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CLARITY OF SINGLE AND DOUBLE FRACTIONATED PALM OLEINS

Keywords: Fractionated palm oleins; clarity; cloud point; fatty acid composition

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The clarity of single and double fractionated palm oleins of different iodine values (IV) were studied. At 5°C, all samples crystallized within a day; two samples (DfPOo IV 65 and 67) were cloudy while the rest became solid. On the other hand, all samples were clear at 20°C except SfPOo IV 56 and 58. Samples DfPOo IV 62, 65 and 67 remained clear at 20°C until day 60. Fatty acid composition and the content of diglycerides seemed to have an influence on the clarity of palm oleins.

INTRODUCTION

Palm oleins that are now readily available in the market are obtained by single fractionation and are characterized by the composition and properties as shown in *Table 1* (Tan and Oh, 1981). In view of their high solid content, they have limitations for use in temperate climates. However, with the recent developments in fractionation technology, it is now possible to produce double fractionated palm oleins with higher iodine values, lower cloud points and better cold stability (Tan, 1989; Deffense and Tirtiaux, 1989). The present study compares the clarity of single fractionated palm oleins against those obtained by double fractionation at 20°C and below.

MATERIALS AND METHODS

Samples of single and double fractionated palm oleins were obtained from local refineries. They included single fractionated palm olein (SfPOo) of iodine values (IV) 56, 58 and 60. The double fractionated palm oleins (DfPOo) were of IV 60, 62, 65 and 67. Samples were bottled and placed in incubators set at 5, 10, 15 and 20°C. Clarity of the samples were determined daily. Cloud points were determined according to AOCS Method No. Cc

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6-25 (AOCS, 1987). Fatty acid composition was determined according to PORIM Test Methods. Morphology of the crystals formed were observed using a Nikon polarizing microscope Model HFX-Dx (Tokyo, Japan).

TABLE 1. CHARACTERISTICS OF PALM OLEIN[a]

	Range	Mean
Iodine Value (Wijs)	56.1 - 60.6	58.0
Slip Melting Point °C	19.4 - 23.5	21.6
Cloud Point °C	6.0 - 11.5	8.8
Solid Fat Content (%)		
5°C	43.6 - 61.0	51.1
10°C	28.1 - 51.8	37.0
15°C	13.3 - 24.9	19.2
20°C	2.9 - 8.6	5.9
Fatty Acid Composition (%)		
12:0	0.1 - 1.1	0.2
14:0	0.9 - 1.4	1.0
16:0	37.9 - 41.7	39.8
16:1	0.1 - 0.4	0.4
18:0	4.0 - 4.8	4.4
18:1	40.7 - 43.9	42.5
18:2	10.4 - 13.4	11.2
18:3	0.1 - 0.6	0.6
20:0	0.2 - 0.5	0.4

[a]Tan and Oh, 1981

RESULTS AND DISCUSSION

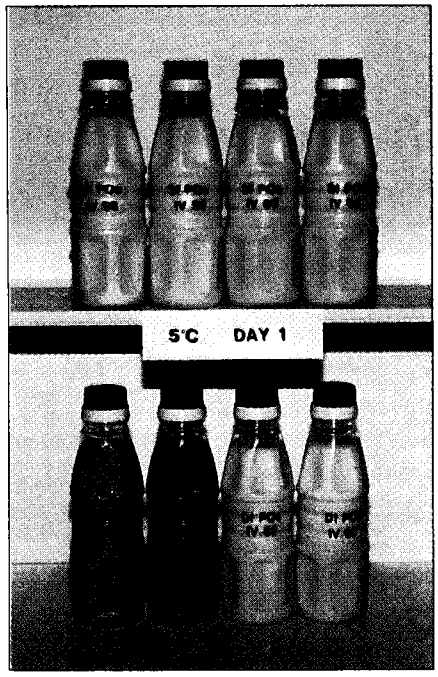
At 5°C, all samples of SfPOo and DfPOo crystallized within a day (*Figure 1a*). Most of the samples became solid except DfPOo IV 65 and 67. The latter could be due to the fact that DfPOo IV 65 and 67 had lower amounts of saturates (C16:0 and C18:0) but more of the mono- and polyunsaturates namely C18:1 and C18:2 than other samples (*Table 2*); their cloud points were also much lower than other samples (*Table 3*). These observations agree with a previous study by Swe *et al.* (1994) which showed that triglycerides containing saturated fatty acids such as palmitic oleic stearic (POS) and oleodipalmitin (POP) were high in the cloud material obtained during storage of palm olein.

