Acceptability and Keeping Quality of Marmalades and Canned Slices in Heavy Syrup of Mango Cultivars[1]

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ABSTRACT

This study evaluated marmalades and slices in heavy syrup of four mango cultivars—Edward, Irwin, Palmer, and Keitt. All varieties gave well over 65% recovery in pulp available for canning or marmalades. Both products exhibited some browning during storage, particularly in the marmalades, perhaps because of the lower pH, but such browning did not impair their acceptability. The quality and acceptability of both products were good for as long as 12 months.

INTRODUCTION

Fruits preserved in syrup, in the form of bars, jellies, marmalades, and many other ways have a great demand as desserts, specially slices of fruits in heavy syrup.

Lately, commercial orchards of mangoes (*Mangifera indica L.*) have been established with the various mango varieties of high quality and flavor that the Agricultural Experiment Station has introduced. This work was undertaken as part of the evaluation of the Edward, Irwin, Palmer, and Keitt cultivars.

Mangoes have been elaborated into nectars, chutneys, canned slices, and pickles in different parts of the world. Sherman et al. (6) describe a process for canning mango slices of the Haden, Zill, Joe Welch, and Ah Ping varieties in 40° Brix syrup heated to 87.8° C. Mangoes have also been canned in 50° Brix syrup containing 0.5% citric acid and heated to 79.4-82.2° C (1).

Little or no information is locally available in regard to the elaboration of mangoes into marmalades and slices in heavy syrup.

MATERIALS AND METHODS

The mangoes used in this study were obtained from an experimental orchard at the Fortuna substation of the Agricultural Experiment Station, located on the southern coast of Puerto Rico. The mangoes were harvested mature green. The fruits were subjected to a hot water treatment

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as described by Pennock et al. (4) and allowed to ripen at ambient temperature.

Only ripe mangoes with a firm texture were used for the preparation of slices and marmalades.

During the course of our study, the different batches of the four varieties of mangoes were also analyzed as fresh fruit. pH, total acidity, soluble solids (as °Brix) and total and reducing sugars were determined by official AOAC methods (3). Moisture and total solids were determined by drying in a vacuum oven at 60° C for 18 h. Vitamin C was determined by the 2, 6, dichlorophenol indophenol visual titration method (3). Fiber was assayed by a quick method used by the FDA in determining fiber in green beans (2).

CANNING OF MANGO SLICES IN HEAVY SYRUP

The fruits were hand-peeled and four slices were cut from each fruit; larger slices were further cut in halves. Prior to candying the slices were immersed in a 1% sodium bicarbonate solution for 20 min. The slices were then rinsed with tap water for removal of the excess of bicarbonate, and drained.

The candying process consisted in placing the slices in boiling 50° Brix sugar syrup with a few pieces of cinnamon and a few whole cloves added for flavoring. The slices with the syrup were boiled gently until a 67° Brix was attained. At this point, heat was turned down and 303 plain tin cans were filled with 364 g of drained slices and 280 g of syrup. The syrup was always kept near boiling to insure sterility. The cans with enameled lids were closed, water-cooled and dried before being stored at ambient conditions.

MANGO MARMALADES

As in the case of the slices, the fruits were hand-peeled and then cut into slices. These were ground in a Hobart[3] grinder with a 1.91 cm dia. die. This gave a mixture of crushed pulp which also contained chunks of mango.

The marmalades were prepared by a procedure similar to the one described in the Preservers Handbook (5): A measured or weighed amount of water (185 g/lb pulp) was placed in a kettle and heated. The proper amount of 150 Grade Citrus Pectin, Rapid Set (5.75 g/lb pulp) was thoroughly mixed with 5–8 times its weight of granulated sugar taken from the total amount required for the batch. The mixture of pectin and

[3] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

sugar was stirred into the hot water and allowed to come to a brisk boil to thoroughly dissolve the pectin. It was then boiled vigorously for about one-half minute. The mango pulp with the remaining amount of sugar was added and boiled as vigorously as possible until a 65° Brix was reached. The amount of a standard tartaric acid solution (1 fl. oz. approx. .392 oz tartaric acid) calculated to adjust the pH of the mixture to 3.4 was added and thoroughly mixed by a brisk boil. The steam was turned down and the glass containers filled and capped while hot (above 87.8° C).

The glass containers were allowed to cool before being stored at ambient conditions.

After at least 2 weeks the slices and the marmalades were assessed for quality and chemical composition. This period brings about an equilibrium between the fruit pulp and the surrounding syrup.

