the general pattern for alkanes in higher plants: 87 to 90% of the C_{21} to C_{31} alkanes had carbon skeletons with odd numbers of carbon atoms (Table 3). Branched alkanes, which are prevalent in citrus (3, 10) were not observed in carambola or loquat fruit. Of the even numbered alkanes only C_{22} and C_{24} were observed at levels higher than 1%. The greatest differences in relative percentages between cultivars occurred with C_{29}, and to a lesser degree with C_{23} and C_{25} alkanes. In most cases, a low level of one of these alkanes was compensated for by high levels in one or both of the others.

Carambola fruit contained monounsaturated hydrocarbons (alkenes) in addition to their alkanes (Table 3). Alkenes accounted for 38% (cultivar 37), 40% (cultivars 17 and 44), 46% (cultivar 42) and 57% (Tean Ma) of the total hydrocarbons in a fruit. The majority (94 to 99%) of these were odd numbered with $C_{23:1}$ and $C_{25:1}$ accounting for 82 to 87% of the alkenes. Differences in alkene profiles for the five cultivars were small. Differences occurred however, between the ratios of $C_{23:1}$ and $C_{25:1}$ alkenes to their respective C_{23} and C_{25} alkanes. These differences accounted, to a large extent, for the total hydrocarbon percentages of the higher alkenes in cultivar 42 and Tean Ma.

Alkane profiles of loquat fruit were quite unique with three odd numbered (C_{27}, C_{29}, C_{31}) making up 92 to 94% and each of the other alkanes less than 2% of the total alkanes (Table 4). Differences between the two cultivars were minimal.

No attempt was made to correlate the differences in these three markers with the differences in oxalic acid, ascorbic acid, and total acid contents reported for four of the carambola cultivars (12). In this preliminary chemotaxonomic study with carambola and loquat fruit, various differences in lipid profiles were observed which may be applicable to other tropical fruits as well. 1) The carambola and loquat fruit had fatty acid, sterol and hydrocarbon profiles intrinsic to their respective species. Thus, hybrids would most likely have their own intrinsic profiles. 2) Oleic acid showed the greatest differences between cultivars for both fruit. 3) A $C_{18:2}$ fatty acid with its double bonds in positions other than 9, 12 is present in carambola fruit and may be useful as a marker in crosses of this species. 4) Isofucosterol was present and stigmasterol absent in both fruit. 5) The campesterol/β-sitosterol ratio was different for each of the 7 cultivars. 6) The ratios of total alkenes to total alkanes are different in the five carambola cultivars while in loquat alkenes were not detected. 7) Percentages of C_{29} and to a lesser degree C_{23}, C_{25} alkanes were different for the five carambola cultivars.

The data in this report and previous studies with citrus (8-11) indicate that of the three lipids, hydrocarbons show the most potential as markers in chemotaxonomy of tropical fruits. Hydrocarbons are easily isolated, very stable and very adaptable to analyses by GLC.

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PROMISING MEXICAN GUAVA SELECTIONS RICH IN VITAMIN C[1]

S. Lakshminarayana
Departamento de Biotecnología, Universidad Autónoma Metropolitana—Iztapalapa, Apartado Postal 55-535, México—13 D.F.

M. A. Moreno Rivera
Departamento de Industrias Agrícolas, Escuela Nacional de Agricultura (U.A.Ch), Chapingo, Estado de México, México

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Abstract. **The study reports the occurrence of several variations in the fruit of Mexican guava with regard to size, color, pulp-seed ratio, vitamin C content and various other morphological and chemical parameters. From amongst several trees producing apparently different types of fruits in 2 principle production centers 10 tentative selections were made based on the vitamin C content of fruits and their botanical and physicochemical characteristics. Fruits from 9 of these selections had a vitamin C content of 500 mg or more per 100 g of pulp and 1 had more than 1000 mg. Vegetative propagation of these is suggested to study their behaviour in future generations for a possible recommendation as commercial cultivars.**