Crystallization also occurred at 10°C but to a lesser extent compared to storage at 5°C. Only SfPOo IV 56 and 58 and DfPOo IV 60 became solid while SfPOo IV 60 and 62 were semi-solid. It was noted that DfPOo IV 62, 65 and 67 were apparently clear at 10°C on day 1 (*Figure 1b*). Better clarity was observed in samples stored at 15°C. On day 1, SfPOo IV 60, 62 and DfPOo IV 62, 65 and 67 were clear (*Figure 1c*). Further improvement in clarity was noted in all samples stored at 20°C, with the exception of SfPOo IV 56 and 58 (*Figure 1d*).

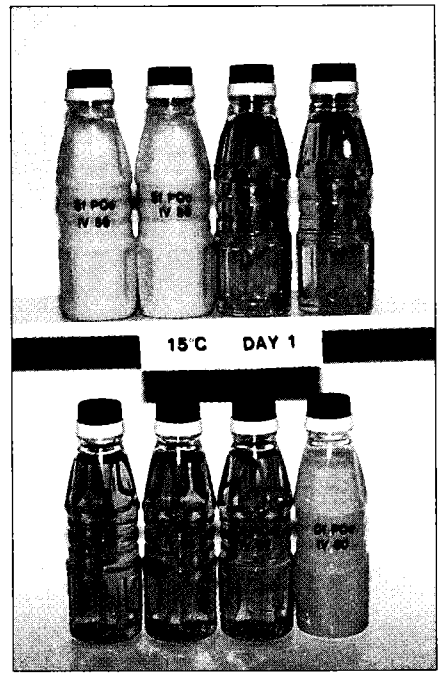
On day 3, samples DfPOo IV 62, 65 and 67 stored at 15°C were still clear while SfPOo IV

TABLE 2. FATTY ACID COMPOSITION OF SINGLE AND DOUBLE FRACTIONATED PALM OLEINS

Fatty acid composition (%)	SfPOo				DfPOo			
	IV 56	IV 58	IV 60	IV 62	IV 60	IV 62	IV 65	IV 67
C12:0	0.3	0.4	0.4	0.5	0.3	0.4	0.3	0.3
C14:0	0.9	1.0	1.0	1.1	0.9	1.0	0.9	1.0
C16:0	39.0	37.7	33.7	33.0	34.7	32.5	30.4	29.6
C18:0	4.0	4.1	3.8	3.8	4.0	3.8	3.5	3.3
C18:1	43.2	43.6	46.2	46.4	45.8	47.4	48.2	48.7
C18:2	11.8	12.4	13.9	14.2	13.4	13.9	15.5	16.0
C18:3	0.2	0.2	0.3	0.2	0.2	0.3	0.4	0.4
C20:0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Others	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2



(a)



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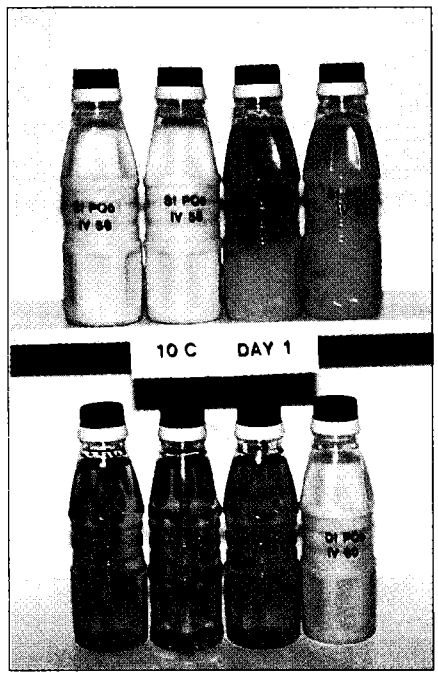

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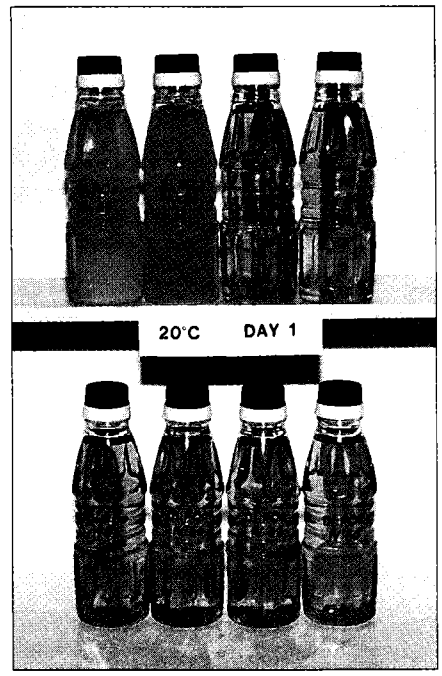

(d)

Figure 1. Appearance of single and double fractionated palm oleins of different IVs stored for 1 day at a) 5°C, b) 10°C, c) 15°C and d) 20°C