TABLE 1.—*Fruit size and composition of the four mango varieties*

Variety	Mean weight of fruits	Pulp[1]	Peel	Seeds[2]
	g	%	%	%
Edward	421.33	68.95	11.50	19.55
Irwin	259.14	65.03	16.03	18.94
Palmer	451.81	70.20	12.68	17.12
Keitt	586.66	73.24	12.47	14.29

[1] Pulp—slices.

[2] Seeds—unclean seeds with remaining pulp after slicing.

The quality of the slices and of the marmalades of the four mango varieties was assessed every other month and up to 1 year of storage by a 7 to 13-member tasting panel. A six-point hedonic scale (6=likes very much; 1=dislikes) was used to measure the organoleptic attributes of appearance, taste, texture, and general acceptability.

Soluble solids, pH, sugars, and total acidity were determined every other month by the methods already mentioned. Total acidity was calculated as citric acid in the mango slices and as tartaric acid in the marmalades. Tartaric acid was used since it was found to give less tartness to the marmalades. Color was measured with a Hunterlab model D-25 color and color difference meter[3], calibrated with a Hunterlab yellow standard No. 3125 ($L = 55.8$, $a = 18.9$, $b = 33.4$) for the slices and a Hunterlab yellow standard No. 3130 ($L = 62.3$, $a = 12.2$, $b = 37.2$) for the marmalades.

RESULTS AND DISCUSSIONS

Table 1 shows that all varieties yielded well over 65% of fruit pulp in slices. The Keitt variety produced the highest yield. It also had the largest fruit, with an average weight of 586.66 g. The Irwin variety

produced the lowest yield and the smallest fruit, with an average weight of 259.14 g. The Edward and Palmer varieties with average fruit weights of 421.33 g and 451.81 g gave yields of 68.95% and 70.20%, respectively. These recoveries are influenced by the size of the fruits and are somewhat

TABLE 2.—*Chemical and physical composition of the four mango varieties*[1]

Variety	°Brix	pH	Total acidity	Moisture	Total solids	Reducing sugars	Total sugars	Ascorbic acid	Fiber
			%	%	%	%	%	*mg/100 g*	*mg/100 g*
Irwin	16.0	4.33	0.21	84.35	15.65	5.49	13.76	32.08	55
Edward	21.2	4.51	.22	78.98	21.02	3.61	17.58	47.51	48
Palmer	20.5	4.54	.19	78.89	21.11	4.56	18.58	39.92	38
Keitt	21.5	3.90	.55	77.58	22.42	5.48	18.07	6.76	55

[1] Each value represents the mean of at least 5 different lots.

TABLE 3.—*Chemical and physical analyses of mango marmalades during storage*

Variety	Days in storage	°Brix	pH	Total acidity	Reducing sugars	Total sugars	Color[1]		
							L	*a*	*b*
				%	%	%			
Edward	Fresh	62.0	3.50	0.396	21.16	61.81	36.35	5.60	24.14
	60	61.8	3.49	.395	28.39	62.24	33.99	6.87	22.26
	120	62.2	3.49	.421	33.94	61.18	33.06	7.08	21.76
	180	62.2	3.51	.427	38.78	62.27	33.00	7.99	21.60
	240	63.2	3.51	.423	40.22	62.70	30.95	7.58	20.15
	300	62.8	3.45	.418	42.55	59.87	30.08	8.00	19.48
	360	63.2	3.37	.421	45.00	61.73	29.24	7.92	18.94
Irwin	Fresh	63.8	3.40	0.353	37.79	64.30	33.06	1.08	22.18
	60	64.2	3.40	.340	43.52	65.40	31.55	1.42	20.95
	120	64.2	3.43	.361	48.05	64.25	28.02	5.04	18.56
	180	64.8	3.43	.368	50.64	63.62	—	—	—
	240	64.8	3.42	.352	50.49	63.52	24.90	5.23	16.18
	300	65.6	3.39	.357	52.09	62.75	23.52	5.18	15.10
	360	64.4	3.38	.369	53.77	62.53	23.48	6.27	15.04
Palmer	Fresh	63.8	3.49	0.399	37.58	57.85	33.51	4.23	22.40
	60	62.6	3.45	.409	36.87	59.71	32.72	6.58	21.60
	120	62.8	3.48	.420	43.19	62.23	33.00	7.50	21.94
	180	62.5	3.49	.382	42.22	59.93	30.33	7.79	19.88
	240	63.1	3.40	.397	46.02	59.93	29.71	7.39	19.05
	300	62.8	3.44	.394	47.45	60.45	31.15	8.54	20.37
	360	62.4	3.43	.432	47.64	57.25	30.58	7.18	19.94
Keitt	Fresh	63.2	3.40	0.560	46.89	60.96	27.82	5.16	18.14
	60	64.4	3.50	.589	51.95	64.10	26.13	5.39	16.81
	120	63.4	3.49	.575	50.42	62.00	25.32	6.32	16.13
	180	63.2	3.49	.544	52.20	61.00	23.78	5.85	15.08
	240	63.0	3.50	.555	52.34	60.87	23.16	5.68	14.75
	360	63.1	3.49	.591	52.70	59.22	21.63	5.48	13.64