Guava (*Psidium guajava* L.) is one of the most important fruit crops of Mexico with a production of 161,115 MT distributed over an area of 12,148 ha valued ca. 250 million

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pesos (1). The important areas of production are the states of Aguas Calientes (accounting for more than 7,500 ha), Guerrero, Jalisco, Michoacán and Zacatecas. The fruit is considered highly nutritious due to the high content of ascorbic acid, minerals and amino acids (5). The fruit can also freeze well and processed in to jam, jelly, puree, fruit bars and flakes, nectars and various other canned products (9).

Guava is a native of the American tropics originating in Mexico or Peru (5, 6, 9). However, it has adapted very well in other tropical and subtropical countries where several cv. are recognized and grown on a commercial scale. Guava in Mexico is generally cultivated by seedling propagation and consequently there is a considerable heterogeneity in fruit shape, size and quality (8). No systematic attempt to date has been made to assess the quality of the fruits produced by seedling trees. With this limitation it is difficult to establish the quality standards for the fruit either for fresh consumption or for processing (7).

The object of this work was to aid the commercial exploitation of Mexican guava by describing types showing desirable morphological, chemical and nutritional qualities on the basis of which cv could be established.

Materials and Methods

After several years of observation of various production areas, 52 guava trees each producing a different type of fruit were marked in Calvillo, Ags and Ixtapan de la Sal, Méx. For convenience these selections were given code numbers (CG and IG indicating the place of origin) which are later quoted in the text.

Fruits produced from these 52 trees were collected and their physical characteristics such as size and weight, shape and form, nature of peduncle, calyx, color (external and internal), number of locules, thickness of pericarp, pulp-seed ratio and taste and flavour were studied following the methods described by various workers (3, 4, 12, 13, 14).

Chemical analysis of the pulp included estimation of total acidity, starch, total nitrogen and tannins by AOAC methods (2), true ascorbic acid by the method of Robinson and Stotz (11), total and reducing sugars by the method of Ting (15) and pectin by the method of McCready and McComb (10). For estimation of the mineral constituents of the pulp AOAC procedures (2) were employed for preparing the samples and the final readings were taken using Perkins atomic absorption spectrophotometer. 4 replicates of 2 separate homogenates of fruit pulp were analyzed over 2 seasons and their average values (fresh weight basis) are presented.

Selections of promising types were made using 3 parameters namely, fruit size and weight, pulp-seed ratio and vitamin C content. Characteristics of fruits of 11 promising types selected on the basis of fruit size and weight and better pulp-seed ratio were presented earlier (8). In the present study the physical and chemical characteristics of fruits from 10 promising selections based on vitamin C content are discussed.

Results and Discussion

Description of morphological and physical characters of the fruit.

CG-01. Good bearer. Fruit globose, slightly pointed at the apex, peduncle elevated and narrow, calyx lobes green, wide and closed, fruit surface smooth with slight reddish blush and red spots, pulp color yellow, quadrilocular, diam 4.5 cm and ht 5.0 cm.

CG-03. Good bearer. Fruit globose and slightly pointed at the apex, peduncle simple and short, calyx lobes brown, wide and open, surface smooth, absence of blush but with occasional red spots, pulp color light yellow, quadrilocular, diam 5.2 cm and ht 5.7 cm.

CG-06. Good bearer. Fruit oval and narrow at the apex, peduncle slightly elevated and short, calyx lobes green, wide and closed, surface smooth, slightly ridged, absence of blush with few reddish spots on yellow base color, pulp color light yellow, quadrilocular, diam 5.2 cm and ht 6.4 cm.

CG-07. Medium bearer. Fruit oval, elongated and slightly wide at the apex at the insertion of the short peduncle, calyx lobes yellow, narrow and closed, surface smooth with red blush on yellow base color with occasional red spots, pulp color white, quadrilocular with an occasional trilocular condition due to abortion, diam 4.4 cm and ht 6.5 cm.

