IDENTITY CHARACTERISTICS OF MALAYSIAN PALM OIL PRODUCTS: FATTY ACID AND TRIGLYCERIDE COMPOSITION AND SOLID FAT CONTENT

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An earlier paper dealt with the identity characteristics of iodine value, slip melting point, cloud point, refractive index and apparent density of palm oil products. This paper concludes the work with a description of the fatty acid and triglyceride composition and the solid fat content of these products. The relationships between the contents of palmitic and oleic acids and between C48, C50 and C52 triglycerides were plotted graphically. A plot of palmitic acid versus oleic acid gave a linear relationship. Linearity was also observed in the plot of C52 versus C48. The graphs were useful for evaluation of palm oils contaminated with other oil products. The fatty acid composition of palm oil and palm stearin were generally similar to oils surveyed in 1980. Some differences were noted in the dioleopalmitin or the C52 triglycerides of palm oil which were lower in values in the present work. Similarly, triglycerides of the palm oleins reflected the lower iodine value of the oil. The present survey shows a slight compositional shift towards lower iodine values in palm oil and palm oleins while palm stearins remain widely variable in composition.

INTRODUCTION

This paper reports the second part of the survey carried out on the identity characteristics of refined palm oil products at export locations, dealing with their fatty acid and triglyceride compositions and solid fat content. The first part of the survey, reported by Siew *et al.* (1992), covered results on iodine value, slip melting point, cloud point, refractive index, and apparent density.

EXPERIMENTAL

The samples collected for the survey were detailed by Siew *et al.* (1992). Fatty acid and triglyceride compositions were determined by gas liquid chromatography, and solid fat content by wide-line NMR. All analyses were carried out using the PORIM Test Methods (1988).

RESULTS AND DISCUSSION

Fatty Acid Compositions

Palm Oil (Table 1)

The mean and range for each fatty acid were generally similar to those found in the 1980 survey (Tan, B K and Oh, C H, 1981, 1981a), although the mean palmitic acid content (44.1%) was slightly higher than before (44.0%), and the oleic acid content a little lower (39.0% as against 39.2%).

The fatty acid composition of the Malaysian palm oil shows that its unsaturation (mean 50.1%) is intermediate between that of Sumatran and Brazilian palm oil. The Sumatran oil has an average unsaturation of 48.4% while that of the Brazilian oil is 51.4% (Klagge *et al.*, 1990).

Palm Olein (Table 2)

The fatty acid composition of palm olein showed some variations when compared with the results of the previous survey in 1980 (Tan and Oh, 1981, 1981a). Thus the mean for palmitic acid was 40.9% compared with 39.8% in 1980. Moreover the range, 36.8%–43.3% was wider than that (37.9%–41.7%) in the 1980 survey. Conversely, the mean for oleic acid was 41.5% as against 42% in the earlier survey.

Palm Stearin (Table 3)

A wide variation was seen in the fatty acid composition of the stearins. Generally the ranges for the major acids, palmitic and oleic, were fairly similar to those in the previous survey.

Triglyceride Compositions

Palm Oil (Table 4)

The triglyceride compositions are of course related to the fatty acid compositions. The slightly higher palmitic acid content in the present survey was reflected in the higher mean C48 triglyceride, which is represented mainly by tripalmitin. The lower oleic acid was reflected in the lower percentage of C52 triglycerides with dioleopalmitin as the main component (37.2% as against 40.5% in the 1980 survey).

Palm Olein (Table 5)

The variations in triglyceride composition again paralleled with the fatty acid compositions. The lower oleic acid content was reflected in the lower percentages of C50 and C52 triglycerides. Both the mean and the range differed greatly from those in the 1980 survey. The mean and range of the C50 triglycerides were 39.5% (42.0%) and 37.9% 40.9% (37.7%–45.4%) respectively, while the mean and range of the C52 were 42.7% (45.7%) and 41.9%- 43.7%, (43.3%–51.3%) respectively, with the bracketed figures being the corresponding 1980 values. The wider range observed in the previous work reflected the wider iodine value range noted in the samples.

