Effect of Several Heat Treatments on Quality and Shelf Life of a Frozen Guava Nectar Base

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INTRODUCTION

Guava products are very popular in Puerto Rico. Large quantities of nectar, paste, jellies, and syrups are manufactured, mostly from wild fruit. The nectar prepared from the wild fruit has a pleasing flavor when fresh but it deteriorates rapidly during storage at ambient temperatures. Some manufacturers freeze the guava pulp in preparing a nectar base but this has not been produced commercially. A frozen nectar base offers the advantage of a longer shelf-life, thus providing consumers with a product of fairly uniform quality the year around.

When wild fruit is processed, there is danger of obtaining high microbial counts on extracted purees. This is mainly due to difficulties involved in selection of fruit. Pasteurization of the purees is highly desirable under such conditions. These studies were conducted to determine: 1, The effect of several heat treatments on the quality and shelf-life of a nectar base prepared from wild fruit and 2, to obtain processing data to guide local manufacturers contemplating production of this type of product.

REVIEW OF LITERATURE

Adriano *et al.* (*1*)[2] studied the freezing of fully ripe sliced guavas packed in syrup and the freezing of guava puree. Cruess (*5*) conducted studies on the effect of freezing on the vitamin C content of guavas, and reported fairly high losses of the vitamin which he attributed to diffusion of the syrup. Joslyn *et al.* (*8*) found that a blanched or unblanched puree with or without sugar added, was the most successful product prepared from guavas. Mustard and Stahl (*11*, *12*) and Wright (*20*) described experiments conducted on the freezing of guava puree prepared from peeled or unpeeled fruit and suggested the use of guava as a baby food. Boyle *et al.* and Boyle (*3*, *4*) described methods for the commercial processing of guava puree and a frozen guava nectar base. The procedure recommended by these authors involves blending the puree with sugar, adjusting the pH between 3.3 and

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[2] Italic numbers in parentheses refer to Literature Cited, pp. 218–19.

3.5 by blending sweet and sour fruit, and packing in enameled cans without heat treatment. Scott (*17*) studied the market potential of the frozen nectar base in Hawaii and in the United States mainland and reported that the product fared best in Hawaii than on the mainland.

Methods for the preparation of fruit purees have been described by Joslyn *et al.* (*8*) and reviewed by Tresler and Evers (*19*). Hohl (*7*) found in the preparation of peach puree that steaming the fruit before pulping prevented oxidative changes during storage. Paul (*14*) reported the addition of sugar to peach, pear, plum, tomato, and other fruit and vegetable purees improved retention of color and flavor during storage. Látimer (*10*) indicated that chilling the fruit before pulping improved the quality of purees. Joslyn *et al.* (*8*) found that the flavor and color of pureed fruit could be preserved better by deaeration. Strackan and Moyles (*18*) studied the use of ascorbic acid as an antioxidant in frozen packed fruits and reported that the addition of the vitamin in quantities ranging from 150 to 200 mg per 15 ounces of finished product protected the fruit from oxidative changes. DuBois (*6*) reported the addition of ascorbic acid to vegetable and fruit purees improves retention of color. Rahman *et al.* (*15*) found that the destruction of vitamin C in some tropical fruit nectars was influenced by the concentration of the vitamin and sugar, higher concentrations of both resulting in a higher retention of vitamin C.

EXPERIMENTAL PROCEDURE

Wild fruit harvested ripe, of a quality similar to that delivered to processing plants, was used in these studies. The fruit was selected from a roller inspection table to discard soft, broken, and anthracnose-infected ones. The fruit was delivered from the inspection table to a soak washer in which the fruit was soaked in 40 p.p.m. chlorine solution. After soaking, the fruit was washed with fresh water in a rod-reel washer.

The washed fruit was cut into small particles in a Fitzpatrick Model D[3] comminuting mill with knives forward, using a screen with ¼-inch perforations, the machine running at 4,600 r.p.m. The comminuted fruit dropped directly into the hopper of a Langsenkamp laboratory stainless steel pulper operating at 1,060 r.p.m. with a 0.060-inch screen with paddles tapering toward the outlet to facilitate discharge of seeds. The extracted pulp was pumped to a Langsenkamp laboratory paddle finisher operating at 1,000 r.p.m. with a 0.033-inch screen. The pulp from the finisher was run through a stone mill using No. 10 stones at a clearance of 0.0002 inch.

