

Authenticity of Palm Kernel Oil by Fatty Acid and Triglyceride Compositions

Siew Wai Lin

RINGKASAN

Ciri minyak isirong asli seperti Nilai Iodin, Takat Lebur Gelincir, Asid Lemak dan Komposisi Trigliserida digunakan sebagai asas bagi pengenalan sampel yang tidak diketahui atau sampel yang disyaki tercemar oleh minyak tumbuhan lain. Nisbah nilai iodin terhadap takat gelincir didapati amat berguna, tetapi pengesahan lanjut dilakukan daripada nisbah asid palmitik terhadap asid laurik/palmitik, dan daripada perhubungan antara trigliserida C48 hingga C52 dengan C36 dan C38.

Palm kernel oil (PKO) is produced from seeds of *Elaeis guineensis*. The palm also yields palm oil from the mesocarp portion of the fruit. Palm kernel oil is closely related in chemical and physical composition to coconut oil. As palm kernel oil is an important commercial commodity used in various food applications, it is useful to be able to establish its purity. In Malaysia, the weevil, *Elaeidobius kamerunicus* introduced to assist in flower pollination has led to increased number of kernels per fruit bunch. It has been suggested that the introduction of the weevil has led to production of palm kernel oil with increased iodine values. However the work by King *et al.* (1986) and Tan *et al.* (1984) did not furnish any evidence for increased iodine values. There is however a natural variation in the composition of the kernel oil produced. In this paper the composition of kernel oil is used as a basis for detection of contaminated samples of palm kernel oil.

MATERIALS AND METHODS

Materials

Samples of crude palm kernel oil were collected from 21 palm kernel crushing mills. These consisted of 100 ml of crude palm kernel oil collected daily and each week's samples were bulked for analysis. Sampling were carried out for about 8 weeks. The 21 palm kernel crushing mill

were located throughout Malaysia. Refined palm oil, palm olein, palm kernel olein were obtained from local refineries.

Slip melting point was by AOCS CC3-25 and Iodine value by Bs 684 2.13. Fatty acid and triglyceride composition were carried out as follows:

Fatty Acid Composition

The fatty acids were converted to their methyl esters by dissolving 0.05 g of the oil in 0.95 ml of petroleum-ether or hexane in a screw cap vial. 0.05 ml of sodium methanolate (1 Normal) was added. The vial was shaken vigorously for six seconds. The solution which was clear turned cloudy due to sodium glyceroxide formation.

The fatty acid composition of the samples were analysed as their methyl esters on a glass column (1.5 m long, 3 mm i.d) of 10% SP 2330 on 100/120 mesh supelcoport. The instrument used was a Perkin Elmer Sigma 1 gas chromatography system. The column was temperature programmed from 100°C to 195°C with the following rates of increase: 100°C to 145°C at 4.0°C/minute, 145°C to 165°C at 3.0°C per minute, 165°C to 185°C at 2.0°C/minute and 185°C to 195°C at 1.0°C/minute. The column was then held

at 195°C for two minutes before resetting the temperature programme for the next run. Detector temperature was set at 220°C while injector temperature was at 200°C. The detector response was checked daily by injecting a standard mixture of C6—C18 methyl esters.

Triglyceride Composition

Triglyceride Analysis by Carbon Number

A Perkin Elmer Sigma 1 Gas chromatograph was used. 5% solution of the samples in chloroform were prepared for analyses. The glass column used was 46 cm × 3 mm i.d. containing 3% OV-1 on 100—120 Gas Chrom Q. The carrier gas was nitrogen at a flow rate of 60—80 ml per minute. Detector and injector temperatures of 370°C were used. The column was programmed from 280°C to 345°C per minute with initial and holding times at the starting and final temperatures set at three

minutes each. Response factors were determined using a standard palm kernel oil reference previously calibrated against a mixture of pure saturated triglycerides.

RESULTS

Iodine Value and Slip Melting Point

The PKO samples have a slip melting point (SMP) of 25.9 to 28.0 while Iodine value (IV) were from 16.2—19.2. There is a poor correlation between Iodine value and slip melting point (*Figure 1*) as both short chain acid and unsaturated acids have an influence on melting point while only unsaturated acids affect the iodine value. Iodine value:Slip melting point ratio for palm kernel oil range from 0.589—0.711. The mean and standard deviation are 0.65 and ±0.02 respectively. Thus one composition as given with an average palm oil may be detected at 3%—5% level.