CG-08. Good bearer. Fruit shape varied ranging from oval to pyriform, peduncle elevated, short and inserted, calyx lobes green, narrow and closed, surface smooth, yellow with red spots, pulp color light yellow, quadrilocular, diam 4.5 cm and ht 6.8 cm.

CG-18. Good bearer. Fruit shape round, narrow at the apex, peduncle short, slightly elevated, calyx lobes green, narrow and closed, surface smooth, yellow with red spots, pulp color yellow, pentalocular, diam 5.1 cm and ht 5.6 cm.

CG-23. Medium bearer. Fruit shape round to oval, slightly pointed at the apex, peduncle elevated, slightly longer, calyx lobes brown, wide and open, surface smooth, greenish yellow with occasional red spots and or red blush, pulp color yellow, pentalocular, diam 6.0 cm and ht 8.3 cm.

CG-28. Good bearer. Fruit shape round to oval, slightly narrow at the apex, peduncle slightly elevated and short, calyx lobes green, narrow and closed, surface smooth, bright yellow, pulp color yellow, quadrilocular, diam 4.9 cm and ht 5.3 cm.

IG-8. Medium bearer. Fruit shape globose to oval, slightly pointed at the apex, peduncle elevated and short, calyx lobes brown, wide and open, surface slightly rugose, yellow in color with absence of blush but with occasional red spots, pulp color white, quadrilocular, diam 4.7 cm and ht 5.9 cm.

IG-20. Heavy bearer. Fruit shape pyriform with a wide apex, peduncle elevated and short, calyx lobes green, expanded and open, surface smooth, yellow in color with absence of blush or spots, pulp color white, quadrilocular, diam 4.7 cm and ht 5.8 cm.

Apart from these differences in fruit characters there were slight variations with respect tree formation, branching and leaf characters in all the trees corresponding to the 10 selections whilst, the season of flowering and fruiting did not alter.

Physical and chemical analysis. Table 1 shows the physical characteristics of the fruit such as weight, thickness of pericarp, weight of pulp and seeds, pulp-seed ratio and organoleptic qualities. It was observed that fruits from all selections fell in the weight range of 50 to 80 g except for CG-23 which weighed more than 100 g, of which 60 to 80% represented the pulp weight. Fruits of IG-20 had the lowest seeds and CG-03 the highest with 16.5 and 42.9% respectively. Best pulp-seed ratio was obtained in selection IG-20 (4:1) and the rest showed a ratio between 3:2 to 2:1. Organoleptic quality (aroma, taste and flavour) of CG-08, CG-23 and IG-20 was rated excellent while rest of the selections were considered good to very good.

Tables 2 and 3 give the results of chemical analysis and mineral composition respectively of the fruit pulp of the 10 selections. It was observed that fruits from all the selections showed variations in chemical and mineral composition. It is however, important to note that the ascorbic acid content was higher than 500 mg in all the 10 selections. It

Table 1. Physical characters of fruits of guava selections from Mexico.

Code number	Fruit wt (g)	Pulp thickness (cm)	Wt of pulp (%)	Wt of seeds (%)	Pulp seed ratio	Pulp color	Seeds	Taste and flavour
CG-01	51.4	0.7	64.6	33.6	2:1	Light yellow	Many, soft	Very good, very good aroma
CG-03	79.8	0.6	56.6	42.9	3:2	Light yellow	Too many, hard	Good, good aroma
CG-06	75.6	0.7	59.9	38.0	3:2	Light yellow	Too many, hard	Good, good aroma
CG-07	59.7	0.7	67.1	32.3	2:1	White	Many, soft	Very good, very good aroma
CG-08	60.5	0.6	62.9	36.4	3:2	Light yellow	Many, soft	Excellent, excellent aroma
CG-18	74.7	0.8	65.4	33.2	2:1	Yellow	Few, soft	Good, good aroma
CG-23	123.0	0.9	67.7	32.2	2:1	Yellow	Many, soft	Excellent, excellent aroma
CG-28	63.6	0.9	72.3	27.4	2:1	Yellow	Many, hard	Very good, very good aroma
IG-8	78.8	0.9	70.1	28.6	2:1	White	Few, soft	Very good, very good aroma
IG-20	65.8	1.2	82.3	16.7	4:1	White	Few, soft	Excellent, excellent aroma

