Cold Stability of Red Palm Oleins

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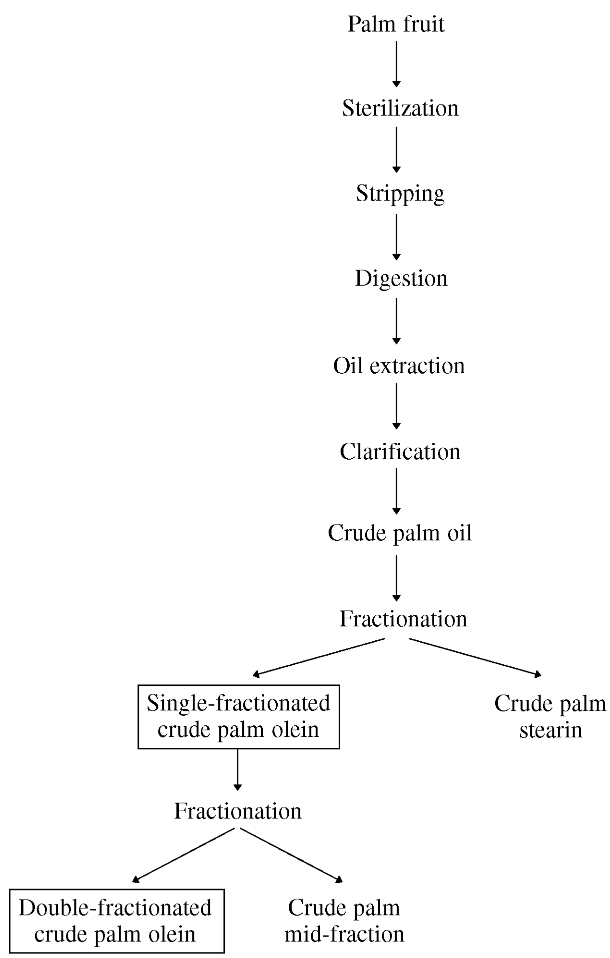
ABSTRACT: Cold stability of crude and refined red palm oleins was investigated. Single- and double-fractionated crude as well as refined single- and double-fractionated red palm oleins were stable against crystallization for more than 1 h but less than 2 h, whereas commercial red palm oleins remained stable for more than 5 h at 5°C. At 20°C, refined red palm oleins had better resistance to crystallization than crude palm oleins. Red palm oleins with lower amounts of saturated fatty acids ($C_{16:0}$ and $C_{18:0}$), lower levels of POP and POS triacylglycerols, and lower cloud points have increased resistance to crystallization and result in better cold stability.

JAOCS 75, 749–751 (1998).

KEY WORDS: Cloud point, cold stability, crystallization, fatty acid composition, iodine value, red palm oleins.

Palm oil and its products are consumed locally and are exported in refined, bleached, and deodorized (RBD) forms. The present refining process destroys most of the carotenes present in the crude oil. As a result, the final product is light golden in color and devoid of carotenes. Efforts have been made to retain carotenes in the oil. In recent years, there has been a growing interest in the use of carotene-rich red palm oil for edible applications (1,2). Red palm oil, an unbleached version, is the only oil among all vegetable oils that contains carotenes, which are precursors of vitamin A.

Cold stability, the ability of the sample to resist crystallization and remain clear at low storage temperatures, of RBD palm olein, the liquid fraction of palm oil, has been reported (3–5). However, no studies have been reported on the cold stability of crude or refined red palm olein. Thus, the aim of this paper is to report findings on cold stability of the latter oils, including commercial red palm oleins that have recently become available.



SCHEME 1

EXPERIMENTAL PROCEDURES

Materials. Single-fractionated crude palm olein (SfCPOo) and double-fractionated crude palm olein (DfCPOo) were obtained from a local refinery. These oils are normally processed by standard procedures, as shown in Scheme 1. Single-fractionated refined red palm olein (SfRPOo) and double-fractionated refined red palm olein (DfRPOo) were obtained by low-temperature deodorization of crude olein to retain their carotenes. Commercial red palm oleins A and B were obtained from local refineries. Specific processing treatments for the two commercial red palm oleins are confidential properties of the manufacturers.

