Some Characteristics of the Chemical Composition and General Quality of the Red Spanish and PR 1-67 Pineapple Varieties[1]

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ABSTRACT

A shelf life study on canned pineapple juices from both cultivars was conducted over an 11-month period. Evaluations were performed monthly. The results indicated no significant differences in chemical characteristics, with the exception of the percentage of total acids, which was about 0.17% higher in PR 1-67. The overall acceptability of the PR 1-67 fresh fruit was ranked significantly higher than that of the Red Spanish variety.

The bromelain activity ranged from 3,522 to 685 in milk clotting units/g (M.C.U./g) in the PR 1-67 green and ripe fruits, respectively, and from 2,203 to 805 M.C.U./g in the Red Spanish green and ripe fruits, respectively. These values compare with those reported for Smooth Cayenne, which range from 2,500 to 800 M.C.U./g.

The sensory evaluation of canned juices from both varieties showed significant difference at the 5% level for the straight juice from variety PR 1-67, which was ranked inferior. However, when blends of different proportions of this juice with Red Spanish juice were tested, there was a significant increase in the acceptance of these products throughout the entire shelf-life period.

INTRODUCTION

The world production and demand for pineapples (*Ananas comosus* (L.) Merr.) has been increasing in tropical countries. In 1976 it accounted for 6.7 million tons, as compared to 2.2 million tons in 1957 (2). The technological advances in agriculture, as well as modern refrigerated shipping systems have made the fresh fruit more available to the consumer.

Pineapple is the most important fruit crop in Puerto Rico, where 95% of the production, processing and marketing of fresh or canned pineapples is handled by the Puerto Rico Land Authority. Total pineapple production in 1980 was 42,493 tons, with a farm value of 6.8 million dollars (4). Cultivar Red Spanish accounts for approximately 85% of the total commercial plantings. Although cv. Red Spanish is of high quality for the fresh market, it has not met expectations for the export market because it differs in some attributes from the world leading variety Smooth Cayenne. The Red Spanish cultivar is hard and thus tolerates

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rough handling in transport and is highly resistant to fruit rot, but it is susceptible to gummosis (12, 13). In Puerto Rico Smooth Cayenne suffers yield losses from mealybug wilt (1, 6, 11, 14, 16).

Variety PR 1-67 was originated from an open pollinated cross of Red Spanish grown in a field adjacent to Smooth Cayenne (15). The outstanding characteristics of the new variety are its excellent flavor as a fresh fruit, its resistance to mealybug wilt and gummosis, and its good size and shape. Yields of 32 tons per acre have been obtained with this variety.

Although other studies have reported the production and improvement of agronomical techniques for increasing yields and attaining better quality fruit of PR 1-67 (7, 8), there is no information available on the sensory evaluation of the fresh fruit and of the shelf life of the canned juice.

The objective of this investigation was to compare varieties PR 1-67 and Red Spanish as to significant characteristics of their chemical composition and general attributes of the fresh fruits and their canned juices.

MATERIALS AND METHODS

Mature pineapples were harvested randomly from a commercial plantation of the Puerto Rico Land Authority. Only mature-green or ripe fruits were used for chemical analyses. Four pineapples per sample of each stage of ripeness were sliced and blended. The juice for analytical purposes was obtained by squeezing the fruit through cotton cloth. This was repeated with samples at each of six pickings from May to August. Soluble solids content was determined with a bench-top model Bausch and Lomb Abbe-56 refractometer.[3] Insoluble solids were expressed as described by the FDA Standards of Identity, Quality, Fill-Pineapple Juice (3). The pH was determined with a Beckman pH meter and the titratable acid was determined by titrating the juice to pH 8.1 with 0.1 *N* NaOH. Color readings were made on a Hunterlab Model D color difference meter calibrated with standard ($Rd = 59.5$, $a = 2.2$ and $b = +22.4$). The activity of bromelain, the proteolytic enzyme of pineapple, was determined by the milk-clotting time method described by Heinicke and Gortner (9) and Balls and Hoover (5). We modified the extraction procedure to obtain a cleaner bromelain powder. This modification included an additional acetone precipitation of the main fraction and a washing with 95% ethanol for the removal of sugar. The crude enzyme

[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.

preparation of about 8 mg reacted with 25 ml of milk (as substrate) in a test tube kept at 40 ± 0.5° C. The time elapsed between the addition of the enzyme to the milk and the clotting of the milk was measured with a stopwatch. The action of the bromelain enzyme was expressed as milk-clotting units/g (M.C.U.)/g = 10^3 m v/wt where/w = mg of enzyme added to milk, t = time in minutes, m = milk factor (1.7 for freshly prepared milk), v = volume of milk in ml. Ten tubes were used per assay. The values obtained were the means of six assays for each variety of pineapple in its mature green and ripe stages, respectively.

A trained panel of 10–12 members evaluated the fresh mature-ripe pineapple of each of the two varieties in four separate sessions. The fruits were cut in equal longitudinal slices the length of the fruit for a representative sample. Each sample was evaluated for overall acceptability with a 5-point hedonic scale (+2 as very acceptable and −2 not acceptable). Panelists were also asked to state their preference.

