

Sapodilla (*Manilkara sapota* L. V. Rogen, *Achras sapota* Linn.) variety trials at southern Puerto Rico¹

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ABSTRACT

Seventeen varieties of sapodilla (*Manilkara sapota* L. V. Rogen, *Achras sapota* Linn.) were planted in 1971 at the Fortuna Experiment Substation, Juana Díaz, Puerto Rico, following a randomized block layout with three replications. During the seasons of 1982-83 through 1986-87 (December through April), the fruits were harvested for evaluation as to appearance, flavor, brix, pH, acidity, % reducing sugars, % total sugars, number of fruits per tree, yield (kg) and average fruit weight per variety (g). In spite of the fact that the data were not statistically analyzed because of many observed variations, valuable information was obtained and is herein reported.

Several varieties achieved acceptability, depending on the criterion used. However, the Larsen variety appears to be one of the best producers as well as the highest rated as to flavor. Russel was preferred as to appearance by the tasting panel. Other varieties were found acceptable in terms of the various parameters studied, such as Jamaica 5, Prolific, Morning Star and Timothe.

RESUMEN

Evaluación de variedades de níspero (*Manilkara sapota* L. V. Rogen) en Puerto Rico

Se evaluaron 17 variedades de níspero en la región costera semiárida del sur de Puerto Rico, Subestación Experimental Agrícola de Fortuna, Juana Díaz. Las variedades se replicaron tres veces en un diseño de bloques al azar. La investigación se hizo a fines de evaluar la calidad de las frutas en relación a sabor, apariencia, Brix, pH, acidez, azúcares reductoras y azúcares totales. Se tomaron datos en cuanto al número de frutas producidas por variedad, peso de la producción, y peso promedio por fruta, tanto para las frutas comerciales como para las no comerciales. Los datos no se analizaron estadísticamente dada la gran variación observada, pero no por eso dejan de ser valiosos.

La variedad Russel resultó ser la de mejor apariencia. La variedad Larsen resultó, en promedio, la de mejor sabor. La variedad Larsen fue además, junto a la variedad Blackwood, la mejor productora, tanto en

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cuanto al número de frutas como al peso de la producción por árbol. Las frutas mostraron gran variación en cuanto a las características evaluadas. Tomando en consideración los parámetros para medir la calidad de las frutas, las variedades más prometedoras resultaron ser: Larsen, Jamaica 5, Russel, Prolific, Morning Star y Timothe.

INTRODUCTION

Sapodilla (*Manilkara sapota* L. V. Rogen, *Achras sapota* Linn.) is a tropical fruit which possibly originated in the Yucatán peninsula of Mexico. It is known by different names such as mespel (Virgin Islands), níspero (Puerto Rico), sapote (Cuba), zapote, chicozapote, zapote chico, chicle, zapotillo (Mexico), muyozapot (El Salvador), sapodilla (United States), naseberry (British West Indies), dilly (Bahamas), sapotille, sapotillier (French West Indies), mispu, mispel, sapodille (Dutch West Indies), sapotille, sapatija, mispelboon (Surinam), and sapoti or sapotilha (Brazil) (4). Sapodilla is the source of the main ingredient for the preparation of bubble gum and can be used in the elaboration of juice, syrup and ice cream. It may also be dehydrated (1), frozen (8), or used as a fresh fruit.

The sapodilla tree may reach over twenty meters high when propagated by seeds. It resists long periods of drought, although it may require irrigation at critical times. This tree is cultivated extensively on the American continent from Mexico to Brazil and the southern tip of Florida (6) as well as in other tropical zones of the world. It produces a fruit botanically classified as a berry, which may be round or elongated, with a harsh brown skin. The pulp is usually sweet with a pleasant flavor. A fruit may have up to twelve seeds, or none at all. They are black, flat, smooth and elliptic, with a white scar in the hilum (9).

The chemical composition of the sapodilla fruit has been studied in India, Venezuela and the United Kingdom (2, 3, 5, 7, 8). Rivas and Martos (8) presented some data related to pH (5.35), total acidity (0.26%), reducing sugars (11.08%), total sugars (13.8%) and other parameters. Ingle et al. (3) also reported data on reducing sugars (4.38), total sugars (6.57) and acidity (0.2%).

