulp in suspension, was centrifuged in a solid-basket centrifugal 12 inches in diameter at 2,100 r.p.m. The centrifuge was generally fed 2 to 3 gallons of juice per minute, and the juice was permitted to overflow the basket. Centrifugation removed a yellow solid in suspension, yielding a more reddish-colored juice. The loss of ascorbic acid during centrifugation was found to be negligible. In the several batches of juice centrifuged, the loss of ascorbic acid never amounted to more than 1 to 2 mg. per 100 ml., as can be seen in table 2.

The appearance of the juice was greatly improved by filtration. Filtra-

TABLE 2.—*Change in ascorbic acid content of juice of the acerola during centrifugation and pasteurization, in grams per 100 ml. of juice*

Exracted juice	Centrifuged juice	Pasteurized juice
1.29	1.29	1.28
1.22	1.25	1.22
1.18	—	1.17
—	1.34	1.14
—	1.169	1.14
1.69	1.691	1.63
1.32	1.31	1.23

tion of the juice at room temperature was successfully carried out in a frame-and-plate filter press using 0.2 percent of Hyflo Supercell. Paper of medium porosity previously precoated with the filter-aid assured a uniform flow of juice from the filter press. The loss of ascorbic acid during filtration was found to be about 73 mg. per 100 ml. of juice.

When the clarified juices were flash-pasteurized at 190°F., the loss of ascorbic acid was fairly small, as is shown in table 2.

When the juice was heated for about 45 seconds at 190°F., the color changed from cherry red to orange red or yellow. When heated for a longer period, the change in color was more pronounced.

Canning of the juice under vacuum, followed by pasteurization in the can at 190°F., resulted in a slighter change in color. The change in color that takes place when the juice is heated can be attributed to the decomposition of the pigment, probably anthocyanin,[3] which exhibits a similar behavior when heated in the presence of ascorbic acid (6).

The type of container used to can the juice has a direct effect on the color and appearance of the product. When plain tin cans (1.25-lb. tin B/B) were used, rapid deterioration of the color took place with the formation of a yellow precipitate. The use of sanitary F-enamel containers improved the appearance of the product. The juice canned in this type of container changed in color from the deep cherry red to a reddish orange. If the juice was filtered free of suspended or colloidal solids, no precipitate formed and the juice remained clear through the storage period. Similar results were obtained with glass containers and with enameled cans with side-seam striped.

EFFECTS OF STORAGE AT DIFFERENT TEMPERATURES

In the course of this work it was observed that the cans of the juice stored at room temperature (85°F.) usually showed swelling in less than a month. Bacterial counts[4] made from these samples showed that the product was generally sterile and free from gas-forming bacteria. In no case could swelling be attributed to fermentation. Neither could swelling be attributed to hydrogen production. Swelling took place in both plain tin and enameled containers. Qualitative tests showed that most of the gas produced was carbon dioxide.

In table 3 are tabulated the results of the determinations of ascorbic acid and reducing sugars in samples of canned acerola juice stored at room temperature. Changes in acidity and pH are shown for the same storage tem-

[3] Work in progress in this laboratory indicates that the pigment present in the acerola juice has characteristics similar to those of anthocyanin.

[4] Counts made by R. Córdova of the Faculty of Natural Sciences of the University of Puerto Rico.

TABLE 3.—*Keeping quality of pasteurized West Indian cherry juice stored at room temperatures of 80° to 85° F.*

Storage age (months)	Ascorbic acid content	Reducing-sugar content	Loss of ascorbic acid
	Sample 1		
	Gm./100 ml.	*Percent*	*Percent*
0	1.12	3.6	
1	1.06	3.6	
2	1.06	3.6	
3	.98	3.7	
6	.74	3.7	
12	.52	3.7	53.5
	Sample 2		
0	0.91	3.0	
1	.87	3.0	
2	.79	3.0	
3	.77	3.0	
6	.61	3.1	
12	.37	3.1	81.5
	Sample 3		
0	1.03	3.4	
1	.97	3.4	
2	.87	3.4	
3	.85	3.5	
6	.67	3.7	
12	.41	3.4	60.2
	Sample 4		
0	1.14	3.5	
1	1.03	3.5	
2	.93	3.5	
3	.91	3.4	
6	.86	3.6	
12	.45	3.5	60.5
	Sample 5		
0	0.84	3.4	
1	.84	3.3	
2	.8	3.4	
3	.74	3.4	
6	.62	3.3	
12	.37	3.4	56.0

TABLE 4.—*Changes in total acidity, pH, and ascorbic acid of pasteurized West Indian cherry juice stored at room temperature of 85°F.*

Storage age (months)	Total acidity	Ascorbic acid	pH
	Sample 1		
	Percent	*Gm./100 ml.*	
0	0.84	1.28	3.6
1	.83	1.16	3.5
2	.81	1.16	3.4
3	.81	.99	3.5
5	.80	.98	3.6
7	.80	.93	3.5
9			
	Sample 2		
0	0.85	1.22	3.7
1	.85	1.11	3.5
2	.84	1.11	3.4
3	.82	.95	3.6
5	.81	.93	3.5
7	.80	.86	3.5
9	.80	.72	3.7
	Sample 3		
0	0.88	1.14	3.5
1	.89	1.06	3.4
2	.88	1.06	3.4
3	.81	.93	3.5
5	.85	.91	3.5
7	.84	.83	3.4
9	.82	.71	3.6

perature in table 4. Similar data appear in table 5 for samples stored at 45°F.