Palm Stearin (Table 6)

Some differences were noted in the triglyceride compositions, the main ones being in the C48, C52 and C54 triglycerides. The ranges observed in this survey varied quite considerably from those in the 1980 survey. For example, C48 triglycerides varied from 12.2%–55.8% in 1980 compared to 14.3% -34.7% in the present survey. The C50 varied from 33.6%–49.8% compared to 37.9%–46.5%. A larger difference was noted in the C52 which showed 5.1%–37.3% in 1980 and 16.4%–31.5% at present. Thus more unsaturated triglycerides were noted in the palm stearin in the present work which complemented earlier results in the palm olein.

TABLE 1. FATTY ACID COMPOSITION (%) OF REFINED PALM OIL[a]

	C12	C14	C16	C18:0	C18:1	C18:2	C18:3	C20:0
Mean	0.24	1.11	44.14	4.44	39.04	10.57	0.37	0.38
Min	0.10	1.00	40.90	3.80	36.40	9.20	0.05	0.20
Max	0.40	1.40	47.50	4.80	41.20	11.60	0.60	0.70
Range	0.30	0.40	6.60	1.00	4.80	2.40	0.55	0.50
S.d.	0.051	0.071	1.054	0.151	0.904	0.385	0.095	0.086
CV(%)	21.4	6.4	2.4	3.4	2.3	3.6	25.7	22.7

[a]Number of samples, 244

TABLE 2. FATTY ACID COMPOSITION (%) OF REFINED PALM OLEIN[a]

	C12	C14	C16	C18:0	C18:1	C18:2	C18:3	C20:0
Mean	0.27	1.09	40.93	4.18	41.51	11.64	0.40	0.37
Min	0.20	0.90	36.80	3.70	39.80	10.40	0.10	0.30
Max	0.40	1.20	43.20	4.80	44.60	12.90	0.60	0.50
Range	0.20	0.30	6.40	1.10	4.80	2.50	0.50	0.30
S.d.	0.053	0.066	0.948	0.173	0.838	0.362	0.121	0.066
CV(%)	19.2	6.1	2.3	4.1	2.0	3.1	30.3	17.8

[a]No. of samples, 238

TABLE 3. FATTY ACID COMPOSITION (%) OF REFINED PALM STEARIN[a]

	C12	C14	C16	C18:0	C18:1	C18:2	C18:3	C20
Mean	0.18	1.27	56.79	4.93	29.0	7.23	0.09	0.24
Min	0.10	1.10	49.80	3.90	20.40	5.00	0.00	0.00
Max	0.30	1.70	68.10	5.60	34.40	8.90	0.50	0.50
Range	0.20	0.60	18.30	1.70	14.00	3.90	0.50	0.50
S.d.	0.046	0.107	3.576	0.266	2.730	0.829	0.078	0.172
CV(%)	25.8	8.4	6.3	5.4	9.4	11.5	86.9	71.5

[a]Number of samples, 205

TABLE 4. TRIGLYCERIDE COMPOSITION (%) OF REFINED PALM OIL[a]

	C44	C46	C48	C50	C52	C54	C56
Mean	0.07	1.18	8.08	39.88	38.77	11.35	0.59
Min	0.00	0.70	4.70	38.90	33.10	10.3	0.50
Max	0.20	2.00	9.70	41.60	41.10	12.10	0.80
Range	0.20	1.30	5.00	2.70	4.00	1.80	0.30
S.d.	0.06	0.19	0.72	0.54	0.62	0.37	0.10
CV(%)	84.8	16.7	8.9	1.3	1.6	3.3	17.1

[a]Number of samples, 244

TABLE 5. TRIGLYCERIDE COMPOSITION (%) OF REFINED PALM OLEIN[a]

	C44	C46	C48	C50	C52	C54	C56
Mean	0.09	0.77	3.28	39.52	42.74	12.80	0.67
Min	0.00	0.40	2.40	37.90	41.90	11.80	0.50
Max	0.30	1.40	3.90	40.90	43.70	13.50	11.00
Range	0.30	1.10	1.50	13.00	1.80	1.70	0.50
S.d.	0.081	0.266	0.318	0.549	0.435	0.368	0.113
CV(%)	94.5	34.5	9.7	1.4	1.0	2.9	17.1