MATERIALS AND METHODS

Seventeen sapodilla varieties were planted at 9 × 9 m spacing in July 1971 at the Fortuna Agricultural Experiment Substation, in the southern semiarid coastal region of Puerto Rico. A randomized block design with five replications was used, although because of the death of some trees throughout the years, replications were eventually reduced to three. New trees were not planted so as not to introduce a new variable (date of planting). The varieties evaluated were Adelaide, Arus, Blackwood, Bocksberg, Jamaica 1, Jamaica 3, Jamaica 4, Jamaica 5, Jamaica 8, Jamaica 10, Larsen, Mary Fancy, Morning Star, Ponce, Prolific, Russel and Timothe (fig. 1).

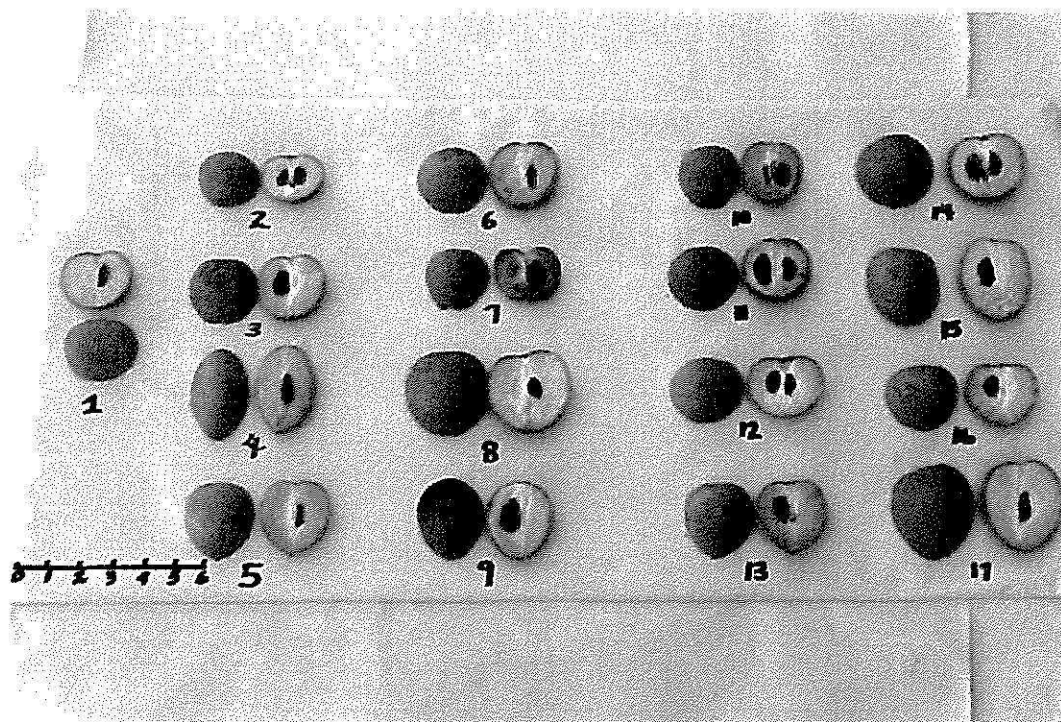


FIG. 1.—Fruits of the seventeen sapodilla varieties evaluated in this experiment.

Legend:

- | | |
|--------------|------------------|
| 1. Timothe | 10. Jamaica 8 |
| 2. Adelaide | 11. Jamaica 10 |
| 3. Arus | 12. Larsen |
| 4. Blackwood | 13. Mary Fancy |
| 5. Bocksberg | 14. Morning Star |
| 6. Jamaica 1 | 15. Ponce |
| 7. Jamaica 3 | 16. Prolific |
| 8. Jamaica 4 | 17. Russel |
| 9. Jamaica | |

From December through April 1983-84, 1985-86 and 1986-87, samples of fruits were sent to the Food Technology Laboratory of the Agricultural Experiment Station at Río Piedras for sensory evaluation of the seventeen sapodilla varieties in regard to flavor and appearance. Each sample was evaluated by a group of seven to eleven members of a taste panel in at least two sessions (table 1).

RESULTS AND DISCUSSION

Because of the great variability observed, the data obtained were not statistically analyzed. In spite of that fact, information was obtained that could be of value to other researchers, as well as to Extension workers and farmers. Awareness of this limitation is important in interpreting the data herein reported.