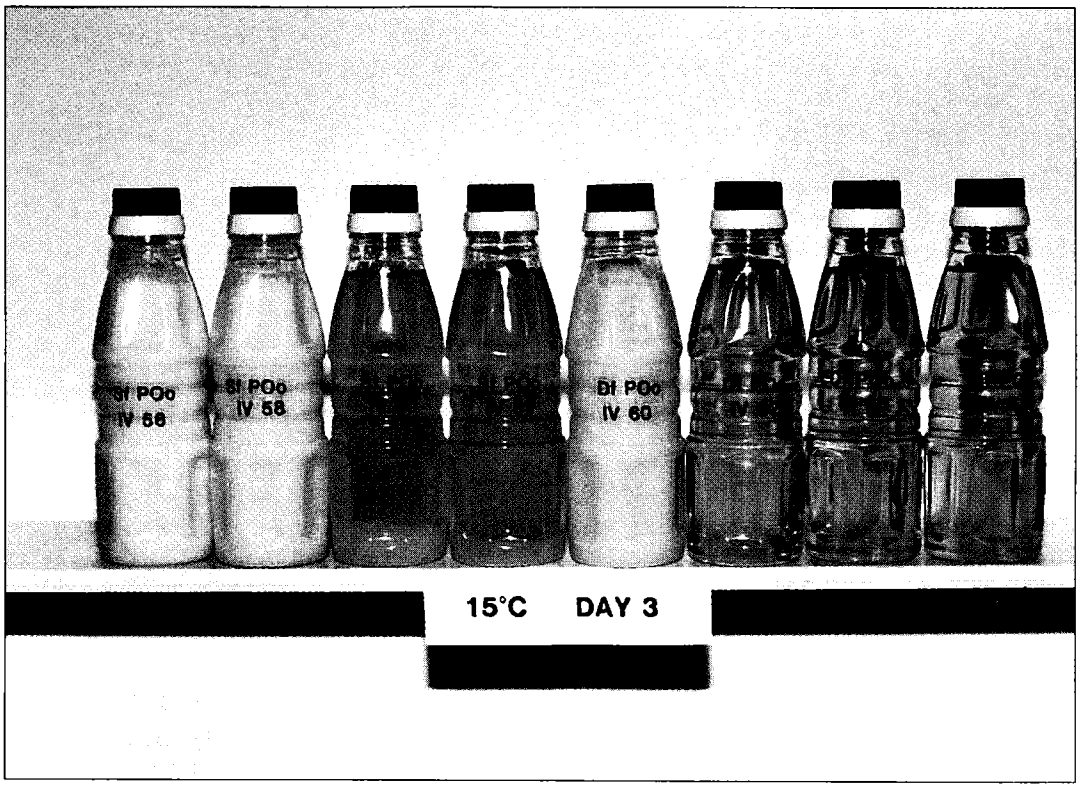

Figure 2. Appearance of single and double fractionated palm oleins of different IVs stored at 15°C for 3 days

