Composition of the Oil in Palm Kernel from *Elaeis guineensis*

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ABSTRACT: The composition of oil from the outer, middle, and inner section of palm kernel had been evaluated by gas–liquid chromatography and nuclear magnetic resonance techniques. The composition was not homogenous throughout the kernel and was found to be more unsaturated in the outer kernel. The inner core of the kernel is less unsaturated, having a higher lauric content. The variation in the iodine value from the outer to inner section of the kernel suggested that composition of palm kernel oil was affected by the kernel size. This was found to be true, as small kernels tend to have oil with higher iodine value than do larger kernels.

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KEY WORDS: Composition, iodine value, palm kernel oil, size, solid fat content.

The palm fruit of *Elaeis guineensis* is a drupe comprised of an outer skin (epicarp), the pulp (mesocarp), and the nut, which includes the kernel. Oil derived from the kernel is quite different from that of from the mesocarp. The kernel oil generally has an iodine value (IV) between 16.2–19.2 (1,2), with an average of 17.8. However, the IV of kernel oil may range between 16.9–19.6 (3). A higher IV usually indicates problems with the fractionation process and the yield of the palm kernel stearin. This paper suggests that variation in the IV of the bulk oil may be mediated by the composition of the oil from different parts of the kernel.

MATERIALS AND METHODS

Three samples of palm kernels (1 kg each) were collected randomly from palm kernel processing plants in Selangor, Malaysia. The kernels were divided into large (diameter >12 mm), medium (9.5–12.5 mm), and small (<9.5 mm), sliced with a stainless-steel knife into thin flakes, and dried in an oven. Oil extraction was carried out on the samples according to Palm Oil Research Institute of Malaysia (PORIM) methods (4). The IV of the extracted oil was determined (4).

In the second experiment, the large, medium, and small kernels were sliced to separate the outer portion and the middle section (each 2-mm thick) from the remaining inner central core of the kernel. The oil was extracted from each section. Experiments were performed in duplicate.

Slip melting point, fatty acid, and triglyceride composition were analyzed according to PORIM methods (4), and solid fat content by parallel procedure of International Union of Applied Chemists (5).

RESULTS AND DISCUSSION

Palm kernels were separated into three size groups—less than 9.5 mm, 9.5–12.5 mm, and larger than 12.5 mm. The medium-sized kernels and the small-sized kernels accounted for about 54 and 24%, respectively, of the kernel population. A negative correlation was observed between kernel size and IV of kernel oil (large kernels, IV 16.5; medium kernels, IV 17.4; and small kernels, IV 18.5). This observation suggests that one of the factors affecting the IV variation in palm kernel oil is its kernel size. Further experiments were carried out to confirm this negative correlation.

Tables 1, 2, and 3 show that the negative correlation observed between kernel size and its IV is mediated by the differences in composition observed in the outer, middle, and inner section of the palm kernel. The IV of the inner kernel section of kernels are very low (10–12.9) in contrast to the values observed in the outer section (25.3–26.8). This resulted in a weighted IV mean of 16.3 in large kernels, 17.8 in medium-sized kernels, and 19.2 in small-sized kernels. Although the IV may vary widely in the kernel, the slip melting point did not depict the differences in composition. Only the outer section of the kernel shows a lower slip melting point.

The fatty acid and triglyceride compositions (Tables 2 and 3) confirmed the IV observed. A higher lauric content, together with a lower unsaturation, is found in the oil from the inner section of kernels. The triglyceride composition indicates that the outer section of kernels is generally quite different from the middle and the inner section, the C_{36} and C_{38} triglycerides being consistently lower. The oil also contains higher content of triglycerides of longer carbon chains. The weighted mean values for the IV, fatty acid, and triglyceride compositions in Tables 1–3 indicated the strong influence of kernel size upon the overall oil composition.

The solid fat content (Table 4) indicates that the oil from the outer section of the kernel is softer as is reflected by its

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TABLE 1
Oil Content and Characteristics of Palm Kernels—Effect of Size and Kernel Section

	>12.5 mm				9.5–12.5 mm				<9.5 mm			
Parameters	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]
Oil content (%)	31.4	42.9	25.7	47.5	32.6	51.3	16.1	44.8	31.8	44.4	23.8	47.6
Slip point	25.0	27.8	27.4	26.8	25.0	27.6	27.6	26.8	25.0	27.5	27.8	26.8
Iodine value	25.3	13.7	10.0	16.3	26.6	14.6	10.6	17.8	26.8	17.1	12.9	19.2

[a]Based on weighted means.