The canned juice was presented to the panelists as straight juice from each pineapple variety, Red Spanish and PR 1-67, and also both varieties blended in 1:1 or 2:1 proportions of each variety, respectively. In this evaluation the panelists were asked to rank the juice in order of preference from 1 to 5. The juice was evaluated over a period of 11 months. The sum of ranks was used to interpret the significance at the 5% level, as described by Kramer (10).

Fifty pineapples of each variety with an average fruit weight of 5 lb were processed. The juice obtained from the pulper-finisher was pasteurized at 192° F (90° C) in a Votator type heat exchanger and poured hot into 46-oz cans. The cans were cooled immediately and stored at room temperature. Samples of each variety were taken monthly for chemical analysis and sensory evaluation.

RESULTS AND DISCUSSION

Table 1 shows average compositional values of fresh pineapple juice from Red Spanish and PR 1-67 varieties. Table 2 shows bromelain activity of the mature-green and ripe pineapple juice. The analysis of variance of 67 replicates of PR 1-67 and 57 of Red Spanish samples showed significant differences at the 1% level between the activity of the mature-green and the ripe fruits of both cultivars. The activity of bromelain on the green PR 1-67 was also found significantly higher than that of the green Red Spanish. It was also found that the bromelain activity of the green pineapple was significantly higher than that of the ripe fruit of both cultivars. Heinicke and Gortner (9), reported bromelain activity in pineapples in the range of 800 to 2,500 milk-clotting units/g. Higher values of 2,000–5,000 M.C.U./g were reported from stem brome-

lain. The enzyme activity of the peels of both cultivars in our study was considerably lower (<1000 M.C.U./g) than that obtained from the fruit. This fact reduces the probability of using a by-product of the pineapple canning industry as a possible source of bromelain.

Table 3 shows the mean compositional values of the canned pineapple juice over a storage period of 11 months at room temperature. No significant changes were observed on the soluble solids content, pH, percent total acidity (expressed as citric acid) and insoluble solids over the 11 month storage of the juice from either pineapple cultivar. However, a highly significant difference was found between the percent total acidity

TABLE 1.—*Average compositional values of fresh pineapple juice*[1]

Variety	Stage of maturity	Bx	pH	Total acidity	Bx/acid
				%	
P.R. 1-67	Green	11.8	3.4	.67	18
P.R. 1-67	Ripe	16.5	3.6	.62	26
Red Spanish	Green	11.2	3.4	.56	20
Red Spanish	Ripe	15.8	3.6	.47	33

[1] Average values of duplicates on 6 determinations on representative samples.

TABLE 2.—*Bromelain activity in the pineapple fruit*

Variety	Maturity stage	Milk clotting units/g
P.R. 1-67	Green	3522a[1]
	Ripe	625ab
Red Spanish	Green	2203a
	Ripe	805ab

[1] a, b Samples are different at the 1% level.

of the two fruit juices. The PR 1-67 juice showed a higher insoluble solids contents than the Red Spanish, and in the PR 1-67 the Brix to acid ratio was lower because of its higher acid content.

The yellow color of the juice measured by the Hunterlab color difference meter as $+b$ values ranged from +23.55 to +25.53 for PR 1-67, and from +48.68 to +51.79 for the Red Spanish juice during the 11-month storage. No significant difference in color was observed in the same canned juice over the entire storage period of 11 months. However, a highly significant difference was observed between the yellow color intensity of the juice of both cultivars. The PR 1-67 juice has a higher yellow coloration than the Red Spanish, which has a very pale color in both pulp and juice.

The following tabulation shows the results from the test on preference and acceptance of the fresh fruit. No significant differences were observed

between the cultivars in the overall attributes tested. However, on a percentage basis, the panelists indicated a highly significant preference for the PR 1-67 cultivar.

Variety	Average mean values	
	Overall Acceptability[1]	Percent for Preference
PR 1-67	1.43	79
Red Spanish	0.90	40

[1] Each mean represents 10-member's panel scores in 4 evaluations.
[2] Based on a 5-point hedonic scale (+2 = very acceptable, −2 = not acceptable).

The following tabulation shows the sensory evaluation socres for unsweetened canned pineapple juice, straight and mixed in different

TABLE 3.—*Mean Compositional Values of Canned Pineapple Juice Stored for 11 Months at 30° C*

	PR 1-67		Red Spanish	
	Range	Mean	Range	Mean
Brix	16.1–16.6	16.4	15.4–16.2	15.7
pH	3.4–3.9	3.6	3.5–4.0	3.6
Total acidity (%)	.69–.72	.70	.52–.55	.53
Insoluble solids (%)	10–16	14	6–12	9.9
Brix/acid	23–25	24	29–31	29

proportions. The scores represent the average of the sum of ranks per evaluation over a period of 11 months at room temperature. The higher numbers correspond to the straight juice of variety PR 1-67, which indicated that the juice from this variety was inferior when compared to the Red Spanish straight juice. However, when the juice from variety PR 1-67 was blended either in 2:1 Red Spanish-PR 1-67 or 1:2 Red Spanish-PR 1-67 or 1:1 Red Spanish-PR 1-67 proportions, either no significant difference was found or in some cases it was found to be superior at the 5% level. The quality of both juices was found acceptable and both meet all the FDA standards of identity for canned pineapple juice.