The pulp was blended with sugar with a slow speed agitator until the

[3] The mention of trade names in this publication does not imply endorsement of particular equipment and are given solely for the purpose of giving specific information.

sugar dissolved. For every 100 pounds of pulp, 54 pounds of sugar were added. F. D. C. Red No. 2 colorant was added at the rate of 1.5 to 2.0 g. per 100 pounds of pulp. This quantity of color was enough to give an attractive red color to the reconstituted nectar.

The prepared nectar base was heated to temperatures ranging from 150° to 215° F. in a steam-heated laboratory Votator. The heated pulp was pumped through a water-cooled Votator, and finally chilled in a third Votator cooled with ammonia. From the last Votator the pulp was filled directly into 8-ounce plain tin or enamel cans and immediately frozen at −40° F. The cans were stored at −10° F.

The frozen samples were analyzed at frequent intervals for pH and total acidity, total and reducing-sugars, vitamin C, and color. For analyses, the nectar base was thawed at room temperature and homogenized in a blender.

For pH and total acidity measurements, about 10 g. of pulp were weighed and diluted with water to 100 ml. The pH was measured with a glass-calomel electrode system, and titratable acidity was determined by titration with 0.1 N NaOH solution to pH 8.1 in a titrimeter with glass-calomel electrodes (*13*). Acidity was calculated as anhydrous citric acid percent undiluted base.

Total and reducing sugars were determined by the Lane and Eynon volumetric method (*17*). Ascorbic acid was determined by the iodate method as modified by Ballantine (*2*). Color was measured in a Hunter Tristimulus colorimeter using a color plate with $Rd = 32.7$, $a = 30.6$, $b = 10.2$, as standard.

For the microbial examination, the samples were removed from the freezer and stored overnight at 45° F. After standing for 1 hour at room temperature, the cans were placed in a shaker for 15 minutes. The cans were opened and a sample of about 50g. removed with a sterile pipette. The sample was transfered to an sterile blender and mixed with 450 ml. sterile distilled water for 2 minutes. Aliquots of 10^2 and 10^3 dilutions were plated using Difco Tryptone glucose for bacteria, and potato glucose for yeast and molds (*16*). Results were calculated as the number of microorganisms per g. of undiluted base.

For organoleptic evaluation, the samples were diluted with 3 volumes of water and then rated for flavor under red light by the method of Kramer and Ditman (*9*) using a + 2, − 2 scale.

RESULTS

The prepared nectar bases were heated in a laboratory Votator to temperatures of 150, 185, and 210 to 215° F., followed by cooling with water to about 125° F. in a second Votator. Before filling the cans, the nectar

base was chilled to 40° to 50° F. in a third Votator cooled with ammonia. Nectar base canned directly without heat treatment served as control. Retention time in the heating Votator was for a few seconds only. The results of the organoleptic tests conducted at four different time intervals during storage are given in table 1. The scores in the table correspond to

TABLE 1.—*Effect of heat treatment on sample quality scores during the shelf-life study of guava nectar bases*

Storage period (days)	Treatment[1]			
	Control	150° F.	185° F.	210°–215° F.
42–44	1.05	0.85	0.60	0.80
	.60	.80	.55	.30
175–182	—	.55	.71	.49
	.90	.60	.90	.82
295–303	.65	.90	.85	.88
	.85	.83	1.00	.43
409–419	.83	.88	.79	.85
	.73	.75	.92	.79

[1] Upper entry—plain tin cans.
Lower entry—enamel cans.