TABLE 1.—Sensory evaluation of sapodilla from 17 varieties grown in southern Puerto Rico¹

Variety	Appearance				Flavor			
	1984	1986	1987	Ave.	1984	1986	1987	Ave.
Adelaide	0.25	—	0.63	.44	1.23	—	0.52	.88
Arus	1.72	0.78	0.93	1.14	1.62	-0.22	1.19	.86
Blackwood	1.33	—	0.88	1.11	0.94	—	0.70	.55
Bocksberg	1.38	0.78	0.84	1.00	0.91	0.00	0.08	.33
Jamaica 1	1.07	1.00	1.37	1.15	0.88	0.48	0.26	.54
Jamaica 3	0.43	1.57	0.77	.92	0.66	1.09	1.22	.99
Jamaica 4	0.66	—	1.45	1.06	0.73	—	0.80	.77
Jamaica 5	1.18	1.20	1.40	1.26	1.27	0.98	1.25	1.17
Jamaica 8	0.41	0.59	1.02	.67	1.03	0.71	0.26	.49
Jamaica 10	0.32	0.75	0.89	.65	0.30	0.50	1.00	.60
Larsen	0.50	1.22	1.11	.94	1.42	1.00	1.56	1.33
Mary Fancy	1.06	-0.15	0.91	.61	1.22	-0.50	0.68	.47
Morning Star	0.79	1.50	1.32	1.20	1.10	0.83	1.03	1.01
Ponce	1.10	0.67	0.91	.89	1.62	0.80	0.23	.88
Prolific	1.70	1.26	0.93	1.30	0.95	0.86	0.72	.84
Russel	1.45	1.26	1.34	1.35	1.35	0.31	0.89	.85
Timothe	1.05	1.09	0.89	1.01	1.23	0.85	1.00	1.03
Variety Averages	.965	.965	1.035		1.086	.549	.76	

¹ +2, -2 scale; +2.0 = Highly acceptable, +1.0 = acceptable, 0 = questionable; -1.0 = Slightly not acceptable, -2.0 = not acceptable.

Data in table 1 indicates that some varieties tend to be inconsistent from year to year in regard to their appearance, taste, or both. Arus variety, for example, obtained 1.72 out of a possible maximum score of 2.0 in regard to appearance in 1984, whereas in 1986 it obtained only 0.78. Jamaica 3, Jamaica 8, Morning Star and Larsen showed a similar situation in regard to appearance, whereas Adelaide, Jamaica 3, Jamaica 8 and Russel showed variation in taste. Mary Fancy variety, on the other hand, may be considered an exception. It received a rating of 1.06 in regard to appearance in 1984 and 0.91 in 1987, but only -0.15 in 1985-86; thus it was rejected by the evaluation panel. A similar situation may be acknowledged in the case of Arus in regard to taste. These variations may be attributed to the attack of pests or mechanical damage at harvest.

The Russel variety consistently shows the best appearance; other varieties may show a better appearance in a given year, but are unable to repeat that performance in successive years.

Other varieties that show an acceptable appearance are, from highest to lowest, Prolific, Jamaica 5, Morning Star, Jamaica 1, Arus, Blackwood, Jamaica 4, Timothe and Bocksberg (table 1). The lowest average for appearance was obtained by Adelaide variety, 0.44. The Larsen variety, whose rating as to appearance did not average above 1.00, was the best variety as to taste, with an average of 1.33. This three-year average was the best among the 17 varieties evaluated. Furthermore, Larsen showed the highest taste score in 1987, when it obtained 1.56. Russel, the variety which showed the highest score as to appearance, was inconsistent in taste; its three-year average was 0.85.

Other varieties with high score values in relation to the taste criterion were Jamaica 5, Timothe and Morning Star. The lowest average in regard to taste was obtained by Bocksberg variety, with 0.33.

Environment seemed to have a profound effect on the quality of fruits produced every year. In 1984, with a variety average of 1.086, the taste was generally better than in 1986 (variety average of 0.549). In 1987, this average was not as high as in 1984, but it was slightly better than in 1986. Variety averages in relation to appearance were more consistent.

The recorded averages of three years showed as unacceptable in appearance all varieties (an average below 1.00) except Arus, Blackwood, Bocksberg, Jamaica 1, Jamaica 4, Jamaica 5, Morning Star, Prolific, Russel and Timothe. Jamaica 5, Larsen, Morning Star and Timothe were the only varieties with acceptable taste. That is, varieties Adelaide, Jamaica 3, Jamaica 8, Jamaica 10, Larsen, Mary Fancy and Ponce scored less than 1.00 in appearance, whereas varieties Adelaide, Arus, Blackwood, Bocksberg, Jamaica 1, Jamaica 3, Jamaica 4, Jamaica 8, Jamaica 10, Mary Fancy, Ponce, Prolific and Russel scored less than 1.00 in relation to the taste.