[1] Yellow standard No. 3130 ($L = 62.3$, $a = 12.2$, $b = 37.2$).

higher than the ones reported by Sherman et al. (6) for fruits of similar weights.

The reported percentage of seeds is not accurate because when four slices are cut from each fruit, an amount of pulp remains attached to the seeds. This pulp can be extracted and utilized in the preparation of mango puree. In a large commercial operation this could very well be another source of raw material.

TABLE 4.—*Chemical and physical analyses of mango slices in syrup during storage*

Variety	Days in storage	°Brix	pH	Total acidity	Reducing sugars	Total sugars	Color[1]		
							L	*a*	*b*
				%	%	%			
Edward	Fresh	67.0	—	—	—	—	—	—	—
	60	59.8	4.22	.175	18.65	60.02	31.53	12.88	21.02
	120	55.4	4.25	.202	19.06	54.98	33.36	14.07	22.16
	180	60.4	4.34	.236	20.47	59.54	—	—	—
	240	58.8	4.30	.172	20.58	56.83	32.15	14.14	21.26
	300	58.4	4.29	.176	21.13	56.28	31.48	13.92	20.66
	360	58.8	4.30	.155	20.61	58.65	30.48	15.59	20.08
Irwin	Fresh	67.0	—	—	—	—	—	—	—
	60	56.2	4.57	.116	14.14	56.42	31.55	14.02	21.09
	120	55.6	4.60	.105	14.68	56.16	30.59	13.41	20.48
	180	56.8	4.60	.127	15.40	56.03	—	—	—
	240	56.2	4.49	.124	17.00	55.77	30.57	13.64	20.28
	300	56.3	4.45	.110	16.06	55.69	30.60	13.90	20.07
	360	56.0	4.49	.114	17.15	55.49	28.84	15.64	18.96
Palmer	Fresh	67.0	4.32	0.181	12.33	54.02	37.73	13.39	25.32
	60	52.2	4.39	.187	13.05	51.19	41.36	13.49	27.48
	120	56.4	4.44	.166	14.12	54.55	—	—	—
	180	56.4	4.44	1.56	14.95	55.13	35.80	16.77	23.83
	240	55.4	4.30	.178	16.50	53.57	35.42	15.33	23.49
	360	55.8	4.30	.201	18.79	51.44	36.41	14.22	24.11
Keitt	Fresh	67.0	4.12	0.334	31.99	58.74	30.64	10.38	20.31
	60	58.2	4.09	.353	31.68	56.69	32.86	13.12	21.73
	120	58.9	4.10	.317	32.75	57.99	30.46	12.60	19.98
	180	55.9	4.12	.334	30.84	52.35	32.70	13.37	21.36
	240	55.8	4.13	.342	32.83	53.75	30.88	13.04	20.24
	300	54.6	4.10	.377	34.21	52.92	28.52	12.21	18.52
	360	58.7	3.90	.367	36.01	54.77	26.22	11.41	17.02

[1] Yellow standard No. 3125 ($L = 55.8$, $a = 18.9$, $b = 33.4$).

Table 2 shows the composition of the four mango varieties. The Keitt variety had the lowest vitamin C content, while Edward had the highest. The Keitt variety had the highest total acidity. Among the four varieties the Irwin had the lowest soluble solids and the lowest total sugars. The lowest reducing sugars were found in the Edward. The Irwin variety had the lowest total solids.

