Sapote (Mammy Apple)* Seed and Oil

Contribution from the Oil, Fat and Wax Laboratory, Bureau of Chemists and Soils, U. S. Department of Agriculture

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THE oil to be described is found in the seed from the fruit of *Calocarpum mammosum* (formerly classified as *Achras mammosa, sideroylum sapota, Vitellaria mammosa* and by other names) belonging to the Sapotaceæ family. For those not specially familiar with this interesting family of tropical plants, the following information is given:

Most of the species that are of interest on account of their oleaginous seeds are sizable trees found in India, the East Indies, and in parts of tropical Africa. Among these may be mentioned those that yield the true illipe or Bassia fats, katio oil, njatno oil and shea butter. With few exceptions the members of this family yield products that are more or less solid fats at ordinary temperatures and practically all of them are characterized by containing large quantities of saturated acids, and not infrequently, as in the case of sapote oil, stearic acid predominates. Recently, Pieraerts, Adriaens, and Muelenburg (*Les Mat. Gras.* 1929, 21, 8701 and 1930, 22, 8782) have found that another species, *Dumoria africana,* from the Belgian Congo yields a fat which contains 46 per cent of saturated acids, the larger part of which is stearic acid, and they call attention to the ease with which this acid can be obtained in quantity from this source.

The sapote or "marmalade tree" which is now cultivated chiefly for its fruit is a native of tropical America. It is found in southern Mexico, Central America, Colombia, Ecuador and other tropical regions. This tree under favorable conditions reaches a height of 30 meters. The brown scaly globose or ovoid fruits which range in length from 10 to 20 centimeters contain one large tapering seed about 8 centimeters long and 3 centimeters at the larger diameter. These seeds generally weigh from about 20 to 26 grams. The pink flesh or pulp of the fruit which has a peculiar sweetish flavor is eaten as such or converted into a beverage, marmalade or jelly. The seeds, which have a flavor resembling that of bitter almonds, are ground in some localities and used in making sweetmeats. From very early times the seed oil has been used by the native inhabitants for dressing the hair. It was believed that its use prevented the falling out of the hair. C. Gayton (*Jour. de. Pharm.* 1840, 26, 771) called attention to the large quantity of oil in the seed and showed also that it contained notable quantities of amygdalin, which accounts for its characteristic flavor. This was later confirmed by F. Altamirana (*La Naturaliza* 1874, 3, 138) who also stated that the oil was used for toilet purposes by the natives. Apparently since this time the oil has not received any attention on the part of the investigators, although it is understood that considerable quantities of the seed are available in some of the localities in which the trees are cultivated.

Some years ago through the Department's Office of Foreign Plant Introduction a quantity of sapote seed was obtained from D. Massin at Guinea Grass, Honduras. An analysis of the seed showed that they contained 9.4 per cent of moisture and 57 per cent of oil. The oil was expressed from the seed by means of the Anderson oil expeller. After standing for more than eight years in cold storage it still possessed a faint almond-like odor and had a very mild pleasant taste. When cooled to about 15° this bright yellow oil solidified. Upon standing a short time between 23° and 27° large quantities of stearin were deposited, as would be expected from its composition.

The chemical and physical characteristics of the oil, which were determined after it had

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*This fruit should not be confused with another of the American tropics known as "Mamme Apple," which is from the tree *Mammea americana* belonging to the natural order of *Guttiferae.*

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been held in storage at 2° C. for more than eight years, are given in Table I.

Table I

Specific gravity 25/25°	0.9105
Refractive index at 25°	1.4652
Iodine number (Hanus)	70.2
Saponification value	189.5
Acetyl value	12.2
Unsaponifiable matter, per cent	1.39
Reichert-Meissl value	0.15
Polenske number	0.30
Saturated acids, corrected, per cent	30.37
Unsaturated acids, corrected, per cent	63.73

The saturated and unsaturated acids were separated and determined by the lead-salt ether method (*J. Assoc. Offic. Agric. Chemists* 1928, 11, 303), and corrections were made for the small quantity of unsaturated acids that is precipitated and weighed with the saturated acid fraction. The percentage of unsaturated acids has also been corrected for the unsaponifiable matter that remains with them. It will be observed that the oil, which distinctly belongs to the non-drying class, is characterized by having a large percentage of saturated acids.

Unsaturated Acids

FROM the iodine number of the oil and the corrected percentage of unsaturated acids, the iodine number of the latter was calculated to be 108. This value was used in the calculation of the proportions of oleic and linolic acids in the oil with the following results:

	Unsaturated Acids Per cent	In Oil Per Cent	As Glycerides Per Cent
Oleic acid	80.2	52.15	53.4
Linolic acid	19.8	12.88	13.1

Saturated Acids

THE saturated acids, which were separated from the oil by the lead-salt ether procedure, were esterified with absolute methyl alcohol in the presence of dry hydrogen chloride (*Jour. Amer. Chem. Soc.* 1920, 42, 1920), and the resulting esters were fractionally distilled under diminished pressure. About 110 grams of the esters were distilled from a 500 cc. Claissen flask, giving five fractions and a residue, which were then refractionated in order from a 150 cc. Ladenburg fractionation flask. Six fractions and a small residue were obtained. At 5 millimeters pressure the bulk of the esters was found to distill between 185° and 197°. The iodine number and the saponification value of each fraction were determined. An examination of the acids separated from the undistilled residue showed that they consisted chiefly of stearic acid and a very small quantity of arachidic acid which melted at 77°.

The free fatty acids were recovered from portions of each of the fractions of esters in the usual manner after saponification with alcoholic potash, and submitted to fractional crystallization from ethyl alcohol. Their identity was established by the melting points and by observing whether or not they were lowered when the substances were mixed with equal quantities of the respective acids, the purity of which had been established by analysis. In no case was there any change in the melting point, and the acids separated from each fraction were in accordance with the deductions drawn from the mean molecular weights as calculated from the analyses of the esters. The quantities of saturated acids in the fractions were calculated from the mean molecular weight of their esters and the theoretical molecular weight of the two esters in each one. The final results are given in Table 2.

Table 2

Acids	Grams	Per Cent	Acids in Oil Per Cent	Glycerides in Oil Per Cent
Palmitic	28.3019	30.95	9.40	9.86
Stearic	63.0861	68.99	20.95	21.89
Arachidic	.0500	.06	.02	.02

The oil is characterized by the large quantity of stearic acid present, and this accounts for the ease with which it solidifies when slightly cooled.

The composition of the expressed oil has been determined, with the following results:

Glycerides of	Per Cent
Oleic Acid	53.4
Linolic Acid	13.1
Palmitic Acid	9.9
Stearic Acid	21.9
Arachidic Acid	Trace
Unsaponifiable	1.4

The oil could be used as a cooking oil, as a salad oil in tropical countries, or for the manufacture of soap.

In the use of brucine alkaloid as a denaturant for technical vegetable oils, trouble may be encountered if the brucine is dissolved in alcohol, according to The New York Quinine and Chemical Works, manufacturers of brucine alkaloid. The preferred method for the use of this alkaloid as a denaturant makes use of the following formula:

> Brucine Alkaloid, 2 lbs. Commercial oleic acid, 1 quart, 12 fluid ounces. Vegetable oil, 1 quart, 1 pint. Heat the oleic acid to 90° C. Add the brucine alkaloid slowly with constant stirring. When the solution is clear, add the vegetable oil. Heat to 90° C. Mix well.

One pint of this solution contains four ounces of brucine alkaloid; the solution will not precipitate crystals on cooling and is miscible in all proportions with vegetable oils.