[a]Number of samples, 238

TABLE 6. TRIGLYCERIDE COMPOSITION (%) OF REFINED PALM STEARIN[a]

	C44	C46	C48	C50	C52	C54	C56
Mean	0.13	3.13	23.72	40.31	25.28	6.86	0.45
Min	0.00	1.50	14.30	37.90	16.40	4.20	0.2
Max	0.40	6.80	34.70	46.50	31.50	9.00	0.7
Range	0.40	5.30	20.40	8.60	15.10	4.80	0.50
S.d.	0.097	0.861	4.405	1.244	3.367	1.146	0.115
CV(%)	72.2	27.5	18.6	3.1	13.3	16.7	25.4

[a]Number of samples, 205

TABLE 7. SOLID FAT CONTENT (%) OF REFINED PALM OIL[a]

	10°C	15°C	20°C	25°C	30°C	35°C	40°C
Mean	53.7	39.1	26.1	16.3	10.5	7.9	4.6
Min	46.1	33.4	21.6	12.1	6.1	3.5	0.0
Max	60.8	50.8	31.3	20.7	14.3	11.7	8.3
Range	14.7	17.4	9.7	8.6	8.2	8.2	8.3
S.d.	2.37	2.19	2.04	1.59	1.41	1.35	1.57
CV(%)	4.4	5.6	7.8	9.8	13.3	17.2	33.9
Mean[b]	50.3	35.2	23.2	13.7	8.5	5.8	3.5

[a]Number of samples, 244
[b]1980 survey, refined palm oil

TABLE 8. SOLID FAT CONTENT OF (%) REFINED PALM OLEIN[a]

	10°C	15°C	20°C	25°C
Mean	38.3	19.9	5.7	2.1
Min	23.9	10.7	0.0	0.0
Max	45.5	25.9	9.0	4.3
Range	21.6	15.2	9.0	4.3
S.d	3.29	2.32	1.41	1.02
CV (%)	8.6	11.6	24.9	49.6
Mean[b]	37.0	19.2	5.9	-
Min[b]	28.1	13.3	2.9	-
Mix[b]	51.8	24.9	8.6	-

[a]Number of samples, 238
[b]1980 survey, refined palm olein

TABLE 9. SOLID FAT CONTENT (%) OF REFINED PALM STEARIN[a]

	10°C	15°C	20°C	25°C	30°C	35°C	40°C	45°C	50°C	55°C
Mean	76.0	68.9	60.2	50.6	40.4	34.3	28.1	22.4	12.5	0.6
Min	49.5	37.2	25.2	15.8	11.2	7.2	6.1	1.0	0.0	0.0
Max	84.1	79.0	71.2	63.5	55.0	46.6	38.0	32.2	21.3	9.1
Range	34.6	41.8	46.0	47.7	43.8	39.4	31.9	31.2	21.3	9.1
S.d.	5.18	6.34	7.35	8.01	7.57	6.82	6.26	5.74	5.21	1.53
CV(%)	6.8	9.2	12.2	15.8	18.7	19.9	22.2	25.6	41.8	254.9
Min[b]	54.2	41.9	31.3	20.2	16.4	12.5	7.4	2.7	0	0
Max[b]	91.1	90.9	87.4	81.9	73.5	65.0	56.6	48.6	39.7	19.3

[a]Number of samples, 205
[b]1980 survey, crude palm stearin

Solid Fat Content (*Tables 7,8,9*)

The solid fat contents of refined palm oil and palm olein remained quite close to those observed in 1980. No comparison could be made for the stearin as the present data were from refined stearin while data for crude stearin were shown in 1980. The figures for the 1980 survey are given in the corresponding tables. As is expected the increase in solids is observed in refined oils.

The solid fat content of refined stearin samples at different temperatures varied over a wide range as expected from their fatty acid and triglyceride compositions *(Table 9)*.

Relationships between Fatty Acids

Palmitic Acid against Oleic Acid

Figure 1 shows the relationship between palmitic and oleic acid contents for all the products. As the oleic acid content is increased the palmitic acid content is reduced.