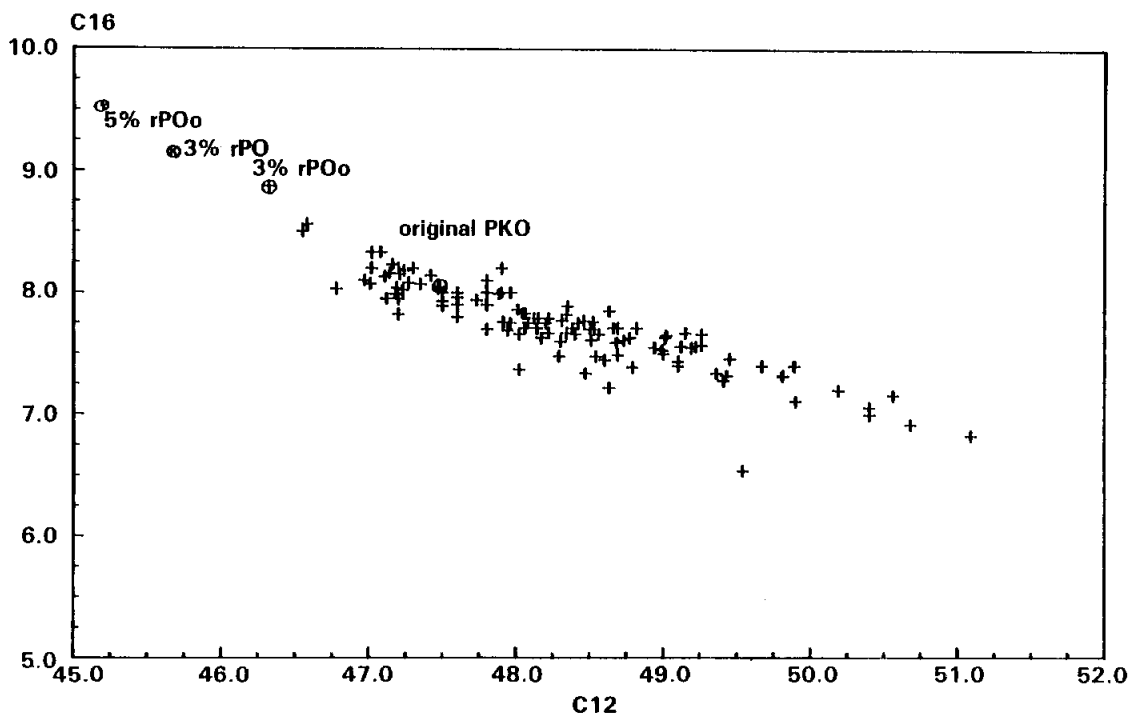


Figure 1. C12 vs C16 Fatty Acids — Detection of Contamination of PKO

TABLE 1.
IODINE VALUE: SLIP MELTING POINT
(IV: SMP) RATIOS

a) IV: SMP Ratio for Malaysian Palm Kernel Oil and Palm Oil

	Mean	Standard Deviation	Observed Range Min—Max
PKO	0.65	0.02 (n = 109 samples)	0.589–0.711
CPO/RPO	1.479	0.08 (n = 118 samples)	1.256–1.678

b) IV: SMP Ratio for Adulterated Palm Kernel Oil Samples

Code	Ratio	I.V./SMP. (Experimental)
PKO 1		0.692
CPO 150		1.933
PKO 1+1% CPO 150		0.699
PKO 1+2% CPO 150		0.707
PKO 1+3% CPO 150		0.702
PKO 1+5% CPO 150		0.746
PKO 2		0.679
RPO 1825		1.400
PKO 2+1% RPO 1825		0.695
PKO 2+2% RPO 1825		0.685
PKO 2+3% RPO 1825		0.732
PKO 2+5% RPO 1825		0.742
PKO 2+10% RPO 1825		0.814
PKO 3		0.689
Crude Palm Kernel Oil		1.206
PKO 3+1% CPK Olein		0.714
PKO 3+2% CPK Olein		0.721
PKO 3+3% CPK Olein		0.742
PKO 3+5% CPK Olein		0.751
PKO 3+10% CPK Olein		0.763
PKO 3+20% CPK Olein		0.801

Fatty Acid Composition

The mean composition for PKO are shown in *Table 2*. Various plots of fatty acids (C12 versus C16, C12 versus C18:2, C12 versus total C18, and C14 versus C18:1 C16 versus C12/C16) were attempted to help distinguish contaminated samples from genuine PKO. The best correlations were obtained from plots of C12 versus C16 fatty acids and C16 versus C12/C16 (*Figures 1*