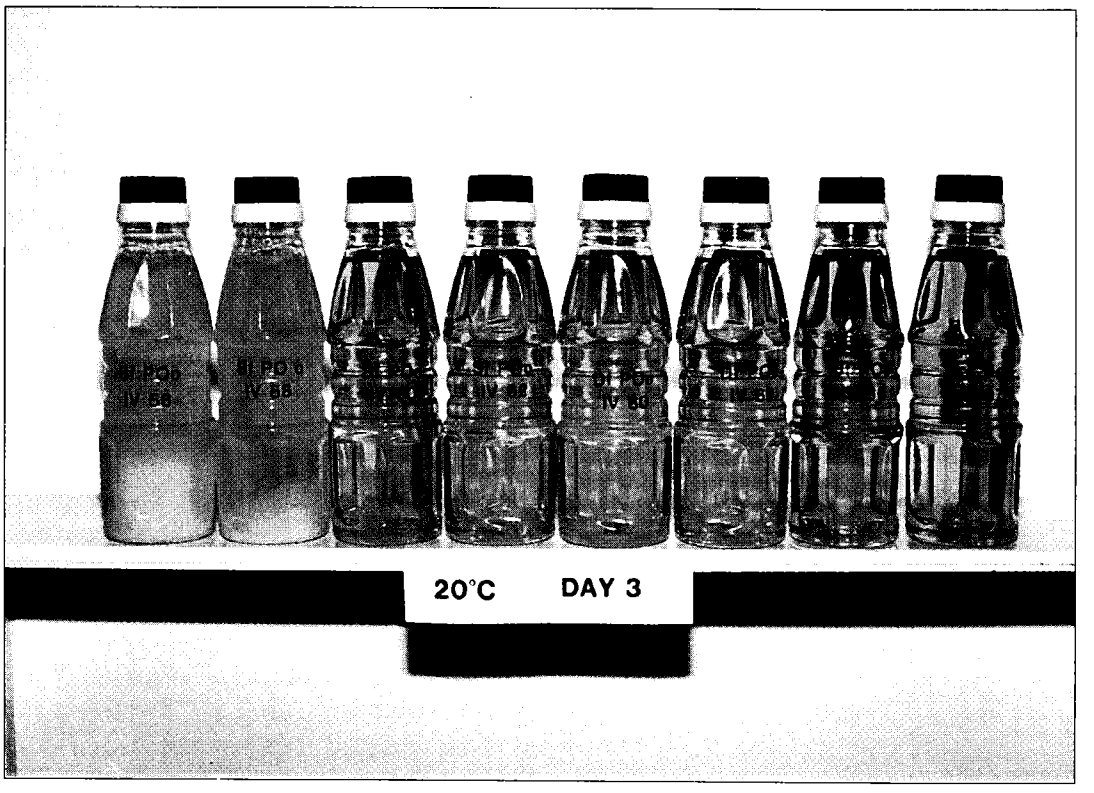

Figure 3. Appearance of single and double fractionated palm oleins of different IVs stored at 20°C for 3 days

60 and 62 which were previously clear had formed sediments at the bottom of the container (*Figure 2*). Most samples were clear at 20°C except SfPOo of IV 56 and 58 (*Figure 3*).

The appearance of the various palm oleins at 15°C on day 20 is shown in *Figure 4*. With time, more crystals formed in SfPOo IV 60 and 62 which adhered to the walls of the containers. At the molecular level, the surface of the glass wall is rough. This offers numerous active sites for the nucleation of the fat crystals to take place and eventually grow. Coalescence of these crystals on the wall of the container into bigger crystals gave the picture that the solidified fat is stuck to the wall. Crystals formation was much less in DfPOo IV 62 and 65. Sample DfPOo IV 67 was apparently clear. Between day 3 and day 20, not much changes were observed at the storage temperature of 20°C (*Figures 3* and *5*) except that more crystals formed on the walls of containers of samples SfPOo 56 and 58 by day 20. All the other samples seemed to be clear.

At 20°C, the period of storage was further extended to 60 days and it was found that DfPOo IV 62, 65 and 67 remained clear (*Figure 6*), However, tiny particles were noted in SfPOo IV 60 and 62 samples while suspensions of larger particles were noted in DfPOo IV 60 and the oil appeared cloudy.

It was quite surprising and unexpected that SfPOo IV 60 had better clarity than DfPOo of similar IV (*Figures 1, 2* and *4*).

TABLE 3. CLOUD POINT OF SINGLE AND DOUBLE FRACTIONATED PALM OLEINS

Sample	Cloud Point (°C)
SfPOo IV 56	8.3
SfPOo IV 58	6.3
SfPOo IV 60	4.0
SfPOo IV 62	3.5
DfPOo IV 60	4.5
DfPOo IV 62	4.0
DfPOo IV 65	2.0
DfPOo IV 67	1.5

Analysis by nuclear magnetic resonance (NMR) showed that SfPOo IV 60 had lesser amounts of solids (13.5% at 10°C; trace amount at 15°C) than DfPOo IV 60 (15.9% at 10°C, 2.4% at 15°C). It is well known that the fatty acid composition has an influence on the clarity of the samples. From *Table 2*, it can be seen that the SfPOo IV 60 had slightly less saturates namely C16:0 and C18:0 (33.7 and 3.8% respectively) than the DfPOo IV 60 (34.7 and 4.0% respectively). The amounts of monounsaturate (MUFA) and polyunsaturate (PUFA) in the SfPOo IV 60 sample were also slightly higher (46.2 and 14.2% respectively) than those found in the DfPOo IV 60 sample (45.8 and 13.6%, respectively).

Besides fatty acid composition, it is also believed that the diglycerides content have an influence on the crystallization of palm olein. Samples containing higher amounts of diglycerides tend to crystallize more easily than those with lower amounts. Crystallization makes the olein less clear giving it a cloudy appearance. A recent study by Swe *et al.* (1995) and that of Siew and Ng (1996) indicated that the crystals formed at room temperature mainly consisted of a diglyceride namely 1,3 dipalmitoylglycerol.

In this particular study, DfPOo IV 60 having higher amounts of total diglycerides (7.3%) crystallized more easily and became cloudy faster than did the SfPOo IV 60 which contained less (6.8%) total diglycerides. The major diglyceride found in both samples was 1,3 palmitoyloleoylglycerol, PO (2.8%). However, DfPOo IV 60 contained more of the 1,3 diapalmitoylglycerol, PP (1.4%) and more of the 1,3 dioleoylglycerol, OO (1.2%) than did SfPOo IV 60 with amounts of 1.0 and 0.2%, respectively.