Table 2 presents the chemical analyses of the 17 sapodilla varieties.

TABLE 2.—*Chemical analysis of sapodilla fruits from 17 varieties grown in southern Puerto Rico*

Variety	Brix°	pH	Acidity	Sugars	
				Reducing	Total
			%	%	%
Adelaide	23.1	4.96	0.076	15.19	19.61
Arus	20.4	5.00	0.75	12.97	18.95
Blackwood	18.0	5.15	0.76	12.63	15.16
Bocksberg	15.2	4.91	0.109	8.95	11.50
Jamaica 1	18.7	4.76	0.099	12.41	14.39
Jamaica 3	22.6	5.39	0.077	13.17	18.86
Jamaica 4	17.7	4.89	0.087	13.14	14.36
Jamaica 5	24.3	5.28	0.078	13.94	21.81
Jamaica 8	18.6	4.85	0.089	12.27	15.13
Jamaica 10	22.8	5.31	0.075	11.24	20.16
Larsen	20.0	5.20	0.074	7.68	16.74
Mary Fancy	21.2	4.92	0.075	11.33	17.11
Morning Star	22.1	5.06	0.068	12.02	17.44
Ponce	18.4	5.19	0.057	10.39	16.05
Prolific	18.5	5.09	0.077	14.49	15.80
Russel	18.2	5.16	0.555	11.63	14.66
Timothe	24.0	5.00	0.054	13.55	20.66

The range of values for all varieties was 15.2 to 24.3 degrees Brix, 4.76 to 5.39 pH, 0.054 to 0.109% acidity, 7.68 to 15.19% reducing sugars and 11.50 to 21.81% total sugars. Bocksberg showed the lowest degrees Brix and percentage total sugars whereas Jamaica 5 showed the highest in both cases. It may be noted that Bocksberg variety averaged the lowest value as to flavor whereas Jamaica 5 averaged second highest.

Jamaica 1 had the lowest pH whereas Jamaica 3 had the highest pH. Timothe showed the lowest percentage of acidity whereas Bocksberg showed the highest. Larsen had the lowest percentage of reducing sugars; Adelaide had the highest.

Data on production of the 17 sapodilla varieties for three consecutive years are presented in tables 3, 4 and 5. The Larsen variety produced the highest number of commercial fruits in 1985-86 as well as the highest commercial yield (kg) per tree during the same year and in 1982-83. Larsen was rated as the highest in regard to flavor. In 1982-83 and 1984-85, Blackwood was the best performer in regard to number of commercial fruits, and in 1984-85, in commercial yield per tree.

The highest mean weight of commercial fruits (g/fruit) was 210.5 for Jamaica 4 in 1982-83; 180.6 for Jamaica 5 in 1984-85; and 243.1, for Jamaica 4 variety in 1985-86. The lowest mean weight of commercial fruits (g/fruit) was 61.0 for Mary Fancy in 1982-83; 68.5, for Jamaica 8, in 1984-85; and 69.4, for Jamaica 1 in 1985-86.

TABLE 3.—Yield, number of fruits and mean weight of fruit of 17 sapodilla varieties, 1982-83

Variety	Yield, kg/tree			Number of fruits			Mean weight of fruit, g		
	Commercial	Non commercial	Total	Commercial	Non commercial	Total	Commercial	Non commercial	Mean
Adelaide	139.9	9.5	149.4	1197	68	1264	116.9	139.7	128.2
Arus	118.8	21.7	140.5	1063	110	1173	111.3	197.3	154.6
Blackwood	207.9	15.8	223.7	2443	121	2564	085.1	130.6	107.9
Bocksberg	112.7	12.2	124.9	843	123	966	133.7	099.2	116.5
Jamaica 1	95.4	14.4	109.8	899	95	994	106.1	151.6	128.8
Jamaica 3	134.4	32.0	166.4	1807	91	1898	074.4	351.6	213.0
Jamaica 4	112.0	7.7	119.7	532	76	608	210.5	101.3	155.9
Jamaica 5	151.6	15.8	167.4	1536	94	1630	098.7	168.1	133.4
Jamaica 8	124.5	17.3	141.8	1446	86	1532	086.1	201.2	143.7
Jamaica 10	86.2	17.6	103.8	823	60	883	104.7	293.3	199.0
Larsen	252.1	33.6	285.7	2385	77	2462	105.7	436.4	271.1
Mary Fancy	123.0	27.1	150.1	2018	150	2168	061.0	180.7	120.9
Morning Star	97.7	9.4	107.1	695	95	1060	140.6	098.9	119.8
Ponce	49.8	4.5	54.3	418	70	488	119.1	064.3	091.7
Prolific	102.1	17.3	119.4	838	83	921	121.8	208.4	165.1
Russel	144.4	5.9	150.3	702	59	761	205.7	100.0	152.9
Timothe	114.0	8.1	122.1	945	73	1018	120.6	111.0	115.8