When the juice was stored at room temperature the loss of ascorbic acid ranged from 53.5 to 81.5 percent of the amount originally present. No change was observed in the reducing-sugar content. When stored at 45°F. the loss in ascorbic acid ranged from 10.8 to 21.2 percent of the amount originally present. Again no change was observed in reducing sugar.

Since the change in color during storage is accelerated by a high temperature, the acerola juice should be stored at 45°F., or lower, to prevent this and to insure maximum retention of the ascorbic acid. When frozen without pasteurization less change takes place and the ascorbic acid is fairly well

TABLE 5.—*Changes in reducing-sugar and ascorbic acid content of pasteurized West Indian cherry juice stored at 45°F.*

Storage age (months)	Ascorbic acid content	Reducing-sugar content	Loss of ascorbic acid
	Sample 1		
	Gm./100 ml.	*Percent*	*Percent*
0	1.12	3.6	
1	1.12	3.5	
2	1.18	3.6	
3	1.18	3.6	
6	1.02	3.7	
12	1.01	3.5	10.8
	Sample 2		
0	0.91	3.0	
1	.96	2.9	
2	.90	3.1	
3	.90	3.0	
6	.81	3.1	
12	.72	3.2	20.8
	Sample 3		
0	1.03	3.4	
1	1.08	3.4	
2	.992	3.4	
3	.985	3.4	
6	.915	3.5	
12	.823	3.5	20.5
	Sample 4		
0	1.14	3.5	
1	1.15	3.4	
2	1.06	3.4	
3	1.06	3.5	
6	1.02	3.7	
12	.901	3.6	21.2
	Sample 5		
0	0.84	3.4	
1	.95	3.3	
2	.90	3.3	
3	.87	3.3	
6	.82	3.4	
12	.78	3.5	7.2

TABLE 6.—*Changes in ascorbic acid content of stored frozen West Indian cherry juice*

Sample No.	Ascorbic acid content of frozen West Indian cherry juice aged—			
	2 months	4 months	10 months	12 months
	Mg./100 ml.	*Mg./100 ml.*	*Ml./100 ml.*	*Mg./100 ml.*
I	0.73	0.67	0.67	0.67
II	.65	.62	.62	.60

retained, as shown in table 6. Freezing also prevents changes in color and flavor.

FLAVOR

Heating and canning altered the flavor of the acerola juice. The pleasant flavor of the freshly extracted juice changed during heating with the development of a haylike flavor. This change in flavor, however, did not prevent the use of the juice as a source of ascorbic acid. It was shown in the course of this work that the addition of the acerola juice to products like pear and apricot nectar, and to grape juice, did not cause any appreciable change in flavor, when made at a rate of 1 part of the acerola juice to 27 parts of the product. This rate is high enough to increase the ascorbic acid content to about 50 to 60 mg. per 100 ml.

SUMMARY

The juice is best extracted from the acerola by pressing the mashed fruit in a cider press. The recovery of juice varies from about 59 to 73 percent of the weight of the fresh fruit used, depending on the pressure applied and the ripeness of the fruit. The extracted juice is clarified by centrifugation followed by filtration using Hyflo Supercell. Although pasteurization of the juice causes but a slight loss of the ascorbic acid content, it induces a change in color and flavor of the juice. The product must be canned in enameled cans to prevent excessive discoloration.

When the juice was stored at room temperature (80° to 85°F.) the loss of ascorbic acid during 1 year amounted to from 53.5 to 81.5 percent. The loss of ascorbic acid is minimized by storage at 45°F. Juices stored at 45°F. suffered a maximum loss of ascorbic acid of about 20 percent during 1 year.

Although the flavor of the juice changed during processing, the product can be used as a source of ascorbic acid to enrich other products without detrimentally affecting their taste. Only 1 part of the juice need be added to 27 parts of the product to be enriched with no appreciable change in flavor of the enriched product.

RESUMEN

El jugo de la acerola se extrae exprimiendo la fruta, previamente triturada, en una prensa hidráulica. La recuperación del jugo varía entre un 59 y un 73 por ciento. El rendimiento depende de la presión que se le aplique a la prensa y del estado de madurez de la fruta. El jugo extraído se clarifica por centrifugación y luego se filtra usando un agente filtrador como Hyflo Supercell. Cuando el jugo se pasteuriza, hay una pérdida pequeña en su contenido de ácido ascórbico. Al pasteurizar el jugo, este sufre un cambio en su color y sabor. El jugo debe ser enlatado en latas esmaltadas para evitar un cambio excesivo en el color.

Cuando el jugo de la acerola se almacena a una temperatura de 85°F., la pérdida de ácido ascórbico varía entre 66 y 80 por ciento del contenido original, al cabo de un año. Cuando los jugos se almacenan a 45°F., por un año, la pérdida de ácido ascórbico asciende a solament un 20 por ciento. Aún cuando el sabor del jugo cambia durante el proceso de enlatado, éste puede usarse como fuente de ácido ascórbico para enriquecer otros productos. La adición de 1 parte del jugo de acerolas a 27 partes del jugo a ser enriquecido, es suficiente para enriquecer el producto sin causar cambios en el sabor del mismo.

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