Table 3 shows the cloud points of single and double fractionated palm oleins. In general, it may be seen that the lower the IV, the higher the cloud point. SfPOo IV 56 with the lowest IV in the series had the highest cloud point (8.3°C) among all the single fractionated oleins. Similarly the double fractionated oleins, DfPOo IV 60 had the highest value (4.5°C) while DfPOo IV 67 showed the lowest (1.5°C). Comparing single

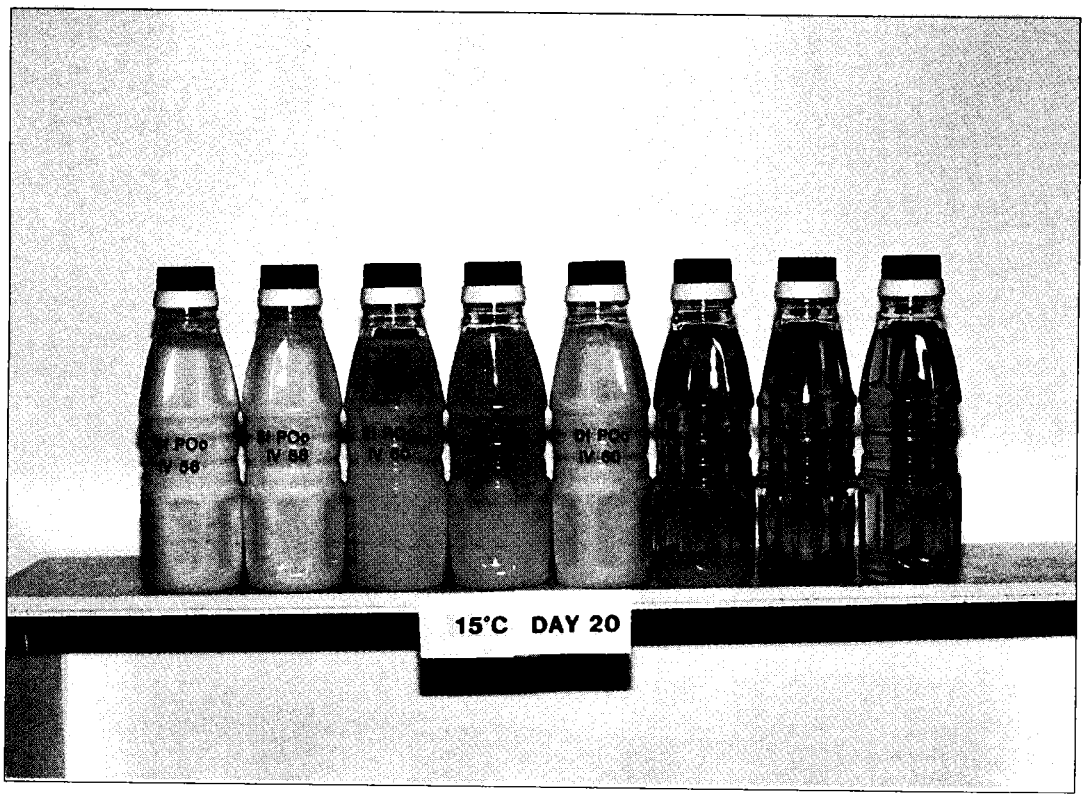

Figure 4. Appearance of single and double fractionated palm oleins of different IVs stored at 15°C for 20 days

Figure 5. Appearance of single and double fractionated palm oleins of different IVs stored at 20°C for 20 days