TABLE 2.
FATTY ACID COMPOSITION (%) OF
MALAYSIAN PALM KERNEL OIL

Composition	Mean	Standard Deviation	Observed Range Min—Max
C6	0.3	0.07	0.1– 0.5
C8	4.4	0.47	3.4– 5.9
C10	3.7	0.24	3.3– 4.4
C12	48.3	0.94	46.3–51.1
C14	15.6	0.33	14.3–16.8
C16	7.8	0.36	6.5– 8.9
C18	2.0	0.19	1.6– 2.6
C18:1	15.1	0.24	13.2–16.4
C18:2	2.7	0.24	2.2– 3.4
Others	0.2	0.09	tr– 0.9

and 2). Samples which fall out of these patterns were considered as suspect samples. As examples, samples of PKO contaminated with 3% and 5% palm oil (rPO) and palm olein (rPOo) were detectable as shown in *Figures 1* and *2*. Such samples showed C16: C12/C16 values which begins to deviate to the higher side of C16 and low C12/C16 axis.

TABLE 3.
TRIGLYCERIDE COMPOSITION (%) OF
MALAYSIAN PALM KERNEL OIL

Carbon Number	Mean	Standard Deviation	Observed Range Min—Max
C28	0.55	0.27	0.1-- 1.9
C30	1.25	0.26	0.8– 2.1
C32	6.34	0.54	5.6– 6.8
C34	8.43	0.49	7.7– 9.5
C36	23.33	1.48	19.1–26.2
C38	16.96	0.64	14.8–18.5
C40	9.79	0.36	9.3–10.8
C42	9.10	0.40	8.3–10.1
C44	6.56	0.33	5.9– 7.2
C46	5.14	0.34	4.7– 5.8
C48	5.79	0.53	4.8– 6.9
C50	2.30	0.31	1.5– 3.4
C52	2.17	0.34	1.7– 3.3
C54	2.43	0.45	1.8– 3.7

