Recent Results on Palm Oil Uses in Food Products

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Recent interest in minimizing the *trans* fatty acid content of fat products has focused attention on palm oil products as a source of solid fat in place of hydrogenated fats. *Table 1* shows the solid fat content profiles of a number of interesterified blends useful as base stocks for margarine (Berger, 1990).

An important criterion in the manufacture of vanaspati is to obtain a granular crystalline structure and a minimum free oil phase at room temperature. This usually has to be achieved with a melting point no higher than 37°C-38°C. *Table 2* shows some blends that have suitable properties. Optimum texture is obtained when a small proportion of hydrogenated oil is incorporated (Kheiri, 1985).

Pakistan, with a population of about 125 million, is one of the major producers of vanaspati, producing about one million tons/year. Current formulations contain 70%-80% palm oil, the balance being partly hydrogenated liquid oil of local or imported origin. The content of *trans* fatty acids is 2.5%-3.8% (Raie *et al.*, 1992), whereas 15 years ago, with formulas based mainly on hydrogenated liquid oils, the *trans* fatty acid content was about 30%.

Bakery shortenings with excellent performance can be formulated using palm products (Idris *et al.*, 1989). The formulas shown in *Table 3* have been processed on a pilot plant scale and compared in practical cake baking tests with a high-quality commercial product. The last line in the

TABLE 1. PHYSICAL PROPERTIES OF RANDOMIZED BLENDS FOR MARGARINES

	Solid fat content (%) for blends					
Temp (°C)	POS:PKOF (60:40)	PO:PKO (80:20)	POF:PKO (90:10)	POS:SBO (40:60)	POS:RSO(LE) (40:60)	POS:CSO (20:80)
10	52.7	57.5	41.6	17.5	19.4	18.7
15	43.7	49.5	30.2	10.7	12.7	100.3
20	30.0	37.1	20.8	5.9	9.6	6.5
25	19.3	25.8	13.8	3.9	5.7	3.7
30	11.4	17.4	7.8	2.5	3.7	2.8
35	3.8	9.3	4.3	0.8	3.6	2.2
37	0.4	4.3	2.3	0.9	2.3	1.1
40	—	2.6	0.8	—	1.6	0.4
Melting point (°C)	35.5	35.5	33.2	32.3	36.0	34.0

Abbreviations: PO, palm oil; PKO, palm kernel oil; SBO, soybean oil; POS, palm stearin; PKOF, palm kernel olein; CSO, cotton seed oil; POF, palm olein; RSO(LE), Rapeseed Oil, Low Erucic Acid.

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TABLE 2. PALM OIL-BASED FORMULAS FOR VANASPATI

	1	2	3	4
Hardened palm olein	24			
Refined palm oil	56			80
Soy or rapeseed* oil	20	30		
Palm stearin		70	60	
Rice bran oil			40	20
Reference no.	2	3	4	4

Notes: Blends 2, 3 and 4 are interesterified. The *trans* fatty acid content of blend 1 is 2.7%. *Low erucic acid.

TABLE 3. SHORTENING-CAKE BAKING TESTS

	1	2	3	4	5	6	7
PO	60						
HPO	20					18	
POS		60	50	50	50	42	
SBO	20			50			
RSO		40	50			40	
CSO					50		
POO(IE)							100
Baking test volume experiment/ control	98	97	101	96	96	101	99

Abbreviations: PO, palm oil, HPO, hardened palm oil (mpt 42°C); POS, palm stearin (iodine value 44); SBO, soybean oil; RSO, rapeseed oil (low erucic); CSO, cottonseed oil; POO(IE), palm olein interesterified.

table shows the results of these tests. The volume of the experimental cake in expressed as a percentage of the volume of the standard. Other properties, such as texture and crumb structure, were considered satisfactory.

When canola oil, or another oil containing predominantly C18 fatty acids, is hydrogenated and used for margarines and shortenings there is a strong tendency to develop β crystallinity and consequently, an unsatisfactory texture. This tendency can be effectively inhibited by the addition of palm oil. Yap and deMan (1989), demonstrated the effect in both selectively and nonselectively hydrogenated canola oil, as shown in *Figures 1* and *2*. In the selectively hydrogenated oil (iodine value ~67), the fats remained mainly in the β form for up to 56 days storage at 5°C. In the nonselectively hydrogenated oil (iodine value ~69), β crystals develop rapidly in the control sample and were progressively inhibited by palm oil additions of 5%-15%. Inhibition was more effective when the palm oil was added before hydrogenation.