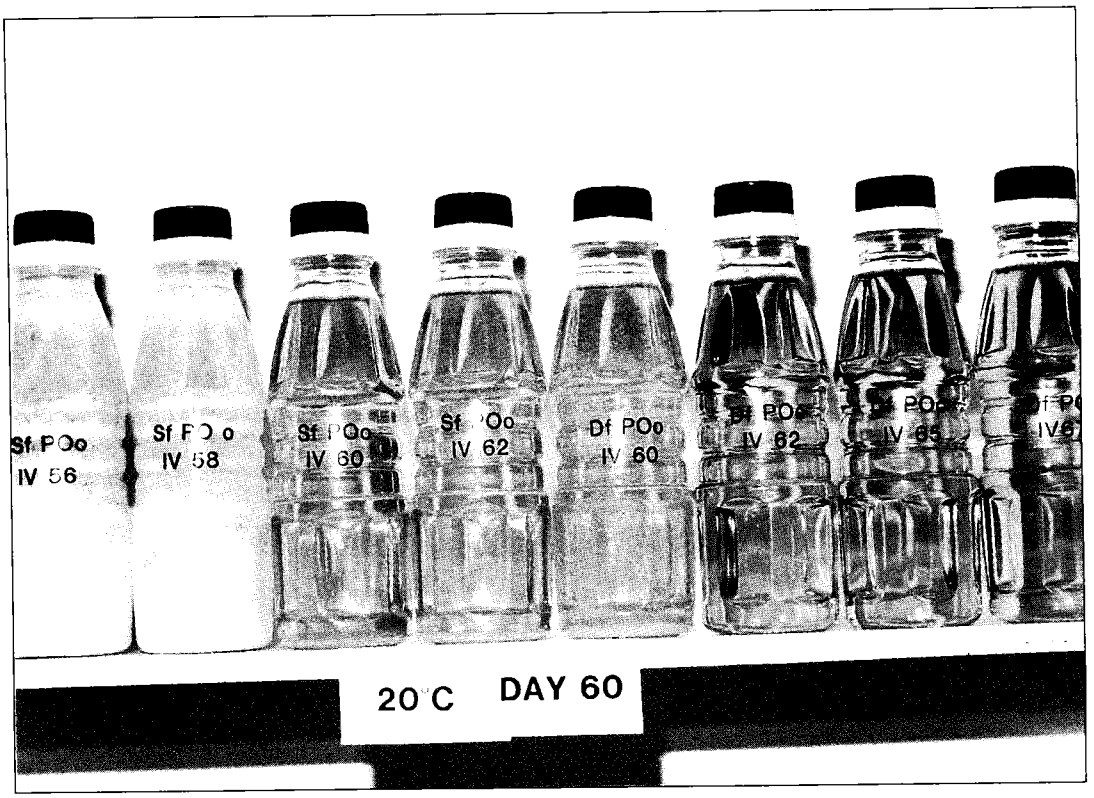

Figure 6. Appearance of single and double fractionated palm oleins of different IVs stored at 20°C for 60 days

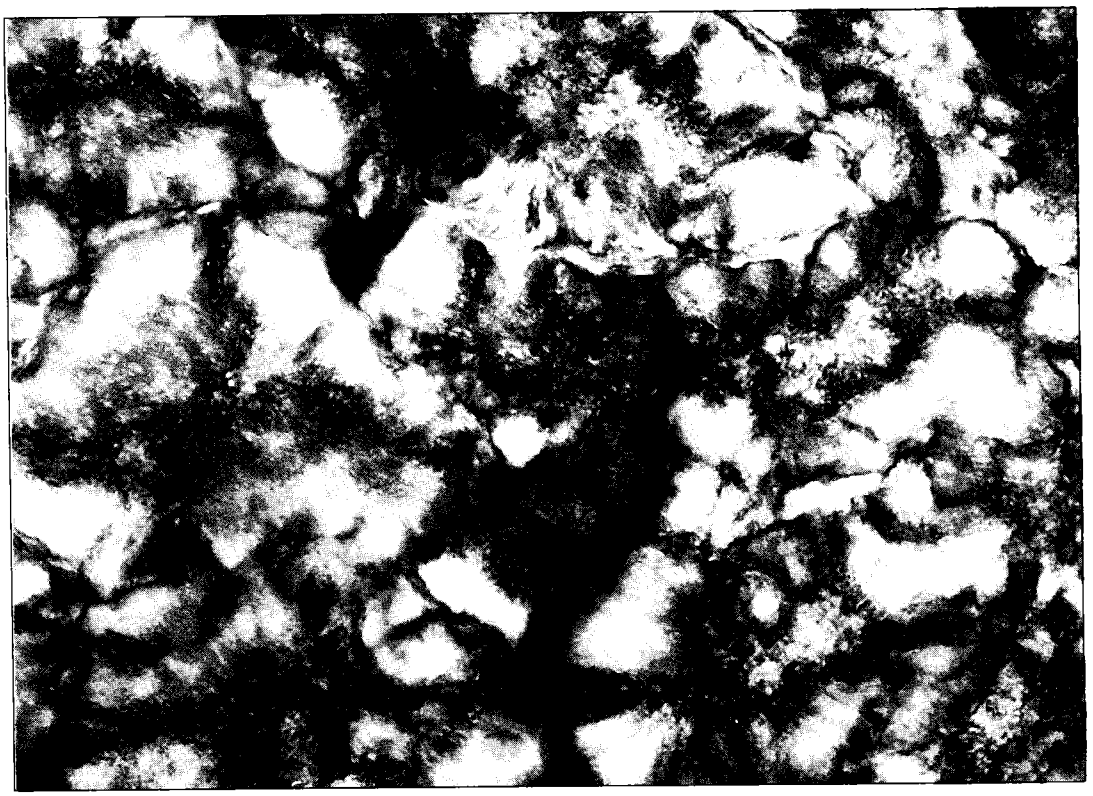

Figure 7. Morphology of double fractionated palm olein IV 62 crystals formed at 20°C over 20 months (magnification 10X)