Another way of presenting the relationship is by plotting the content of palmitic acid (C16) against the ratio of palmitic to oleic acid (C16/C18:1). This was done in *Figure 2*. Good correlations were observed for all the products: palm oil, palm olein and palm stearin. The graphs may

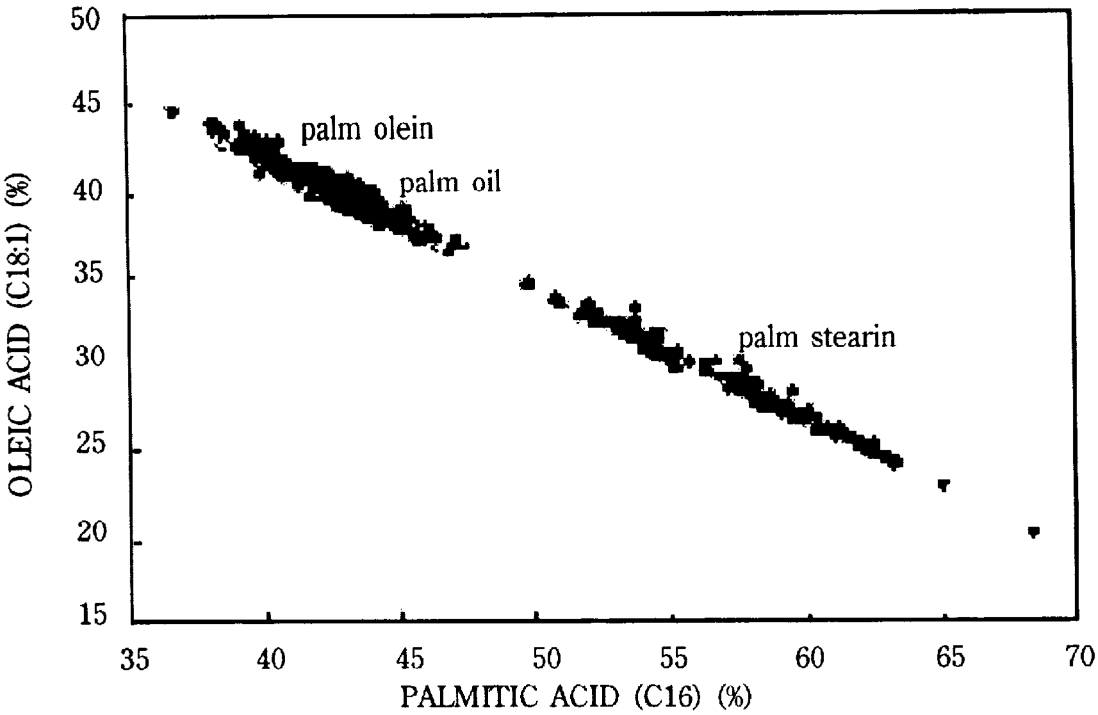

Figure 1. Palmitic Acid (C16) Versus Oleic Acid (C18:1).