Tables 3 and 4 show the chemical and physical properties of the

marmalades and the slices in heavy syrup. In the marmalades, the most marked changes occurred in the reducing sugars, which increased more than one-fold as storage time increased; and in color lightness which decreased as shown by L values. This is also evident when the total color difference $\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$ is calculated and plotted (fig. 1). The curves show an increase in total color difference as evidenced by

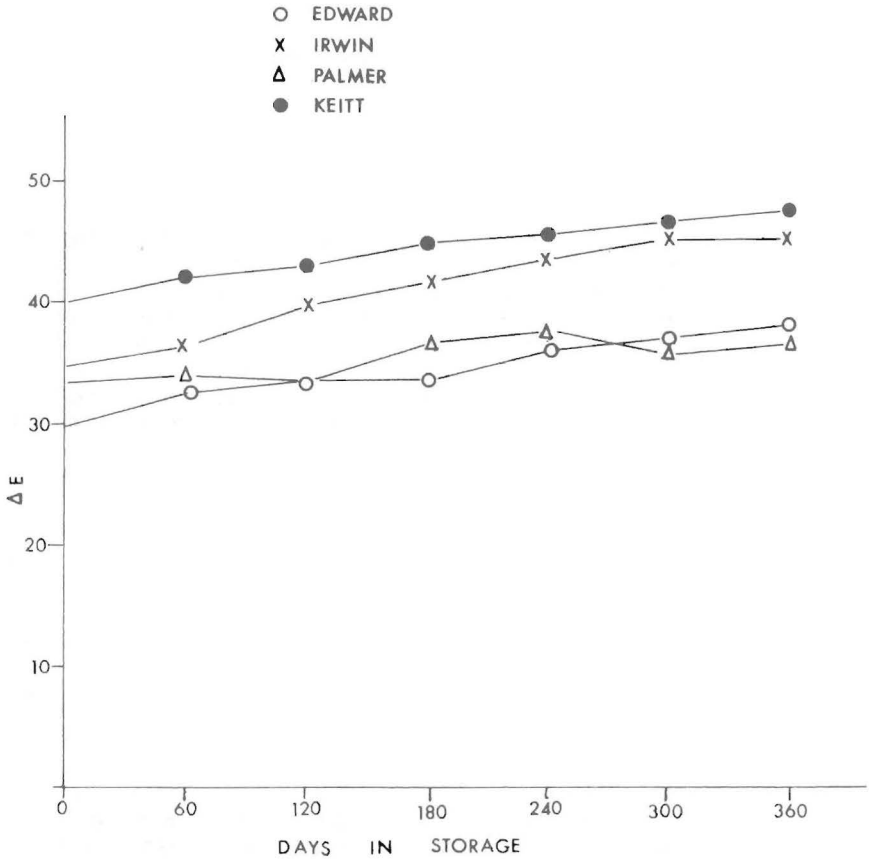

FIG. 1.—Color difference values (ΔE) of the different mango marmalades during storage.

an increase in the browning discoloration of the samples. The Keitt and Irwin marmalades exhibited the most browning. Neither the total acidity nor the pH changed appreciably.

In the slices in heavy syrup the most marked changes occurred in the color and in the Brix. The Brix showed a marked reduction in the syrup during the first months, which is due to the stabilization of the slices with the syrup. The color as seen by the L values shows a decrease in lightness.

This is corroborated when the total color difference is calculated and plotted (fig. 2). The curves demonstrate the same tendency to a less degree as in the marmalades.

Although the reducing sugars increase during storage, as expected, this increase is not as high as in the marmalades.

As in the marmalades, the total acidity and the pH did not reflect change.