Frying is universally a traditional method of cooking in the household. It has also become very important in fast-food restaurants and in the large-scale manufacture of snack foods. In these applications, the economy of the process is highly dependent on the length of time that the frying oil can be used, since it is usually the most expensive major ingredient of the food product. A large number of carefully controlled comparative frying tests have been carried out. Those tests demonstrate that palm oil or palm olein are very satisfactory frying oils on their own and significantly improve the frying properties of other oils when blended with them (Berger *et al.*, 1989). The results of some of these tests are shown in *Table 4*. Packaged snack foods are required to have an extended shelf life, and the high oxidative stability of palm products improves the stability of blends and hence the shelf life. Palm oil or palm olein are used extensively in Europe for potato crisps and other fried snack foods and in Asia for the preparation of instant noodles. In Japan and South Korea, palm products have largely displaced the animal fats that were traditionally used for noodle frying.

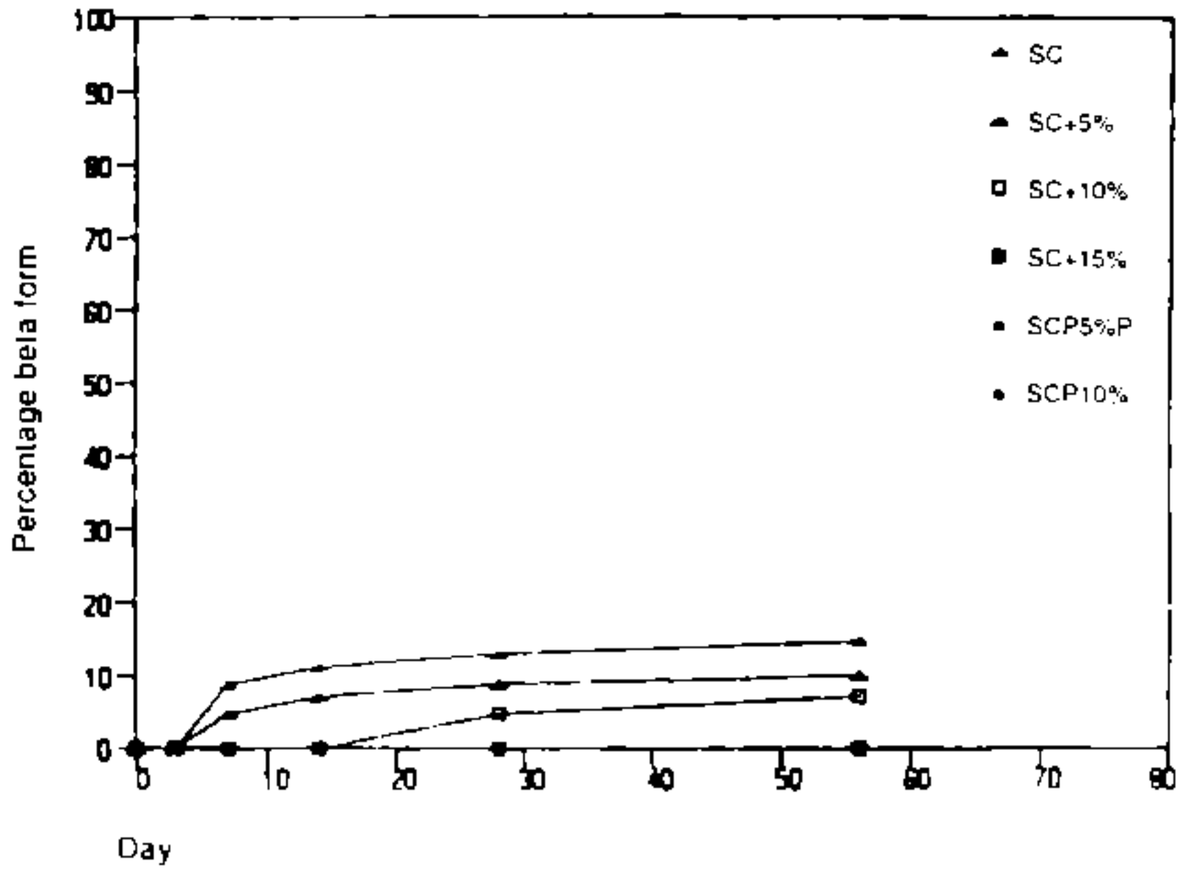

Figure 1. Percentage of crystals in the β-polymorphic form during isothermic storage at 5°C of selectively hydrogenated oils (values for SCP 5%, SCP 10% and SC + 15% P) were zero through the storage period.