Table 2. Proximate chemical composition of the pulp of Mexican guava selections.[z]

Code number	Acidity (% citr. ac. anhy.)	Ascorbic acid (mg/100g)	Total sugars (%)	Starch (%)	Total pectin (%)	Total tannins (%)	Total proteins (%)
CG-01	1.0	1014.4	8.2	2.3	1.1	1.1	0.5
CG-03	0.9	520.8	8.3	2.1	0.7	0.7	0.4
CG-06	1.1	513.7	10.3	2.5	0.9	0.9	0.4
CG-07	0.8	713.2	9.3	2.6	0.6	0.9	0.5
CG-08	0.8	590.3	9.4	1.7	0.5	0.6	0.6
CG-18	1.1	501.3	10.9	1.9	0.6	0.7	0.5
CG-23	0.8	557.0	8.7	1.7	0.2	1.0	0.6
CG-28	0.5	559.8	8.1	2.0	0.4	1.1	0.6
IG-8	0.8	645.0	7.5	1.6	0.5	0.8	0.4
IG-20	0.7	543.0	6.9	2.3	0.9	0.9	0.7

[z]Average of 4 replicates expressed on fresh weight basis.

Table 3. Proximate mineral composition of the pulp of Mexican guava selections.[z]

Code number	Ash (%)	Major elements					Minor elements			
		P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)
CG-01	4.10	0.02	0.36	0.02	0.01	0.002	3.20	2.40	4.50	3.22
CG-03	3.60	0.01	0.30	0.02	0.01	0.002	2.99	1.70	3.11	3.11
CG-06	3.00	0.01	0.28	0.01	0.01	0.002	3.57	1.79	3.57	1.74
CG-07	2.93	0.02	0.26	0.02	0.01	0.002	2.37	0.19	4.04	1.17
CG-08	4.32	0.02	0.32	0.01	0.01	0.002	2.96	0.59	4.74	0.87
CG-18	3.16	0.03	0.28	0.02	0.01	0.002	4.21	1.44	1.31	0.56
CG-23	4.38	0.02	0.34	0.03	0.01	0.006	4.49	0.80	0.97	1.05
CG-28	3.74	0.03	0.33	0.02	0.01	0.002	3.18	0.54	1.09	0.62
IG-8	4.40	0.02	0.25	0.01	0.01	0.002	2.68	0.45	0.77	0.82
IG-20	2.60	0.02	0.28	0.01	0.01	0.001	3.05	0.51	1.10	1.18

[z]Average of 4 replicates expressed on fresh weight basis.

was noted that larger fruits showed lower ascorbic acid content than selections producing medium and small fruits.

Guavas produced around the World belong to 3 pulp color types namely, white, yellow and red. Commercially grown Mexican guavas generally had yellow or white pulp and in some cases with an occasional red tinge. A number of names have been used in different countries to identify guava cv producing fruits similar in size, shape and color, seedlessness, etc. These fruit characteristics have been preserved by resorting to vegetative propagation to maintain

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 MEXICO[1]

S. Lakshminarayana
Departamento de Biotecnología,
Universidad Autónoma Metropolitana–Iztapalapa,
Apartado Postal 55-535, México–13 D.F.

M. A. Moreno Rivera
Departamento de Industrias Agrícolas,
Escuela Nacional de Agricultura (U.A.Ch),
Chapingo, Estado de México, México

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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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