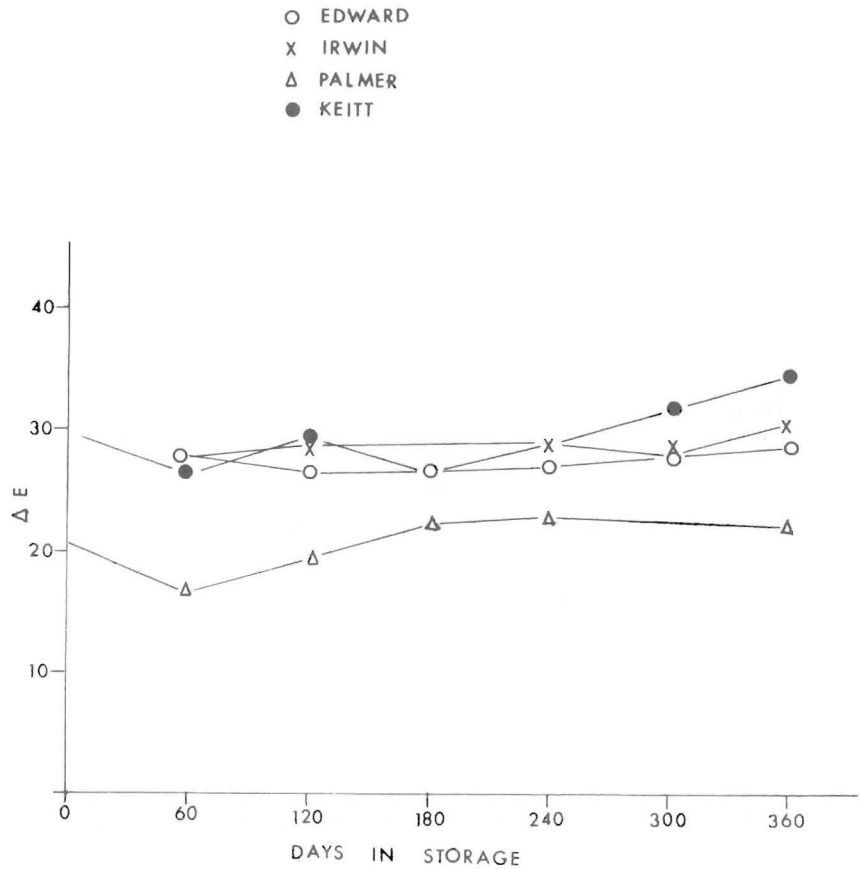

FIG. 2.—Color difference values (ΔE) of the different mango slices during storage.

In general, good quality marmalades and slices in heavy syrup, having good acceptability were obtained. The high acceptability of the marmalades as seen in table 5 was maintained for about a year. During the last two months of storage the scores dropped, bringing the acceptability of all the marmalades, except that of Edward, to moderately liked. This drop in score may be due to the increase in browning and the development

of some off-flavors. The marmalade from the Keitt variety had the greatest drop. The acceptability of the slices in heavy syrup (table 6) was good throughout the year in storage. The Keitt and Palmer varieties were the ones with the greatest drop in score but still remained acceptable.

TABLE 5.—*Quality of mango marmalades when fresh and after 12 months*

Variety	Days in storage	Appearance		Taste		Texture		General acceptability	
		Score[1]	Rating	Score	Rating	Score	Rating	Score	Rating
Edward	Fresh	5.4	Likes	5.0	Likes	4.8	Likes	4.9	Likes
	360	5.1	Likes	4.7	Likes	4.4	Likes Moderately	4.6	Likes
Irwin	Fresh	5.2	Likes	4.0	Likes Moderately	4.5	Likes	3.8	Likes Moderately
	360	5.3	Likes	4.1	Likes Moderately	4.3	Likes Moderately	4.1	Likes Moderately
Palmer	Fresh	5.3	Likes	4.9	Likes	4.9	Likes	5.0	Likes
	360	5.0	Likes	4.2	Likes Moderately	4.7	Likes	4.3	Likes Moderately
Keitt	Fresh	5.2	Likes	4.9	Likes	5.3	Likes	5.2	Likes
	360	4.3	Likes Moderately	3.5	Likes Moderately	4.5	Likes	3.5	Likes Moderately

[1] Six-point scale: 6 likes very much; 5 likes; 4 likes moderately; 3 neither likes or dislikes; 2 dislikes a bit; 1 dislikes.

TABLE 6.—*Quality of mango slices in heavy syrup when fresh and after 12 months*

Variety	Days in Storage	Appearance		Taste		Texture		General acceptability	
		Score[1]	Rating	Score	Rating	Score	Rating	Score	Rating
Edward	Fresh	5.0	Likes	5.2	Likes	4.9	Likes	4.8	Likes
	360	5.0	Likes	4.9	Likes	4.6	Likes	4.7	Likes
Irwin	Fresh	5.3	Likes	4.9	Likes	4.9	Likes	4.9	Likes
	360	5.0	Likes	4.7	Likes	4.0	Likes moderately	4.6	Likes
Palmer	Fresh	5.3	Likes	5.2	Likes	4.8	Likes	5.2	Likes
	360	5.0	Likes	4.8	Likes	4.8	Likes	4.6	Likes
Keitt	Fresh	4.5	Likes	4.8	Likes	4.7	Likes	4.7	Likes
	360	4.5	Likes	4.2	Likes moderately	4.2	Likes moderately	4.2	Likes moderately

[1] Six-point scale: 6 likes very much; 5 likes; 4 likes moderately; 3 neither likes or dislikes; 2 dislikes a bit; 1 dislikes.

RESUMEN

Tajadas en almíbar y mermeladas de cuatro variedades de mangoes; Edward, Irwin, Palmer, y Keitt, se prepararon y se evaluaron. Todas las variedades produjeron más de un 65% de pulpa disponible en forma de tajadas o para mermaladas. Los dos productos reflejaron un obscurecimiento durante el período de almacenamiento. Las mermeladas se obscurecieron más, debido quizás al pH más bajo, pero este cambio no afecta totalmente la aceptabilidad. La buena calidad y la aceptabilidad de ambos productos perduró por 12 meses en almacén.

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