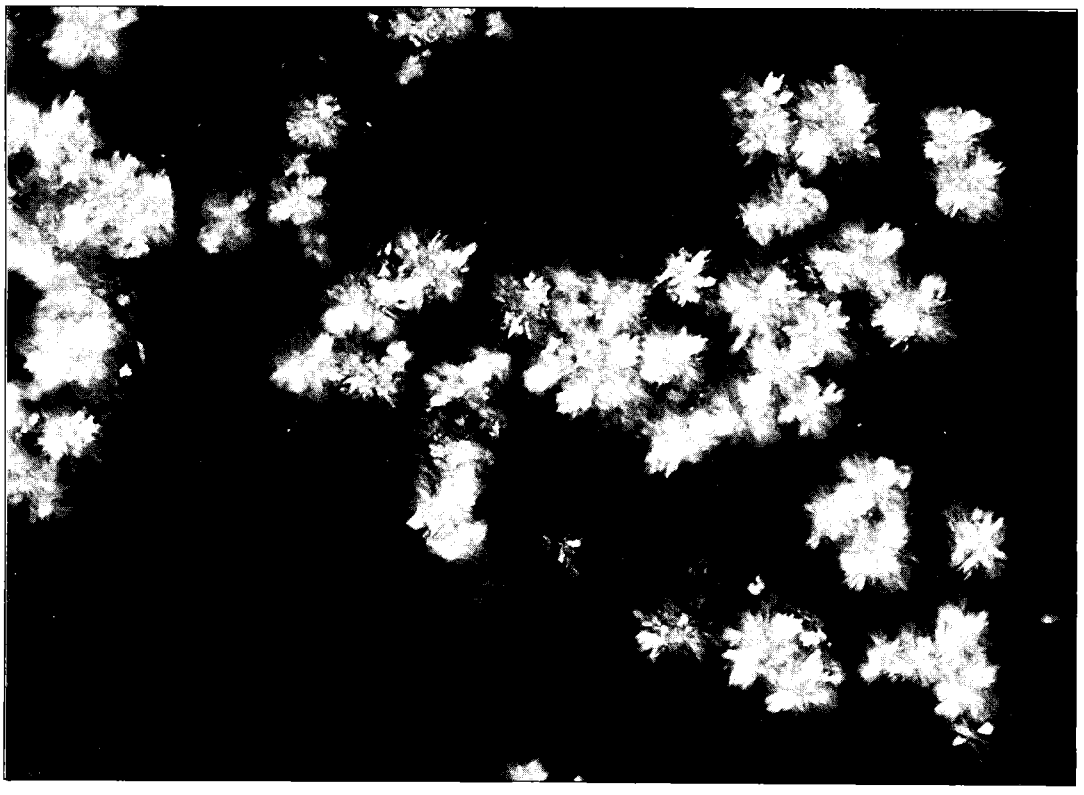

Figure 8. Morphology of double fractionated palm olein IV 65 crystals formed at 20°C over 20 months (magnification 10X)