Cold stability. The oils were heated to 70°C and then filtered through a Whatman qualitative filter paper of 240-cm diameter (Whatman International Ltd., Maidstore, England).

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TABLE 1
Cold Stability of Various Red Palm Oleins

Sample	Storage temperature (°C) 5	10	15	20
Single-fractionated crude palm olein	>1 h < 2 h	>1 h <2 h	>5 h	2 d
Double-fractionated crude palm olein	>1 h <2 h	>3 h <4 h	<2 d	20 d
Single-fractionated refined red palm olein	>1 h <2 h	>2 h <3 h	>5 h	<6 d
Double-fractionated refined red palm olein	>1 h <2 h	>4 h <5 h	3 d	>200 d
Commercial red palm olein A	>5 h	23 h	3 d	>200 d
Commercial red palm olein B	>7 h	>3 d	>6 d	>200 d

Filtration was conducted in a cabinet maintained at 50°C. The oils were allowed to cool at room temperature. They were then weighed into 250-mL plastic bottles. The amount of sample in each bottle was 240 g. The bottles were closed with screw caps. Six sets of samples for each experiment were prepared in duplicates. The samples were stored at 5, 10, 15, and 20°C. Observations were conducted daily to determine clarity of the sample during storage.

Cloud point. Cloud points were determined according to AOCS Test Method Cc 6-25 (6).

Fatty acid composition. Fatty acid compositions were determined as methyl esters, which were prepared according to a method proposed by Timms (7). Analyses were conducted with a capillary column (100 m × 0.25 mm i.d.) with a split ratio of 1:100. Flow rate was 0.8 mL He/min, oven temperature was set at 180°C, injector temperature at 230°C, and detector temperature at 240°C. Analyses were conducted under isothermal conditions on a Hewlett-Packard 6890 gas chromatograph (Avondale, PA).

RESULTS AND DISCUSSION

Table 1 shows cold stability of various red palm oleins. At 5°C, both single- and double-fractionated crude oleins (SfCPOo and DfCPOo) as well as refined red oleins (SfRPOo and DfRPOo) were stable against crystallization for more than 1 h but less than 2 h. Better resistance to crystallization was observed in the commercial red palm oleins; sample A remained clear for more than 5 h, while commercial sample B remained clear for more than 7 h at 5°C.

There was an improvement in clarity of the oils when stored at 10°C. DfCPOo remained clear for more than 4 h at 10°C. Much better resistance to crystallization was observed at 10°C in commercial sample A, which remained clear for 23 h, and still better clarity was observed in commercial sample B, which remained clear for more than 3 d. The latter could be due to the fact that commercial sample A had a lower amount of saturates ($C_{16:0}$), while commercial sample B had a lower amount of $C_{18:0}$ when compared with other samples (Table 2). SfCPOo and SfRPOo have higher amounts of saturates ($C_{16:0}$) than DfCPOo and DfRPOo. On the other hand, DfCPOo and DfRPOo have higher amounts of monounsaturates ($C_{18:1}$) and also higher amounts of polyunsaturates ($C_{18:2}$) than their single-fractionated counterparts. Commercial red palm olein A contained the lowest amounts of saturates ($C_{12:0}$, $C_{14:0}$, and $C_{16:0}$) among the samples. On the other hand, its content of polyunsaturates ($C_{18:2}$) was the highest.

At 15°C, SfCPOo and SfRPOo remained clear for more than 5 h. On the other hand, DfCPOo crystallized within 2 days while DfRPOo and commercial red palm olein A remained clear for 3 d at 15°C. Refined red palm olein, whether single- or double-fractionated, had better cold stability at 20°C than crude palm oleins. DfRPOo and commercial red palm oleins A and B remained clear for more than 200 d at 20°C.