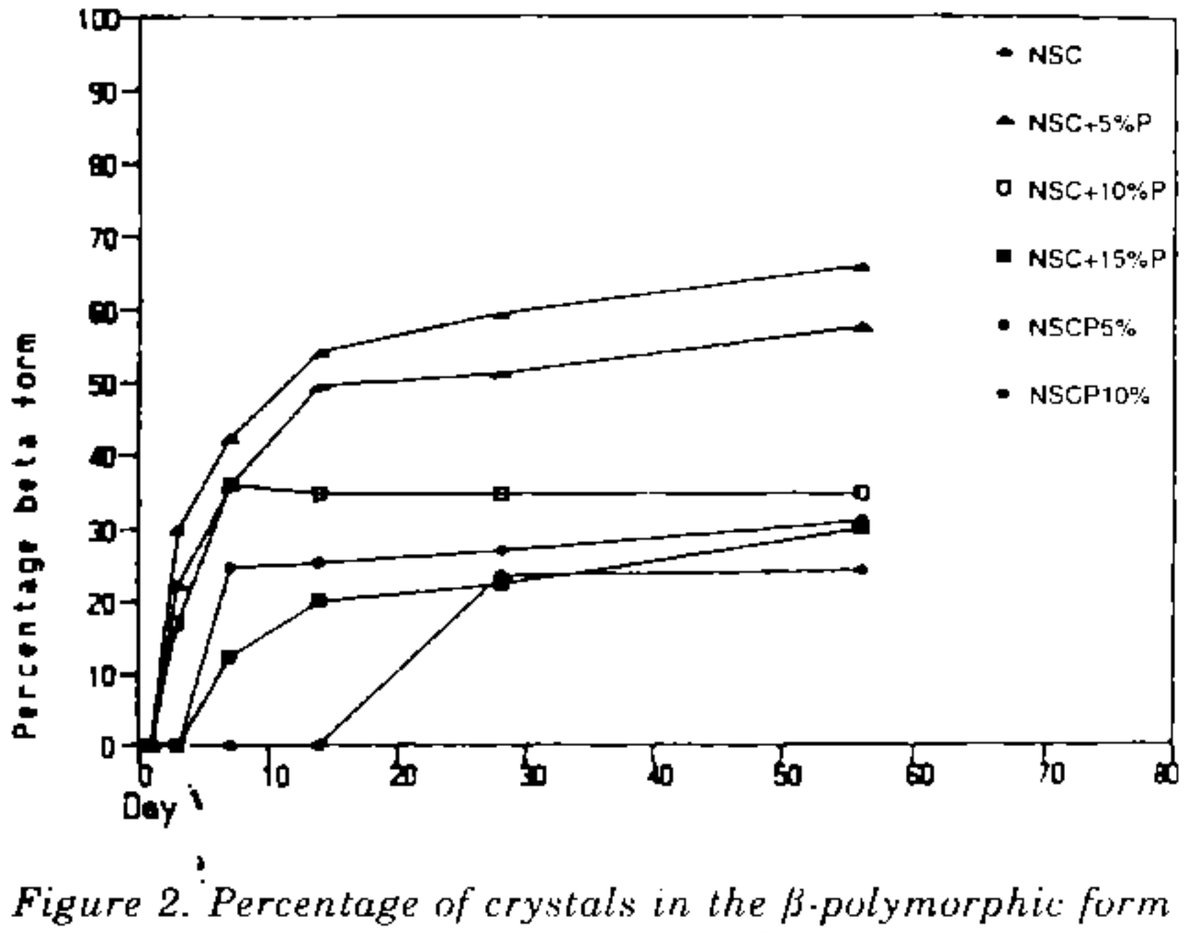

Figure 2. Percentage of crystals in the β-polymorphic form during isothermic storage at 5°C of nonselectively hydrogenated oils.

The fractionation of palm oil into a standards olein of minimum iodine value 56 and stearin of maximum iodine value 48 is a well-established process, with very large quantities entering world trade. Codex Alimentarius specifications for the products are in an advanced state of approval. The sophistication of the fractionation process has resulted in the availability of double-fractionated oleins with low cloud point, and of various grades of palm stearin (Tan, 1989). These products give more choice of ingredients to the end user. Some analytical data is given in *Tables 5* to *8* and *Figure 3*.

