Palm Oil From The Belgian Congo[1]

A contribution from the Oil, Fat and Wax Laboratory, Bureau of Chemistry and Soils, United States Department of Agriculture.

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PALM oil is obtained from the fibrous-fleshy portion of the fruit from the numerous varieties of the palm Elaeis guineensis, a native of tropical West Africa, which has been introduced into other regions and which is being extensively cultivated in Sumatra. Formerly, all the oil exported from Africa was prepared by very crude inefficient native methods, but in recent years, owing to the rapidly increasing competition in the world markets of the Sumatra product, which is of superior quality, serious attempts are under way in the Belgian Congo, Nigeria, and some other African localities to introduce modern equipment and methods for handling the fruit and preparing the oil, besides giving attention to improving the natural groves of palms so that they will become more productive. Also, in some African localities experimental plantings are being made. As a result of these efforts, some of the African palm oil is of notably better quality than that formerly exported.

For those not familiar with this product, it may be stated that commercial palm oil varies in color from yellow to a deep orange, and sometimes is dark brown. The color depends largely upon the variety of the fruit and the method of preparation. At ordinary temperatures, the oil varies from a semi-liquid consistency to the hardness of tallow. The higher the percentage of free fatty acids, the harder is the oil. Large quantities of the oil are used by the tin plate industry and soap manufacturers. The high grade oil is being used in increasing quantities in making margarine for which it is particularly well adapted.

The composition of palm oil has received until recently but little attention. Armstrong and Allan (J. Soc. Chem. Ind. 1924, *43*, 216 T), state that the fatty acids from a sample of the oil, the source of which is not given, contained the following percentages of acids: Oleic —48; linolic—7; myristic—1; palmitic—35.5; and stearic—8.5.

A. Rayner and S. G. Campbell (J. Soc. Chem. Ind. 1928, 47, 149 T) examined nine samples of palm oil from different localities and found that the percentages of the saturated acids varied from 39.7 to 57.9. According to their determinations, these fractions contained from 12.5 to 18.5 per cent of stearic acid. By means of the iodine numbers, they estimated that the unsaturated acid fractions contained, on the average, 20 per cent of linolic acid and 80 per cent of oleic acid.

In view of repeated requests for further information on the characteristics and composition of palm oil, the following investigation was made on an authentic sizable sample of H. C. B. Plantation Palm Oil from Port Maladi, Belgian Congo, which was kindly furnished by the Lever Brothers' Plant at Cambridge, Mass. This sample, which was orange colored, was very soft and had a delicate, pleasant odor.

The chemical and physical characteristics are given in Table I. It will be observed that the Reichert-Meissl value is very low as compared with that (.7 to 1.9) previously reported, but according to Elsdon (Edible Oils and Fats, p. 319) palm oils of good quality would be expected to give a negligible Reichert-Meissl value, and further the high values reported would be correct only in the case of rancid oils. The percentage of saturated and unsaturated acids was determined by the lead-salt-ether method, and corrections were made for the small quantity of unsaturated acids that are precipitated and weighed with the saturated acid fraction (J. Amer. Chem. Soc. 1920, *42*, 2398; Cotton Oil Press, 1922, *6*, 41). The percentage of unsaturated acids has also been corrected for the unsaponifiable matter that remains with the unsaturated fraction.

The range of the characteristics reported by various observers is as follows: Density at 15°, .920 to .926; refractive index at 40°, 1.453 to 1.457; saponification value, 196 to 205; iodine number, 48 to 58; Reichert-Meissl value, 0.7 to 1.26; Polenske number, 0.4 to 0.6; melting point, 27 to 50°; titer, 38 to 47°, and unsaponifiable matter, 0.3 per cent. As previously mentioned, the large variation in the melting points is due to the wide range in the quantity of free fatty acids.

[1] Presented before the American Oil Chemists' Society at New Orleans, La.