Juice Proportion	Sum of ranks[1] (means)
Red Spanish (RS)	28 a[2]
PR-167	41 b
1 RS: 2 PR-167	28 a
2 RS: 1 PR-167	24 a
1 RS: 1 PR-167	28 a

[1] Scores based on a five point scale (5 = inferior, 1 = superior).
[2] Means followed by letters in common do not differ significantly at 5% probability level.

It can be concluded that the new variety of pineapple PR 1-67 is acceptable for the fresh market or for canned juice. Among its outstanding characteristics are its excellent flavor, its resistance to mealybug wilt and gummosis, its good size, with an average weight of 5.8 pounds, and a crop yield of 32 tons per acre.

RESUMEN

Un estudio sobre la duración en almacén del jugo enlatado de dos variedades de piña (Española Roja y PR-167) se llevó a cabo por un período de 11 meses, evaluándolos mensualmente. Los datos no arrojaron diferencias significativas entre las características químicas de las dos variedades, con excepción del porcentaje de ácidos totales, que en la PR-167 fue casi un 0.17% más alto. La apreciación de la fruta en fresco de la PR-167 fue significativamente más alta que la de la variedad Española Roja.

La actividad de la bromelina arrojó una escala de 3,522 a 685 unidades de leche coagulada por gramo de jugo en la piña verde y madura, respectivamente, de la PR-167 y de 2,203 a 805 en el jugo de la piña verde y madura, respectivamente, en la Española Roja. Estos valores son comparables con los informados para la variedad Cayena Lisa, que varía de 2,000 a 800 unidades.

En la evaluación sensorial de los jugos enlatados de ambas variedades se observó que únicamente el jugo puro de la variedad PR-167 se juzgó inferior. No obstante, al comparar diferentes proporciones de este jugo con el de la variedad Española Roja su apreciación mejoró considerablemente.

LITERATURE CITED

1. Alvarez-García, L. A., 1956. Problemas fitopatológicos en la producción de piña en Puerto Rico, Rev. Agric. P.R. 44 (1): Enero-Junio.
2. Anon., 1977. Anuario de Producción, Organización de las Naciones Unidas para la Agricultura y la Alimentación, Roma 31: 174.
3. Anon., 1976. FDA Standards of Identity, Quality, Fill-Pineapple Juice.
4. Anon., 1980. Monthly Bulletin of Agricultural Statistics, Dep. Agric. P.R., January.
5. Balls, A. K. and Hoover, S. R., 1937. The milk-clotting action of papain, J. Biol. Chem. 121: 737.
6. Gandía-Díaz, H. and Samuels, G., 1958. Cultivo y elaboración de la piña en Puerto Rico, Bol. 145, Esta. Exp. Agric. Univ. P.R.
7. González-Tejera, E., 1975. Efecto de niveles de nitrógeno, potasio y magnesio sobre la producción y calidad de la piña *Ananas comosus* (L), Presented at the XXIII Ann. Meet. Am. Soc. Hort. Sci. (Tropical Region), Antigua, Guatemala, C.A., July, 20–26.
8. ——, 1979. Efecto del peso de la "semilla", la distancia de siembra y la edad al momento de provocar la floración sobre la producción de la piña *Ananas comosus* (L). Presented at the XXVII Ann. Meet. Am. Soc. Hort. Sci. (Tropical Region), Mazatlán, Mexico. November.

9. Heinicke, R. M. and Gortner, W. A., 1957. Stem bromelain—A new protease preparation from pineapple plants, Econ. Bot. 11 (3): 225.
10. Kramer, A., 1963. Revised tables for determining significance of differences, Food Technol. 17 (12): 1596.
11. Mathews, W. H., 1959. Pineapples in Florida, Circ. 195, Agric. Ext. Serv. Univ. Fla.
12. Pérez, M. E., 1957. Pineapple gummosis in Puerto Rico and its control, Tech. Pap. 21, Agric. Exp. Stn. Univ. P.R.
13. ——, 1959. Further experiments on the control of pineapple gummosis in Puerto Rico, J. Agric., Univ. P.R. 43 (2): 116.
14. Platts, P. K., 1956. Pineapple ABC's, Bull. 125, State Fla. Dep. Agric.
15. Ramírez, O. D., Gandía, H. and Vélez-Fortuño, J., 1970. Two new pineapple varieties for Puerto Rico, J. Agric. Univ. P.R. 54 (3): 417.
16. Wolfenbarger, D. O. and Spender, H., 1951. Insect control on pineapples, Circ. 5–36, Univ. Fla. Agric. Exp. Stn.