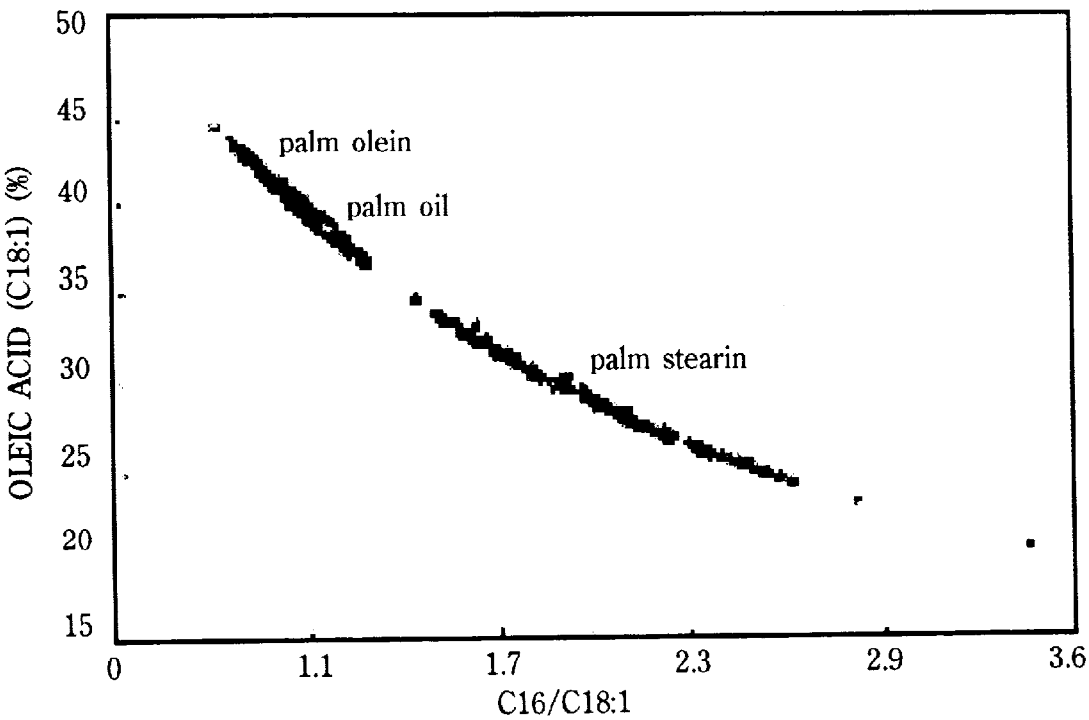

Figure 2. C16/C18:1Versus Oleic Acid (C18:1).

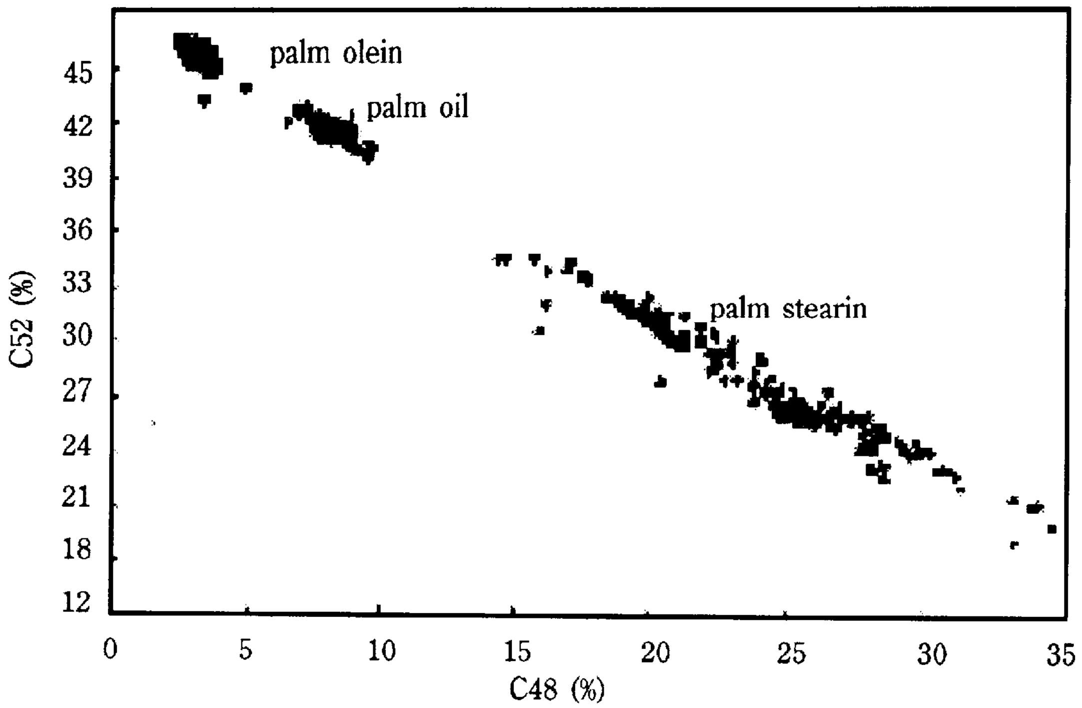

Figure 3. C48 Versus C52 Triglyceride Palm Oil Products.