Siew and Ng (8) reported that the ratio of palmitic-oleic-palmitic (POP) to palmitic-oleic-oleic (POO) triacylglycerols in the olein is important in determining the cold stability of palm olein. For example, oleins with better cold stability showed an average ratio of 0.56 ± 0.20, while less resistant oleins had an average ratio of 0.89 ± 0.24. In this study,

TABLE 2
Fatty Acid Compositions and Iodine Values of Crude and Refined Red Palm Oleins[a]

Fatty acid composition	SfCPOo	DfCPOo	SfRPOo	DfRPOo	Commercial A	Commercial B
$C_{12:0}$	0.5	0.3	0.3	0.4	0.2	0.3
$C_{14:0}$	1.1	1.1	1.1	1.1	0.9	1.1
$C_{16:0}$	38.3	36.4	40.0	34.5	34.0	34.5
$C_{16:1}$	0.2	0.2	0.2	0.2	0.2	0.3
$C_{18:0}$	3.8	3.9	4.0	3.8	3.8	3.6
$C_{18:1}$	42.4	43.4	43.4	47.5	45.0	46.8
$C_{18:2}$	13.2	14.0	10.7	12.2	15.3	12.8
$C_{18:3}$	0.5	0.6	0.3	0.3	0.5	0.2
Iodine value	60.4	62.8	60.5	62.6	66.3	62.8

[a]SfCPOo, single-fractionated crude palm olein; DfCPOo, double-fractionated crude palm olein; SfRPOo, single-fractionated refined palm olein; DfRPOo, double-fractionated refined palm olein.

TABLE 3
Triglyceride Compositions[a] of Red Palm Oleins

Sample	OLL	PLL	MLP	OLO	PLO	PLP	OOO	POO	POP	PPP/SOO	POS	PPS	SOS	Total TG
SfCPOo	0.5	2.6	0.5	1.7	10.2	9.6	4.0	24.3	29.9	2.8	5.2	0.1	0.3	91.7
DfCPOo	0.5	3.0	0.6	2.0	11.5	9.8	4.2	26.2	25.0	3.1	4.6	0.1	0.6	91.2
SfRPOo	0.5	2.7	0.7	2.0	10.9	10.1	3.9	24.6	29.8	3.4	5.4	0.2	0.7	94.9
DfRPOo	0.6	3.1	0.6	2.5	13.5	9.5	5.4	31.6	19.2	3.9	3.7	0.3	0.5	94.4
Commercial A	0.7	3.3	0.7	2.6	13.6	9.9	5.5	31.4	18.9	3.9	3.4	0.3	0.4	94.6
Commercial B	0.7	3.8	0.7	2.5	15.0	10.5	5.2	32.6	15.4	3.7	2.4	0.1	0.1	92.7

[a]O, oleic; L, linoleic; M, myristic; P, palmitic; S, stearic.

SfCPOo and SfRPOo had higher amounts of POP (29.9 and 29.8%, respectively) than DfRPOo (19.2%), commercial sample A (18.9%), or commercial sample B (15.4%); thus, their lower cold stability, compared to the latter oils, was in agreement with the earlier finding (8). The POO contents of SfCPOo and SfRPOo were lower (24.3 and 24.6%, respectively) than for DfRPOo (31.6%), commercial sample A (31.4%), or commercial sample B (32.6%). It appears that, in spite of the low POO content, the higher POP content of the SfCPOo and SfRPOo is sufficient to cause lower cold stability. In fact, the lower POP/POO ratio of 0.47 for commercial B is consistent with the observation of its better cold stability compared with commercial A.

