

uniformity in the raw material. Similar techniques should be employed in Mexico with these promising selections and many more which could be chosen from other areas not only to study their behaviour in future plant generations but also with a view to establish cv in general and to improve the quality of guava in particular.

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PROXIMATE CHARACTERISTICS AND COMPOSITION OF SAPODILLA FRUITS GROWN IN MEXICO¹

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Abstract. Considerable variations occurred in morphological and physical characters of sapodilla fruits grown in Mexico suggesting that selection of promising types would be desirable for establishing cultivars. In a preliminary study of 20 sapodilla selections producing apparently different types of fruits, 3 predominant shapes namely, round, oval and conical were identified. The weight of the fruit was sometimes related with its shape, but not always. Fruit pulp showed marked variations in color, texture, taste and flavour and seed number while its chemical composition did not indicating the existence of sufficient parameters for the establishment of cultivars for large scale cultivation. The morphological, chemical and quality characteristics of 9 sapodilla selections are discussed.

Sapodilla (*Manilkara achras* L; syn. *Achras sapota* L.) is a native of tropical America and probably originated in the south of Mexico or central America (3, 7). From there it has spread to other countries such as south of Florida in the United States, India, Sri Lanka, Burma, Indonesia, Philippines, the Caribbean Islands, Guatemala, Venezuela

and many Central and South American countries where it is commercially grown. The area dedicated for sapodilla fruit production in Mexico is limited to only 1511 ha (1). Apart from this, in the southeastern part of the Republic there are 4000 ha of sapodilla trees grown mainly for the extraction of chicle gum while, there are also a large number of wild sapodilla trees unexplored. According to a recent report, India has more than 2000 ha of sapodilla (8). Precise data is not available on the production of sapodilla elsewhere around the World.

The fruit of sapodilla is a fleshy berry, generally globose, conical or oval with 1 or many seeds. The fruit is 5 to 9 cm in diameter and generally weighs 75 to 200 g, but some types produce fruit weighing almost a kg. The fruit has a thin, rusty brown, scurfy peel and an yellowish brown or red pulp with a pleasant, mild aroma and an excellent taste.

According to Naik (6) 9 cv have been recognized in India, while, Cheema et al. (4) report 7 in western India and 12 in southern India. Florida has 5 cv (3). Unfortunately, studies relating to the establishment of cv have not been conducted in its native countries. Instead, they are identified by their forms such as round, oval or conical. Sapodilla is highly heterozygous and seasonal changes greatly influence the shape and size of the fruit to a great extent. In countries where sapodilla cv are recognized fruit shape, size and weight, pulp color, seed number, taste and flavour and production characters are taken in to consideration for identification.

From the middle of 1975, the states of Veracruz, Oaxaca, Campeche, Tabasco, Yucatan, Chiapas and Quintana Roo were visited with the idea of knowing the different types of sapodilla grown and the heterogeneity existed in them. After these preliminary visits it was found that large commercial orchards were located only in Campeche and Veracruz and to a lesser extent in other states. Therefore, our studies were confined to the different types grown in Campeche and Veracruz. Altogether, 32 trees producing apparently different types of fruits were marked with code numbers starting with SCH. During the 2 years of study

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fruits of only 20 types were analyzed with the object of detecting the most significant variations in morphological, chemical and organoleptic features and to use them for establishing cv for commercial exploitation.

Materials and Methods

From the 20 marked trees, physiologically mature fruits were harvested and brought to the laboratory in Mexico, a distance of approximately 800 km. They were allowed to ripen at 25°C and 65 to 75% RH. 20 ripe fruits selected at random, were used for noting length, diameter and weight individually and later were combined to make 2 homogenates of 10 fruits each. From each of them 2 samples were taken for chemical analyses. Pulp color and presence of gum were noted visually while, fruit quality and organoleptic characters such as texture, juiciness and taste and flavour by simple tasting opinions expressed by a panel of 5 judges. Moisture, vitamin C, acidity, pH, total soluble solids, starch and tannins were determined by the AOAC methods (2) and sugars by the method of Ting (9). All values were expressed on fresh weight basis. From amongst the 20 types of sapodilla analyzed, the data pertaining to only 9 selections, possessing apparently better characters than the rest, are reported here.

Results and Discussion

Description of morphological characters of sapodilla selections.