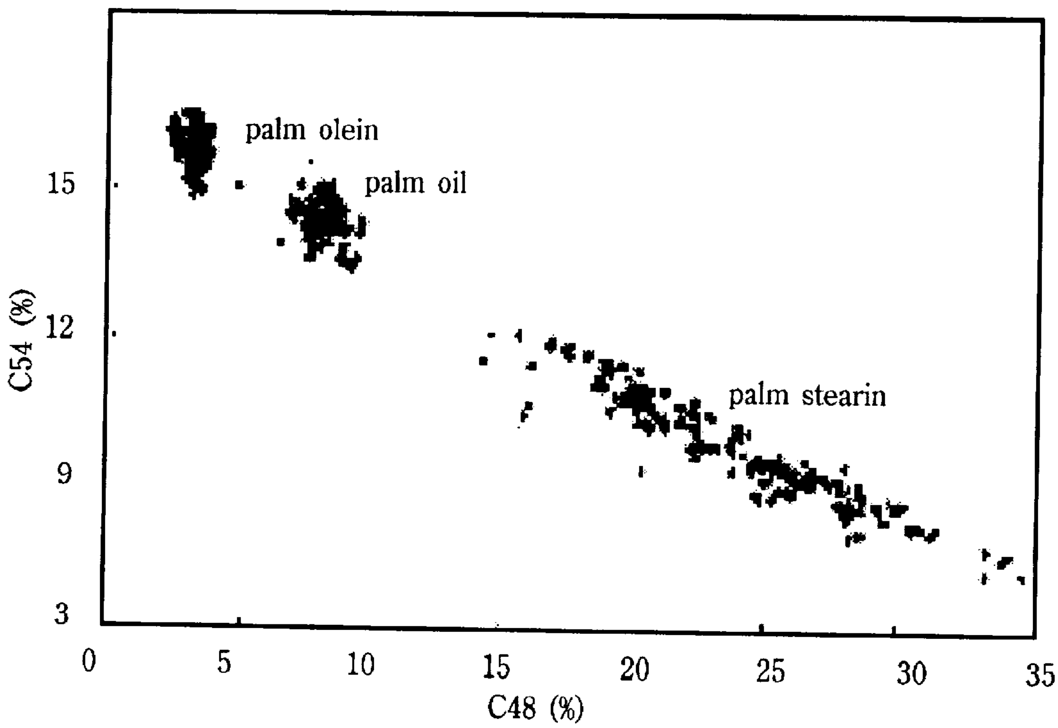

Figure 4. C48 Versus C54 Triglyceride Palm Oil Products.