TABLE 2
Fatty Acid Composition of Palm Kernels—Effect of Size and Kernel Section

	>12.5 mm				9.5–12.5 mm				<9.5 mm			
Fatty acid	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]
6:0	0.20	0.20	0.40	0.25	0.20	0.30	0.40	0.28	0.30	0.30	0.20	0.28
8:0	2.80	5.90	5.80	4.90	2.80	4.20	5.20	3.90	3.00	3.70	3.10	3.33
10:0	2.50	2.50	3.00	2.63	2.50	3.80	4.30	3.46	2.60	3.40	3.80	3.24
12:0	43.90	53.90	56.30	51.38	42.30	52.70	55.10	49.70	44.70	49.60	54.60	49.23
14:0	16.70	16.00	16.60	16.37	16.90	16.20	16.20	16.43	16.70	16.20	17.00	16.55
16:0	9.80	7.00	6.10	7.65	10.40	7.10	6.40	8.06	10.10	8.00	7.10	8.45
18:0	1.70	1.80	2.60	1.97	1.90	1.90	2.60	2.01	2.00	2.00	2.20	2.05
18:1	19.00	11.10	8.40	12.89	20.10	12.10	8.90	14.19	18.50	14.60	10.40	14.84
18:2	3.20	1.40	0.50	1.73	2.60	1.60	0.90	1.81	1.90	2.00	1.30	1.80
18:3	0.10	0.10	0.10	0.10	0.10	0.10	0.00	0.08	0.10	0.10	0.20	0.12
20:0	0.10	0.10	0.20	0.13	0.20	0.00	0.00	0.07	0.10	0.10	0.10	0.10

[a]Based on weighted means.

TABLE 3
Triglyceride Composition of Palm Kernels—Effect of Size and Kernel Section

	>12.5 mm				9.5–12.5 mm				<9.5 mm			
Triglyceride	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]
C_{28}	3.31	1.82	3.68	2.76	4.23	1.81	2.82	2.76	4.37	1.61	2.67	2.73
C_{30}	3.31	3.83	5.69	4.14	4.03	3.68	4.99	4.00	4.27	3.17	4.39	3.80
C_{32}	5.57	8.32	10.47	7.99	5.92	7.86	9.67	7.53	5.96	6.79	8.27	6.88
C_{34}	6.52	10.39	12.34	9.66	6.94	9.97	11.74	9.28	7.09	8.75	10.28	8.60
C_{36}	17.75	24.71	25.48	22.69	18.32	24.13	25.14	22.42	18.60	22.38	24.24	21.64
C_{38}	14.64	17.45	17.02	16.43	15.20	17.63	17.23	16.78	15.16	16.90	17.49	16.50
C_{40}	9.38	9.48	8.71	9.24	9.74	9.82	9.07	9.68	9.71	9.96	9.68	9.82
C_{42}	9.43	7.51	6.19	7.77	8.93	8.01	6.70	8.10	8.53	8.80	7.41	8.38
C_{44}	7.37	4.94	3.63	5.36	6.84	5.44	4.08	5.67	6.58	6.29	4.79	6.02
C_{46}	6.12	3.63	2.37	4.09	5.71	3.98	2.77	4.35	5.70	4.88	3.48	4.80
C_{48}	6.82	3.58	2.11	4.19	5.66	3.93	2.62	4.28	5.40	5.13	3.13	4.73
C_{50}	3.56	1.82	0.96	2.14	3.32	1.61	1.16	2.09	3.55	2.21	1.66	2.50
C_{52}	3.11	1.41	0.70	1.91	2.76	1.16	0.96	1.64	2.83	1.66	1.31	1.94
C_{54}	2.81	1.11	0.65	1.53	2.30	0.96	1.06	1.41	2.16	1.46	1.21	1.62
C_{56}	0.30	0.00	0.00	0.09	0.10	0.00	0.00	0.03	0.10	0.00	0.00	0.03

[a]Based on weighted means.

TABLE 4
Physical Characteristics of Palm Kernel—Effect of Size and Kernel Section

	>12.5 mm				9.5–12.5 mm				<9.5 mm			
Solid fat content	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]	Outer	Middle	Inner	Mean[a]
10	48.70	70.00	68.80	63.00	47.00	69.10	72.90	62.51	48.10	66.90	70.50	61.78
15	35.90	61.70	58.20	52.70	34.70	59.70	61.70	51.87	35.40	56.50	61.80	51.05
20	22.60	46.60	42.50	38.01	22.30	42.30	46.30	36.42	22.00	41.70	46.40	36.55
25	4.60	22.60	17.60	15.66	3.80	18.40	22.20	14.25	4.10	9.70	13.40	8.80
30	0.30	—	—	0.09	1.30	1.40	—	1.14	1.30	1.60	1.40	1.46
35	—	—	—	0.00	1.50	0.70	—	0.85	1.30	0.90	1.10	1.07

[a]Based on weighted means.

higher IV. There are very little solids beyond 20°C. In contrast, the solid fat content of the oils from the middle and inner sections are relatively high. The high solid fat content observed at low temperatures in the oils from the inner core and its low IV suggest that this oil is a good base for producing cocoa butter substitutes (CBS). However, it does not have the optimum properties of typical palm kernel stearin. Removal of its high oleic acid content by fractionation should improve its characteristics for use as CBS.

The study concludes that variation in amount of large, medium, and small size kernels affects their IV. This also implies that proper sampling is crucial when analyzing the IV of batches of palm kernels. The average IV of a batch of kernels is based on the size of the kernels. The value will be further distorted if sampling is skewed toward the smaller or larger kernels. This effect of the size of the kernels is important in cases where plantations produce smaller or larger kernels.

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