TABLE 2.—*Changes in acidity and reducing sugars during storage of prepared guava nectar bases at −10° F.*

Storage period	Constituent (percent)	Treatment[1]							
		Control		150° F.		185° F.		210°–215° F.	
Days	*Percent*	*Percent*		*Percent*		*Percent*		*Percent*	
14–42	Acidity	0.69	0.80	0.63	0.79	0.63	0.79	0.64	0.78
411–419		.74	.81	.69	.80	.64	.80	.65	.83
14–42	Reducing sugars	4.04	4.12	3.56	3.28	3.61	3.17	3.38	2.86
411–419		5.23	5.08	3.76	5.38	4.18	3.79	3.69	3.02

[1] Left entry—plain tin cans.
Right entry—enamel cans.

average values from each test for the reconstituted base tasted under red light using a + 2, − 2 scale according to the method of Kramer and Ditman (*20*). No significant differences were found among the control and the heat treated samples at the four different time intervals studied during storage. No significant change in quality took place during storage for over 400 days at −10° F.

The effect of the treatments on the acidity and reducing-sugar content

TABLE 3.—*Changes in color during storage of guava nectar bases at −10° F.*

Storage period (days)	Color value	Treatment[1]			
		Control	150° F.	185° F.	210°–215° F.
14	*Rd*	12.5	14.2	14.4	14.5
		14.2	13.8	14.5	14.9
	a	20.0	22.0	23.3	22.8
		19.2	20.8	21.3	21.1
	b	10.9	11.8	12.3	13.0
		13.3	12.5	12.8	13.2
	$\text{Tan}^{-1}a/b$	64°36′	61°48′	62°36′	60°15′
		56°14′	58°56′	58°56′	57°58′
215–226	*Rd*	13.8	15.1	14.2	14.7
		15.0	15.1	15.3	15.2
	a	21.3	21.9	20.9	22.2
		19.4	20.8	20.1	20.3
	b	12.3	13.2	12.4	12.7
		13.5	13.3	13.5	14.1
	$\text{Tan}^{-1}a/b$	60°21′	59°21′	59°19′	60°10′
		55°14′	55°38′	56°1′	55°20′

[1] Upper entry—plain tin cans.
Lower entry—enamel cans.

TABLE 4.—*Vitamin C content of guava nectar bases in mg. per 100 g. of base at several time intervals of storage at −10° F.*

Processing temperature ° F.	Storage period in days[1]					
	14–23		215–226		411–442	
	A	*B*	*A*	*B*	*A*	*B*
Control	88.91	114.85	118.13	109.67	92.76	103.26
150	84.42	133.46	85.28	125.75	87.55	116.95
185	84.61	127.60	79.05	126.55	84.64	123.05
215	85.20	124.97	80.46	120.44	83.69	122.26

[1] A—plain tin cans.
B—enamel cans.

during storage is shown in table 2. No changes in acidity or pH were observed during storage for over 400 days. A slight increase in the reducing-sugar content was observed in samples heated to lower temperatures and in control samples.

The change in color during storage is shown in table 3. Values given in the upper entries in the tables are for the nectar base canned in plain tin cans. The lower entries for nectar canned in guava enamel cans with side seam stripped. Insignificant changes in color took place during storage in both types of cans even though F. D. C. Red No. 2 colorant, which is bleached by plain tin was added.

Changes in vitamin C content during storage are shown in table 4 for

TABLE 5.—*Effect of heat treatment on microorganism counts on guava nectar bases*

Treatment	Microorganisms per g. × 10^2 [1]			
	Bacteria		Yeast	
	A	*B*	*A*	*B*
Control	146.0	—	372	0
150° F.	9.0	240.0	1.6	1.3
185° F.	15.5	39.0	0	3.3
210°–215° F.	1.0	6.0	0	0

[1] A—plain tin cans.
B—enamel cans.

nectars canned in plain tin cans and in enameled containers. The retention during storage is shown in the following tabulation:

Processing temperature in ° F.	*Ascorbic acid retention during storage*	
	Plain tin cans *Percent*	*Enamel cans* *Percent*
Control	104.3	89.9
150	103.7	87.6
185	100.0	96.4
215	98.2	97.8

It should be noted that retention of vitamin C in the plain tin cans exceeded 100 percent in three of the samples. An increase in values of ascorbic acid during storage has been reported in the literature and attributed to formation of interfering reducing substances. The apparent increase in the ascorbic acid content has been observed repeatedly in previous studies with acid fruits conducted in this Laboratory. The reducing substances formed are related apparently to dissolution of tin from the con-

tainers because this apparent increase in ascorbic acid content is not observed in fully-enameled cans.