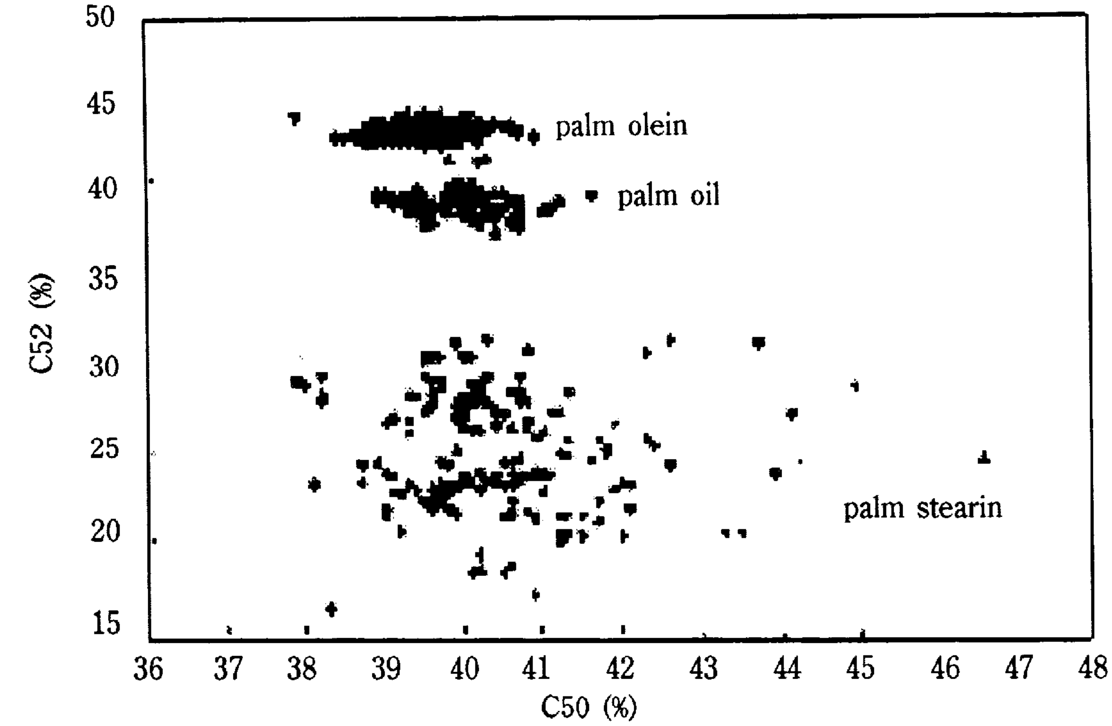

Figure 5. C50 *Versus C52 Triglyceride Palm Oil Products.*

be used as one of the criteria to detect the presence of other oils in palm oil or its fraction because in such cases, the contents of C16:0 and C18:1 acids will result in the plot of C16:0 against the ratio C16:0/C18:1 falling out of the linear relationship shown in *Figure 2.*

C48 versus C52 Triglycerides *(Figure 3)*

Good correlations were observed whereby decreases in C52 triglycerides, mainly palmitodioleo triglycerides were accompanied by significant increases in the C48 triglycerides. The relationship can be used to detect admixture of other oil products with palm oil, but not palm oil fractions in whole palm oil, as the addition of stearin or olein does not upset the linearity of the relationship. Similar work has been carried out by King and Sibley (1984).

C48 versus C54 Triglycerides *(Figure 4)*

As with C48 and C52, the C48 versus C54 triglycerides of olein, palm oil and stearin taken together indicated a good correlation. However closer examination revealed that in the case of palm olein and palm oil, the graph of C48 versus C54 both showed wider scatter whereas in the case of stearin, the scatter was less.

C50 versus C52 Triglycerides *(Figure 5)*

The relationship between these two sets of triglycerides resulted in different positions for palm oil, palm olein and palm stearin on the graph. It is of interest also to note that while C48 versus C54 showed a linear relationship for palm stearin products, C50 versus C52 showed a wide scatter. The C50 versus C52 also showed that for palm oil and palm olein, the contents of C50 were fairly constant, ranging within 38% to 41% whereas the C52 contents were distinctly different. For palm stearin, the C50 content showed only a slightly wider range from 38% to 44%. This indicated that in normal fractionation process, the C50, whose main constituent is oleodipalmitin (POP) is quite evenly distributed amongst the fractions.

CONCLUSIONS

The composition studies showed some slight differences between the oils of the 1980 survey and the present samples. This was mainly reflected in the higher C48 and lower C52 triglycerides of palm oil from the present study. The composition of the oleins reflected the lower iodine value as shown in Siew *et al.* (1992). The slight differences in the composition of the palm oils from the two surveys could be due to slight differences in planting materials and age factor, and the variation in the oleins and stearins while reflecting such changes in planting materials are however also due to process variations.

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REFERENCES

KING, B and I SIBLEY (1984). Authenticity of Edible Oils and Fats. Part II Palm oil and Palm Oil Fractions. Leatherhead Food RA Research Reports No. 462.

KLAGGE, P and SEN GUPTA, A R (1990) *Fett. Wiss Technol. 92*(8), 315-319.

PORIM Test Methods (1988). Palm Oil Research Institute of Malaysia.

TAN, B K and OH, C H (1981) Malaysian Palm Oil Chemical and Physical Characteristics. *PORIM Technology No 3.*

TAN, B K and OH, C H (1981a) Olein and Stearins from Malaysian Palm Oil — Chemical and Physical Characteristics. *PORIM Technology No. 4.*

SIEW, W L; CHONG, C L ; TAN, Y A; TANG, T S and OH, C H (1992). Identity characteristics of Malaysian Palm Oil Products. *ELAEIS, 4: 2* .pp. 79–85.