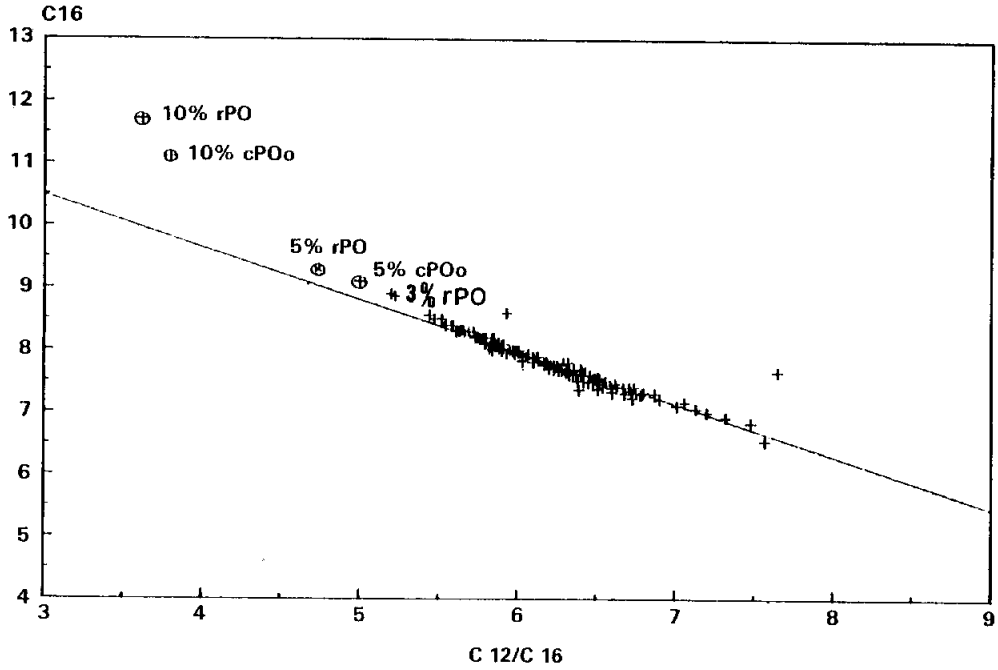


Figure 2. C12 vs C12/C16 — Detection of Contamination of PKO

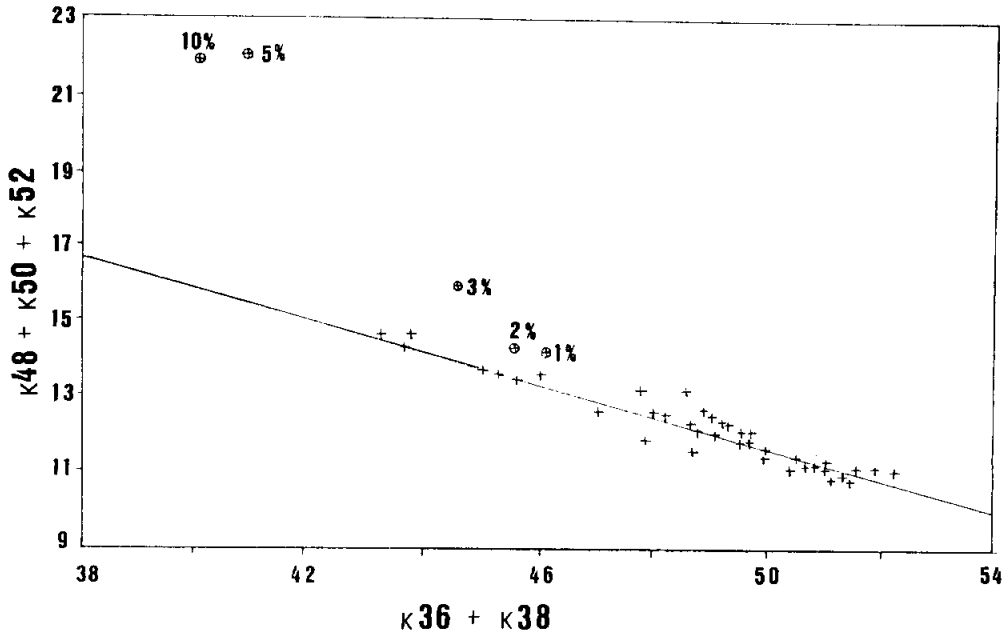


Figure 3. K48+K50+K52 vs K36+K38 — Detection of Contamination of PKO With Palm Oil

Triglyceride Composition

Major triglyceride in PKO is C36, in keeping with the high lauric acid content. There are also significant amounts of C34, C38, C40 and C42 (Table 3). Various plots of mixtures of triglycerides were attempted to detect contaminated samples (C36 versus C52, C36 + C38 versus C52, C36 versus C50). All of these showed poor correlations. The best relationships were obtained from a plot of K48 + K50 + K52 versus K36 + K38 where K values were obtained from normalization of triglycerides with carbon number (36 to C52, forming new K36 to K52 values). Figure 3 showed that K48 + K50 + K52 decreases with increase in K36 + K38. Samples contaminated with 3%–10% palm oil could be easily detected from this relationship. However samples contaminated with 1%–2% showed some difficulties in detection.

DISCUSSION

Although iodine value and slip melting point may be used to detect contamination at higher levels, the poor correlations between iodine value and slip point indicated that detection of lower contamination levels (< 5%) with palm oil products such as palm olein or palm kernel olein may be difficult. This, however depended on the iodine value of the authentic kernel oil and that of the contaminant. Using the average IV: SMP ratios of palm oil at 0.65 and that of PKO at 1.479, the detectable level of contamination with palm oil is calculated to be 7.5%. Thus combinations of analyses such as fatty acid and triglyceride composition may be obtained to further confirm presence of contamination.

The palmitic acid plotted against a ratio of lauric acid/palmitic acid gave a linear correlation of $r^2 = 0.907$. Similar usage of triglyceride compositions such as the plot of K48 + K50 + K52 versus K36 + K38 also helped further in checking the authenticity of palm kernel oil. For detection of coconut oils in PKO, King *et al.*, proposed

normalizing C30 to C42 to give K30 to K42 and plotting K34 + K40 versus K36 + K38.

In other studies by King *et al.* (1986) the use of sterol compositions were suggested for differentiation between palm kernel oil and coconut oil. Other possibilities include tocopherol analyses by HPLC. As tocopherol content (tocopherols and tocotrienols) are absent or at most present in minute quantities as compared to other vegetable oils, this parameter could be an additional indicator in detection of authenticity of PKO.

CONCLUSION

The parameters such as iodine value, slip melting point, fatty acid composition and triglyceride composition provide useful checks for detecting and confirming contaminated samples of palm kernel oil. The iodine value: slip melting point ratio, plots of palmitic acid to lauric acid and the relationships between triglycerides C48 to C52 and C36 and C38 were transformed to give patterns expected of authentic palm kernel oil samples.

ACKNOWLEDGEMENTS

The author thanked the Director-General, PORIM for permission to publish this paper. Thanks also to ex-TAR college student Ms. Tan Voon Che who carried out her training in PORIM in 1984.

REFERENCES

- KING, H and ZILKA, S A (1986). Authenticity of Edible Vegetable oils and Fats. Part IX, Palm kernel oil. Leatherhead Food R.A. Research Reports No. 559.
- TAN, B K; ONG, S H; SIEW, W L; TAN, Y A and CHOW, M C (1984). Effects of the Weevil on the Composition, Properties and Quality of Palm Oil and Palm Kernel Oil. *Proceedings of the Symposium on Impact of the Pollinating Weevil on the Malaysian Oil Palm Industry.*