Oils of similar iodine value (IV) do not necessarily have similar cold stability, for example, SfCPOo and SfRPOo; DfCPOo, DfRPOo; and commercial B (Tables 1 and 2). Although DfCPOo (IV 62.8), DfRPOo (IV 62.2), and commercial B (IV 62.8) had similar IV, commercial B had a significantly longer cold stability at 5°C (>7 h), 10°C (>3 d), and 15°C (>6 d) than the other two oils. At 20°C, DfRPOo and commercial B had significantly longer cold stability (>200 d) than DfCPOo (20 d). Even though commercial A had the highest IV, its stability was still not as good as the commercial B samples, especially at 10 and 15°C. Results indicated that the triacylglycerol composition of the samples had a pronounced effect on their cold stability. Commercial sample B, which had the best cold stability, had the lowest amount of POP (15.4%), palmitic-oleic-stearic (2.4%), and stearic-oleic-stearic (SOS) (0.1%) among the samples (Table 3).

Commercial sample B also had the highest amount of palmitic-linoleic-linoleic (3.8%), palmitic-linoleic-oleic (15.0%), and POO (32.6%), which are lower-melting triacylglycerols, compared to POP, palmitic-palmitic-stearic, or SOS. Cold stability of oils can be influenced by their cloud points. Cloud points of the samples ranged from 2.5 (DfRPOo) to 8.3°C (SfCPOo), as shown in Table 4. Crude palm oleins had higher cloud points than oleins in the refined form. It is likely that impurities, such as gums, phospholipids, and trace metals, present in the crude oil, caused its cloud point to be higher. These impurities also act as crystal promoters. For this reason, crude palm oleins had lower cold stability than refined red palm oleins. In general, the lower the cloud point, the better was the cold stability of red palm oleins.

TABLE 4
Cloud Points of Red Palm Oleins

Sample	Cloud point (°C)
Single-fractionated crude palm olein	8.3
Double-fractionated crude palm olein	5.0
Single-fractionated refined red palm olein	7.5
Double-fractionated refined red palm olein	2.5
Commercial red palm olein A	3.0
Commercial red palm olein B	2.6

The cold stability of red oleins can be improved either by blending or by incorporating anti-crystallizers. Work is now in progress to determine the most effective anti-crystallizer that can delay or overcome cloudiness in palm oleins.

ACKNOWLEDGMENTS

The authors thank I. Zaimi and M. Noraini for technical assistance, and the Director General of PORIM for permission to publish this work.

REFERENCES

1. NorAini, I., Highly Nutritious Satay Sauce Made with Unrefined and Partially Refined Palm Oleins, *Palm Oil Developments* No. 22, Palm Oil Research Institute of Malaysia, 1995, pp. 17–20.
2. Sarojini, G., L. Radha, and K.N. Bharani, Stability of Total and β-Carotenes in Food Products Prepared with Red Palm Oil Blends, in *Proceedings of the PORIM International Palm Oil Congress on Chemistry and Technology,* Palm Oil Research Institute of Malaysia, 1996, pp. 271–279.
3. NorAini, I., Y. Basiron, H. Hanirah, and B. Roszilah, Effect of Some Additives on Resistance to Crystallization of Palm Olein, *Elaeis 5:*47–64 (1993).
4. Teah, Y.K., and A. Ibrahim, Palm Olein Improves Cooking Oil Blend, *Palm Oil Developments* No. 15, Palm Oil Research Institute of Malaysia, 1994, pp. 2–8.
5. NorAini, I., and H. Hanirah, Clarity of Single and Double Fractionated Palm Oleins, *Elaeis 8:*104–113 (1996).
6. *Official Methods and Recommended Practices of the American Oil Chemists' Society,* 4th edn., edited by R.E. Walker, American Oil Chemists' Society, Champaign, 1989.
7. Timms, R.E., Artifact Peaks in the Preparation and Gas–Liquid Chromatographic Determination of Methyl Esters, *Aus. J. Dairy Technol. 33:*4–6 (1978).
8. Siew, W.L., and W.L. Ng, Crystallization Behaviour of Palm Oleins, *Elaeis 8:*75–82 (1996).

[Received September 2, 1997; accepted December 24, 1997]