Table I

PALM OIL CHEMICAL AND PHYSICAL CHARACTERISTICS

Specific gravity 25/25°	0.9146
Refractive index at 40°	1.4578
Acid value	20.65
Saponification value	197.9
Unsaponifiable matter (%)	0.39
Iodine number (Hanus)	53.7
Acetyl value (Andre-Cook)	15.27
Reichert-Meissl value	0.10
Polenske number	0.29
Saturated acids (corrected) (%)	44.3
Unsaturated acids (corrected) (%)	50.6
Iodine number of Unsat. acids	99.9

Unsaturated Acids

THE iodine number of the unsaturated acids is 99.9, indicating that this fraction consists of oleic acid (Iodine number 90.1) and linolic acid (iodine number 181.4). The following percentage composition of the unsaturated acids fraction was calculated from these figures:

	Per cent	In Oil Per cent	Glycerides in Oil Per cent
Oleic Acid	89.36	45.17	47.2
Linolic Acid	10.64	5.38	5.6

William Brash (J. Soc. Chem. Ind. 1926, *45*, 438T) found that the unsaturated acids in a sample of neutralized palm oil amounted to 48.5 per cent.

Saturated Acids

THE saturated acids, which were separated from the mixed fatty acids of the oil by the lead-salt-ether method, were esterified with absolute methyl alcohol, using dry hydrogen chloride gas (J. Amer. Chem. Soc. 1920, *42*, 1200), and the resulting esters were fractionally distilled under diminished pressure. The data for the distillation are given in Table II.

TABLE II

FRACTIONAL DISTILLATION OF METHYL ESTERS OF SATURATED ACIDS

(109.6 g. taken for distillation)

Preliminary distillation under 2 mm. pressure	Fraction	Temp. °C	Weight Grams
	A	160 to 163	21.40
	B	164	22.70
	C	165	22.60
	D	166 to 167	21.70
	E	170 to 180	19.10
	Residue		2.00
Final distillation under 2 mm. pressure			
Fractions A + B added	1	150 to 155	10.70
	2	156 to 157	23.30
Fraction C added	3	157	23.05
" D "	4	157 to 161	23.52
" E "	5	162 to 166	20.05
Residue "	6	173 to 185	8.50
	Residue		.37

The preliminary distillation was made from a 500-cc. Claisson flask, giving 5 fractions and a residue of undistilled esters, all of which were redistilled in the order indicated in the table, from a 150 cc. Ladenburg fractionation flask. Six fractions and a small residue were obtained.

Examination of Fractions

THE iodine numbers and the saponification values of these six fractions were determined and are recorded in Table III.

The iodine numbers of the various fractions are the measure of the contaminating unsaturated acid, and from these values the percentage of the esters of these unsaturated acids was calculated. From these percentages and the saponification values the mean molecular weight of the saturated acid esters in the several fractions was calculated. The mean molecular weights indicate what saturated acids may be present in each fraction. For example, the mean molecular weights of the saturated acid esters in fraction 1 and 2 (Column 5, Table 3) are between those of methyl myristate (242.3) and methyl palmitate (270.3), indicating that this fraction contains both esters, whereas the molecular weights of fractions 3, 4, 5, and 6 indicate that they consist of various proportions of methyl palmitate and stearate (298.4).

In order to determine the correctness of these deductions, the free fatty acids were recovered from several of the fractions by saponifying them with alcoholic potash, removing the alcohol, dissolved the soaps in water, and decomposing them with hydrochloric acid. The constituent saturated acids entirely freed from mineral acid were isolated by fractional crystallization from ethyl alcohol. Their identity was established by the melting points and by observing whether or not the melting points were lowered when the substances were mixed with equal quantities of the respective acids which they were suspected of being, the purity of which had been established by analysis.

The deductions drawn from the molecular weights of the saturated acids were confirmed as follows: The final residue was saponified with alcoholic potash, and the fatty acids were liberated with hydrochloric acid, collected, dried and crystallized from about 12 cc. of 95 per cent alcohol. The crystallizable fatty acids were subjected to fractional crystallization and finally 0.1401 grams of stearic acid, melting at 68-9°, and 0.1900 grams of lignoceric acid, melting at 80.-80.5°, were obtained. No arachidic acid could be isolated.