Improved retention of the ascorbic acid was attained when processing at temperatures of 185° F. and higher, possibly due to inactivation of the oxidases. The addition of vitamin C in quantities ranging from 94 to 623 mg. per 100 g. did not improve retention during storage. The retention of the vitamin in samples with initial levels within the range indicated are given in the following tabulation:

Initial level of vitamin C mg./100 g.	*Retention during storage at −10° F. for 215 days Percent*
94.19	91.18
243.57	89.88
233.38	97.97
364.10	90.22
406.86	99.26
442.18	94.66
623.31	93.41

The effect of heat treatment on counts of yeasts and bacteria are shown in table 5. Yeasts were destroyed in one lot processed at 185° F. and in the two lots processed at 210 to 215° F. Bacterial counts also were reduced by heat treatment. In general, the lots processed had low bacterial counts. Because the cans were filled under atmospheric conditions, counts should not be expected lower than these.

From the standpoint of processing, the method described under Experimental Procedure for preparation of bases proved satisfactory. Pulp recovery from the finisher ranged from 74.0 to 80.2 percent. Although the base was fairly viscous, it could be pumped readily through the Votators. Heating the bases had no effect on either product quality or shelf-life; thus the base may be packed directly without heat treatment in commercial practice provided adequate sanitary practices are followed during processing, or the base pasteurized to assure low bacterial counts in the finished product.

SUMMARY

Studies were conducted concerning the effect of several heat treatments on the quality and shelf-life of a frozen guava nectar base prepared from wild fruit. Heating nectar bases to 150°, 185° and 210° to 215° F., followed by rapid cooling and chilling, had no apparent effect on quality and shelf-life. No appreciable changes were observed in acidity and reducing-sugars over a storage period of 400 days at −10° F. Insignificant changes in color occurred in plain tin and fully-enameled containers, even when F. D. C. Red No. 2 colorant was added to improve the color.

Vitamin C retention during storage ranged from 89.0 to 97.8 percent. Vitamin C retention was observed higher than 100 percent in the samples canned in plain tin containers, attributed to formation of reducing interfering substances. Addition of vitamin C in levels ranging from 94 to 623 mg. per 100 g. of base had no effect on vitamin C retention.

Heat treatments reduced bacterial and yeast counts. Because the several heat treatments tested had no appreciable effect on quality and shelf-life, the product may be packed without heat treatment in commercial practice or may be pasteurized by heating above 185° F. to reduce microorganism counts.

RESUMEN

Se llevó a cabo un estudio para determinar cómo se afecta la calidad y la duración en almacén de un concentrado de néctar de guayaba cuando se calienta a temperaturas de 150°, 185° y de 210° a 215° F. Al calentarse a las temperaturas indicadas y luego enfriarse rápidamente antes de enlatarse, se observó que los distintos tratamientos a que se sometió no surtieron efecto alguno sobre la calidad y duración en almacén. No se registraron cambios significativos en la acidez total, ni en el contenido de azúcares reductores durante un periodo de almacenamiento de más de 400 días a −10° F. Aun cuando se añadió el colorante F. D. C. Rojo No. 2, no se observó gran cambio en el color de las muestras que se envasaron en latas estañadas.

La retención de la vitamina C durante el almacenamiento a −10° F. fluctuó entre un 89.9 y un 98.8 por ciento. Las muestras envasadas en latas estañadas sufrieron un cambio aparente en el contenido de vitamina C, lo cual se atribuye a la formación de substancias reductoras que interfirieron en la determinación del ácido ascórbico. El añadir ácido ascórbico en cantidades que fluctuaron entre 94 y 623 mg. por cada 100 g. del concentrado, no tuvo efecto alguno sobre la retención de la vitamina C durante el almacenamiento.

Los tratamientos con calor redujeron los contajes de bacterias y levaduras.

Los resultados de estos estudios sugieren que en la práctica comercial el concentrado puede envasarse sin calentarse o pasterizarse a una temperatura de 185° F. o más, para reducir el contaje de microorganismos.

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