SCH-01. Fruit shape oval to slightly elongated, brown in color, surface smooth to scurfy, peduncle short, thin, smooth and straight, shoulders not marked, cavity absent, base narrow and apex rounded (location Campeche, Camp.).

SCH-05. Shape ellipsoidal, surface yellowish brown and smooth, peduncle short, stout, straight and slightly rugose, shoulders and cavity absent, base elevated and narrow, apex elongated and pointed (location Campeche, Camp.).

SCH-08. Oval shape with sometimes unequal sides, color light brown, surface smooth to scurfy, peduncle thin, straight and slightly rugose, shoulders low, not well marked, cavity around the peduncle slight, flat base, apex elevated and pointed (location Campeche, Camp.).

SCH-10. Fruit shape oval but narrow towards the apex, light yellowish brown color, surface smooth, peduncle short, stout, straight, slightly rugose, shoulders and cavity just noticeable, base flat, apex narrow and drawn to a point by the persistent style (location Campeche, Camp.).

SCH-13. Round shape with sometimes unequal sides, color dirty brown, surface very scurfy and segmented, peduncle short, stout, straight and rugose, shoulders markedly elevated and striated, cavity pronounced, base flat and wide, apex broad and pointed with a persistent style (location Campeche, Camp.).

SCH-15. Oval shape tending to be conical with equal and uniform sides, light brown color, surface scurfy, peduncle thin, straight, slightly rugose and greenish colored, shoulders and cavity scanty, base slightly flat, apex elevated and ending in a point (location Campeche, Camp.).

SCH-17. Oval to conical in shape with occasionally unequal sides, light brown color, surface smooth, peduncle long, thin, slightly tilted and greenish, shoulders and cavity just noticeable, base slightly broad and flat, apex narrow and deeply pointed with persistent style (location Casas Blancas, Camp.).

SCH-28. Oval in shape with uniform sides, color light brown, surface smooth, peduncle short, thin, straight and smooth, shoulders and cavity absent, base and apex rounded, apex pointed with persistent style (location Acayucan, Ver.).

SCH-30. Oval to spindle shaped with uniform sides, color light brown, surface smooth but occasionally scurfy, peduncle long, thin and slightly tilted, shoulders and cavity absent, base narrow, apex narrow and pointed (location Acayucan, Ver.).

Physical, chemical and organoleptic characters. Table 1 shows physical characters of sapodilla fruits. It was observed that all the selections had fruits generally weighing more than 100 g except for SCH-17. SCH-08, 10 and 13 produced fruits weighing more than 200 g. Round fruits were heavier than either oval or conical ones. SCH-13 with round shape, sometimes produced fruits weighing more than a kg. Fruit weight seemed more uniform in SCH-17 and 15 due to least standard errors while SCH-13 was erratic. Least number of seeds were seen in fruits of SCH-01, 08 and 30 while 17 had most seeds.

Table 2 shows fruit quality and organoleptic characters. On a general basis fruits from all these selections were good in quality. Overall taste and flavour of SCH-01, 08, 28 and 30 was rated excellent. It is well known that the fruit of sapodilla absorb the latex completely on reaching physiological maturity (5). When slightly immature fruits are harvested and ripened, the unabsorbed latex coagulates and precipitates forming localized pockets of gum in the center of the fruit. Therefore, the presence of gum in the fruits of most of the selections should not be misunderstood for a genetic character. Probably these fruits were harvested a trifle early.

Table 3 shows the proximate chemical composition of fruits. There was a great range of variation in vitamin C, total soluble solids, sugars and tannins content in the fruits of all selections. However, moisture content, total acidity and pH of the fruit pulp was more or less consistent in all the selections. Vitamin C content was generally superior in the Mexican sapodilla (range of 8.9 to 41.4 mg/100 g) as compared to the Indian cv (range of 0.1 to 11.9 mg/100 g) (5, 8). Similarly, the sugar content was generally high and consistent in Mexican sapodilla (range of 11.14 to 20.43%) as compared to the Indian cv (range of 7.0 to 26.0%). The