Table III

PALM OIL

RESULTS OF ANALYSIS OF FRACTIONS OBTAINED BY DISTILLING THE METHYL ESTERS

Fraction	Iod. No.	Sap. Val.	Esters of Unsat. Acids %	Mol. Wt. of Sat. Acid Esters	Myristic Acid %	Myristic Acid Gram	Palmitic Acid %	Palmitic Acid Gram	Stearic Acid %	Stearic Acid Gram	Lignoceric Acid Gram
1	0.96	209.3	1.00	267.8	7.76	0.8303	85.51	9.1395			
2	1.12	207.6	1.15	270.0	0.96	0.2238	92.77	21.6161			
3	1.52	206.7	1.57	271.1			90.69	20.9500	2.67	0.6149	
4	3.0	205.6	3.15	272.2			85.70	20.1560	6.25	1.4700	
5	7.4	201.9	7.78	276.6			68.25	13.7822	19.35	3.9713	
6	11.9	192.9	12.51	289.7			26.09	2.2230	58.37	4.9620	
Res.										0.1401	0.1900
Totals						1.0541		87.8658		11.1583	0.1900

Lignoceric acid ($C_{24}H_{48}O_2$) melting at 80. to 80.5° was isolated from the residue; stearic acid ($C_{18}H_{36}O_2$) melting at 68-9° was separated from fractions 4 and 6 as well as from the residue; palmitic acid ($C_{16}H_{32}O_2$) melting at 63° was obtained from fractions 1 and 3. Ten crops of crystals were obtained from the fractional crystallization of the fatty acids from fraction 1 by gradually reducing the volume of the alcoholic solution and finally by adding small quantities of water. The tenth and eleventh crops of crystals which melted at 54 to 55° were myristic acid ($C_{14}H_{28}O_2$).

The quantity 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 fraction.

Table IV

PALM OIL

SATURATED ACIDS

Acids	Saturated Acid Fraction Grams	Saturated Acid Fraction Per Cent	Acids in Original Oil Per Cent	Glycerides in Original Oil Per Cent
Myristic	1.054	1.05	0.47	0.51
Palmitic	87.867	87.63	38.85	40.75
Stearic	11.158	11.13	4.93	5.15
Lignoceric	0.190	0.19	0.08	0.08
		100.00	44.33	

In Table IV, the percentage composition of the saturated acids is given in Column 2. These values calculated to the basis of the original oil are given in Column 3. Column 4 gives the equivalent percentages of the glycerides.

Summary

THE chemical and physical characteristics of a sample of palm oil from the Belgian Congo, Africa, have been determined. The oil was found to contain 44.33 per cent of saturated and 50.55 per cent of unsaturated acids.

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

Glycerides of	Per Cent
Oleic acid	47.2
Linolic "	5.6
Myristic "	.5
Palmitic "	40.8
Stearic "	5.2
Lignoceric "	.1
Unsaponifiable matter	.39

This is the first time that lignoceric acid has been reported as a constituent of palm oil.

Linseed Survey Completed

THE Tariff Commission has concluded its work in connection with the cost of production investigation covering flaxseed and is now preparing to submit its findings to President Hoover. The President, in turn, it was explained plans to re-submit the report to the House Committee on Ways and Means, along with the findings of the Commission in other investigations involving the costs of production of halibut, hosiery, fir logs, corn, canned tomatoes and tomato paste, and window glass. The purpose of deferring executive action on these reports was said at the Commission to be due to a desire of Mr. Hoover to prevent a duplication of work which is being performed by Congress in enacting a new tariff law.

General Naval Stores Co., Inc., New York City Branch announces the appointment of Mr. Howard Goodman, 940 Seneca Street, Buffalo, New York as their exclusive Buffalo Agent.