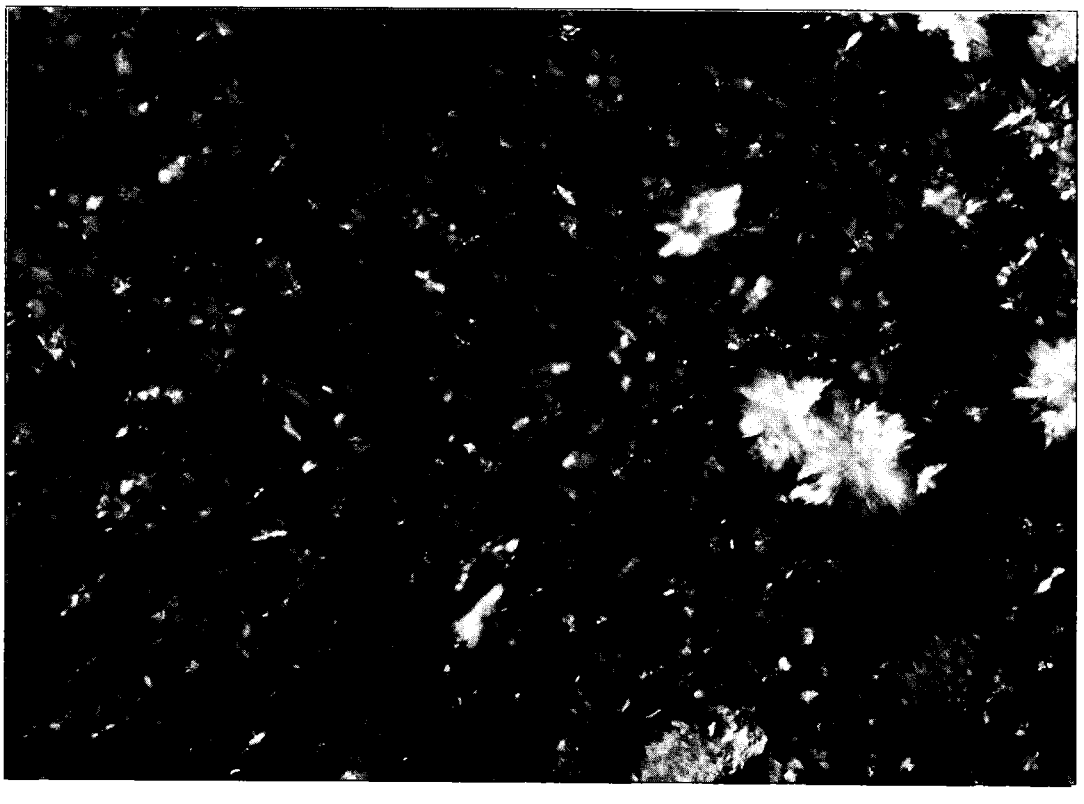

Figure 9. Morphology of double fractionated palm olein IV 67 crystals formed at 20°C over 20 months (magnification 10X)

Figure 10. Morphology of double fractionated palm olein IV 58 stored at 20°C (magnification 10X)

and double fractionated oleins of the same IV (60 and 62), single fractionated oleins in this particular study tended to have lower cloud point than did the double fractionated oleins. This anomaly may be explained by the overall fatty acid composition, total diglyceride content and fatty acid composition of the diglycerides in the oils. The single fractionated olein had slightly less saturates, less amount of total diglycerides and less amounts of 1,3 dipalmitoylglycerol and 1,3 dioleoylglycerol than did the double fractionated oleins. Since the diglycerides have an influence on the crystallization of palm olein, removal of the diglycerides should improve cold stability and marketibility of the oil.

The oleins were also stored at 20°C for more than 20 months and the crystals formed in the olein samples after 20 months of storage were observed using a polarizing microscope. The crystals were found to be of various sizes and shapes. Generally speaking, palm oleins of lower IV formed larger crystals than did oleins of higher IV. This is especially true in the case of double fractionated palm oleins (*Figures 7* to *9*). Crystals of DfPOo IV 62 were larger, more densed and compact compared to crystals formed in DfPOo IV 65 or DfPOo IV 67. The crystals of DfPOo IV 65 were in aggregates, forming spherulites (*Figure 8*). In DfPOo IV 67, the crystals were very tiny and scattered apart. Occasionally, there were formation of a few clusters where the crystals aggregated (*Figure 9*). In contrast, crystals of SfPOo IV 58 were very large and compact. They were needle-like and stacked together to form bundles (*Figure 10*).

CONCLUSIONS

In general DfPOo IV 62, 65 and 67 had better clarity than did SfPOo IV 56, 58, 60 or 62. However, an anomaly was found in SfPOo IV 60 which displayed better clarity than DfPOo of a similar IV, presumably due to its lower content of diglycerides, lower amounts of saturates and higher amounts of both monounsaturates and polyunsaturates. Overall, palm oleins of higher IV showed lower cloud points than those with lower IV. The

crystals formed in the oleins on prolonged storage of greater than 20 months at 20°C, were of different sizes and shapes with oleins of low IV forming larger, denser and more compact crystals.

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REFERENCES

DEFFENSE, E and TIRTIAUX, A (1989). Fractionation, a fast growing technology. Paper presented at Fats for Future II Conference, Auckland, New Zealand, 12-17 February.

SIEW, W L and NG, W L (1996). Characterisation of crystals in palm olein. *J. Sci. Food Agric. 70* : 212-216.

SWE, P Z; CHE MAN, Y B; GHAZALI, H M; WEI, L S (1994). Identification of major triglycerides causing the clouding of palm olein. *J. Am. Oil Chem. Soc. 71* : 1141-1144.

SWE, P Z; CHE MAN, Y B; GHAZALI, H M;, WEI, L S (1995). Composition of crystals of palm olein formed at room at room temperature. *J. Am Oil Chem. Soc. 72* : 343-347.

TAN, B K and FLINGOH, C H OH (1981). Oleins and stearins from Malaysian palm oil - chemical and physical characteristics, *PORIM Technology No. 4.*

TAN, B K (1989). Novel fractions and fats from palm and palm kernel oils. Paper Presented at Fats for Future II Conference, Auckland, New Zealand, 12-17 February.