Table 1. Physical characters of sapodilla fruits from Mexico.^a

Code number	Length (cm)	Standard deviation	Diameter (cm)	Standard deviation	Weight (g)	Standard deviation	Seed number
SCH-01	5.2	0.61	4.8	0.42	127.7	37.2	1 to 2
SCH-05	8.8	1.02	6.1	0.71	172.1	42.4	2 to 5
SCH-08	9.2	1.21	7.2	0.58	233.5	77.8	1 to 2
SCH-10	8.3	0.94	7.3	0.71	228.7	39.5	2 to 4
SCH-13	7.0	0.62	9.3	0.87	363.6	108.6	3 to 7
SCH-15	7.1	0.65	6.3	0.54	152.5	27.8	3 to 7
SCH-17	6.8	0.42	5.0	0.38	90.1	12.3	5 to 7
SCH-28	8.9	0.71	6.3	0.43	172.1	40.1	1 to 2
SCH-30	8.7	0.72	6.3	0.49	165.7	38.9	1 to 2

^aAverage of 20 fruits.

Table 2. Fruit quality and organoleptic characters of Mexican sapodilla.

Code number	Pulp color	Texture	Juiciness	Presence of gum	Overall taste and flavour
SCH-01	Reddish brown, stalk end dark red	Soft, slightly sandy	High	Very little	Sweet, excellent aroma
SCH-05	Light yellowish brown	Firm, fine sandy	High	Little	Starchy, sweet, slightly astringent, good aroma
SCH-08	Yellowish brown, red tinge at both ends	Firm, fine sandy	Medium	Little	Astringent, very sweet, excellent aroma
SCH-10	Uniformly light brown	Soft slightly sandy	Medium	Little	Sweet, astringent, very good aroma
SCH-13	Uniformly light reddish brown	Soft, sandy	Least	High	Sweet, astringent, very good aroma
SCH-15	Uniformly yellowish brown	Firm, sandy	High	Little	Very sweet, slight aroma
SCH-17	Light yellowish brown	Soft, slightly sandy	Medium	Little	Sweet with slight aroma
SCH-28	Brick red with yellow tinge in center	Soft and sandy	Medium	Little	Very sweet with excellent aroma
SCH-30	Light yellowish brown	Soft and mealy	High	Absent	Very sweet with excellent aroma

Table 3. Proximate chemical composition of fruits of Mexican sapodilla.^a

Code number	Moisture (%)	Vitamin C (mg/100g)	Tot. acid (%)	pH	Tot. solu. solids (°Brix)	Carbohydrates (%)				Total tannins (%)	
						Glucose	Fructose	Sucrose	Tot. sug.		
SCH-01	73.8	17.8	0.12	5.2	21.1	5.84	5.67	7.46	18.33	3.25	1.16
SCH-05	70.2	21.5	0.15	5.0	20.2	6.18	6.23	1.48	13.27	6.40	6.15
SCH-08	74.6	19.0	0.09	5.3	19.7	6.94	6.03	4.81	11.14	3.53	3.57
SCH-10	73.3	23.8	0.10	5.3	19.7	6.35	4.47	8.75	19.08	4.08	5.30
SCH-13	70.9	10.3	0.14	5.1	23.3	7.09	4.52	7.88	18.90	3.75	1.19
SCH-15	69.6	19.8	0.12	5.2	23.7	9.23	7.13	4.89	20.43	3.30	3.16
SCH-17	75.7	8.9	0.13	5.1	17.4	6.98	5.77	1.65	13.66	2.98	1.15
SCH-28	69.0	41.4	0.15	5.3	21.7	7.22	5.21	7.35	19.16	4.85	6.17
SCH-30	73.6	10.7	0.13	5.2	18.0	7.59	6.14	1.96	14.99	3.60	5.63

^aAverage of 4 replicates expressed on fresh weight basis.

high values obtained for tannins in the Mexican selections were probably due to the incorporation of peel during homogenation of the samples.

Considering the data presented here, it is rather difficult to identify marked differences with respect to morphological characters although 3 predominant shapes were quite distinguishable such as oval, conical and round. Nature of peduncle, unequal or oblique fruit sides and persistent style (forming pointed apex) may serve as good parameters as they show distinct differences. These, together with fruit weight, seed number and color of pulp may also be useful to differentiate the characters as a basis for the establishment of cv of sapodilla, while none of the chemical constituents analyzed in this work would be helpful in characterization of cv as they did not show wide differences. It is also necessary to conduct agronomic studies to know the production aspects before making final recommendations regarding acceptance of these selections as cv.

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