TABLE 4.—Yield, number of fruits and mean weight of fruit of 17 sapodilla varieties, 1984-85

Variety	Yield, kg/tree			Number of fruits			Mean weight of fruit, g		
	Commercial	Non commercial	Total	Commercial	Non commercial	Total	Commercial	Non commercial	Mean
Adelaide	195.1	24.4	219.5	2328	662	2890	088.8	043.4	063.6
Arus	107.8	48.0	155.8	1449	1576	3025	074.4	030.5	052.5
Blackwood	302.4	30.7	333.1	3716	631	4347	081.4	048.7	065.1
Bocksberg	150.7	21.9	172.6	1628	503	2131	092.6	043.5	068.1
Jamaica 1	168.3	21.5	189.8	2349	466	2815	071.6	046.1	058.9
Jamaica 3	92.6	40.5	133.1	1181	1433	2614	078.4	028.3	053.4
Jamaica 4	190.4	22.3	212.7	1138	287	1375	167.3	094.1	130.7
Jamaica 5	201.9	18.2	220.1	1118	371	1489	180.6	049.1	114.9
Jamaica 8	159.1	31.1	2324	710	3034	068.5	043.8	056.2	
Jamaica 10	80.1	44.8	124.9	1009	1401	2410	079.4	032.0	055.7
Larsen	216.2	114.1	330.3	2705	3756	6461	079.9	030.4	055.2
Mary Fancy	170.1	54.5	224.6	2348	1385	3733	079.9	030.4	055.2
Morning Star	128.6	12.3	140.9	1231	223	1454	972.4	039.4	055.9
Ponce	110.0	12.3	122.3	1216	286	1502	104.5	055.2	079.9
Prolific	135.4	15.3	150.7	995	240	1235	136.1	064.0	100.0
Russel	261.8	7.7	269.5	1782	91	1873	146.9	084.6	115.8
Timothe	196.5	11.7	208.2	1741	290	2031	112.9	040.3	076.6

TABLE 5.—Yield, number of fruits and mean weight of fruit of 17 sapodilla varieties, 1985-86

Variety	Yield, kg/tree			Number of fruits			Mean weight of fruit, g		
	Commercial	Non commercial	Total	Commercial	Non commercial	Total	Commercial	Non commercial	Mean
Adelaide	76.5	.0	76.5	604	126.7	.0	063.4		
Arus	25.3	1.5	26.8	261	22	283	096.9	068.2	082.6
187.2	.0	137.2	1277	0	1277	107.4	.0	053.7	
Blackwood	52.4	4.1	56.5	444	69	513	118.0	059.4	088.7
Bocksberg	41.7	3.0	44.7	601	47	648	069.4	063.8	066.6
Jamaica 1	41.7	3.0	44.7	601	47	648	069.4	063.8	066.6
Jamaica 3	82.5	7.3	89.8	445	97	542	185.4	075.3	130.4
Jamaica 4	59.8	3.3	63.1	246	20	266	243.1	165.0	204.1
Jamaica 5	42.6	2.5	45.1	351	51	402	121.4	049.0	085.2
Jamaica 8	80.9	3.2	84.6	876	58	934	092.4	063.8	078.1
Jamaica 10	33.9	1.8	35.7	288	27	315	117.7	066.7	092.2
Larsen	147.7	23.2	170.9	1656	163	1819	089.2	142.3	115.8
Mary Fancy	127.4	5.7	133.1	1392	100	1492	091.5	057.0	074.3
Morning Star	50.6	5.3	55.9	350	54	404	144.6	098.1	121.4
Ponce	45.9	.0	45.9	387	0	387	118.6	.0	059.3
Prolific	34.6	5.3	39.9	204	75	279	169.6	070.7	120.2
Russel	119.1	.0	119.1	550	0	550	216.5	.0	108.3
Timothe	83.8	.0	83.8	617	0	617	135.8	.0	067.9

This study suggests that, considering all characteristics evaluated, varieties Larsen, Jamaica 5, Russel, Prolific, Morning Star and Timothe are the most promising for commercial production.

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