The availability of superoleins of low cloud point has proved of particular interest to users. For example, it enables the use of palm olien in salad dressing and mayonnaise that are stable during storage at 5°C (Idris *et al.*, 1995). The recent availability of a red palm oil and palm olein (Choo *et al.*, 1993), that have been refined so that the major portion of the natural carotenoid content is preserved, is arousing considerable interest. Their content of carotenoids, tocopherols, and tocotrienols fulfills the modern concept of a functional food. Analytical data for red palm oil are given in *Table 9*. Apart from its importance as a precursor for vitamin A, β-carotene acts as a natural antioxidant, and some studies have shown anticancer activity. The French pharmaceutical company Martin Privat is marketing 'Oxytrap' capsules containing red palm olein as a major ingredient. Its carotenoids, tocopherols and tocotrienols are stated to be functional in protecting the body against attack by free radicals. Experimental data are also available on preparing snack food fried in red palm olein. The carotenoids are present at a level of 400ppm or more and reflect the complete spectrum of compounds in the crude oil *(Table 10)*.

Vegetable fats are used to replace the butterfat in dairy products for a number of reasons. Countries with inadequate milk supplies import skim milk powder and reconstitute it with locally available vegetable oil. These are usually cheaper and can be adjusted to give specific performance. One example of this is ice

TABLE 4. ANALYSIS OF FRYING OILS AFTER THREE DAYS OF USE

	Rapeseed		Sunflower		Soybean		Groundnut		Olive	
	oil	blend	oil	blend	oil	blend	oil	blend	oil	blend
Induction period (h)*	11.5	16.0	6.0	7.0	16.0	19.0	15.0	21.0	11.8	—
Cloud point (°C)	-5	0	-9.5	-2.3	-9.0	-2.2	1.9	2.0	-10.0	—
Free Fatty acids (%)	0.40	0.41	0.29	0.30	0.14	0.18	0.78	0.71	0.65	0.67
Viscosity at 40°C (poise)	9.7	8.7	10.0	9.9	5.3	6.0	6.8	7.5	12.0	9.8
Polymers (%)	2.8	1.8	2.8	2.3	—	—	1.5	0.7	—	—
Colour (Lovibond red)	9.0	8.3	3.5	5.0	—	—	14.2	16.2	2.0	2.0
Oxidized acids (%)	3.3	1.7	5.1	2.9	2.5	1.7	2.7	3.0	2.2	3.0
Smoke point (°C)	192	190	203	208	212	210	162	171	192	190

* Rancimat at 100°C. Blends contain 30% palm olein.

cream, where the correct product structure is obtained only when a partly solid fat is used (Berger, 1990). It appears that the solids content at the storage temperature of the mix before freezing (about 5°C) and at the temperature during freezing and aeration are critical. *Table 11* shows relevant figures for two samples (by NMR) of butterfat and for palm oil.

Another example is in use in baker's whipping cream. In hot climates and during temperate summers, the stand up characteristics of a whipped cream made with butterfat are inadequate. Nesaretnam *et al.* (1993), found that interesterified blends of hardened palm kernel oil (iodine value 1.0, slip melting point 35.2°C) with palm stearin (iodine value 19.0, slip melting point 59.2°C) gave satisfactory whipping properties and improved stability at higher temperatures in a commercial cream formula in comparison with the standard fat. The solid fat content of blends tested is given in *Table 12*.

TABLE 5. PALM OIL STANDARD COMMERCIAL FRACTIONS

	Palm Olein		Palm Stearin
	range	mean	range
Melting point (°C)	19-23	21.6	48-56
Cloud point (°C)	6-10	8.8	—
Main fatty acids (%)			
C 16.0	37.8-41.7	39.8	47.2-73.8
C 18.0	4.0-4.8	4.4	4.4-5.6
C 18.1	40.7-43.9	42.5	15.6-37.0
C 18.2	10.4-13.4	11.2	3.2-9.8

TABLE 6. SUPER OLEINS

	PL60	PL62	PL65
Iodine value	60.8	62.9	66.4
Melting point (°C)	15.6	14.5	12.0
Cloud point (°C)	5.6	5.0	12.0
Cold stability at 15°C (hr)	36	>138	>138

The leakage of serum from the whipped product after storage at controlled temperature was taken as a measure of its physical stability *(Table 13)*. The results show that quite small increases in the higher melting component can be used to adjust the whipped cream stability to the required temperature of use.

TABLE 7. SPECIAL PALM STEARINS

Code	HS 32	HS 22	SS 40	SS 35
Iodine value	29.1	21.6	45.8	47.5
Melting point (°C)	55.8	58.3	40.0	34.5
Palmitic acid content (%)	62.2	71.1	47.9	46.1

TABLE 8. PALM MID FRACTIONS

		PMF 34*	PMR 50
Iodine value		34.7	49.3
Melting point (°C)		32.4	27.8
Solids content	10°C	92.0	66.2
	15°C	88.2	50.1
	20°C	78.5	32.0
	25°C	42.6	4.9
	30°C	8.4	—
	35°C	0.9	—

* For confectionary use in CBE.

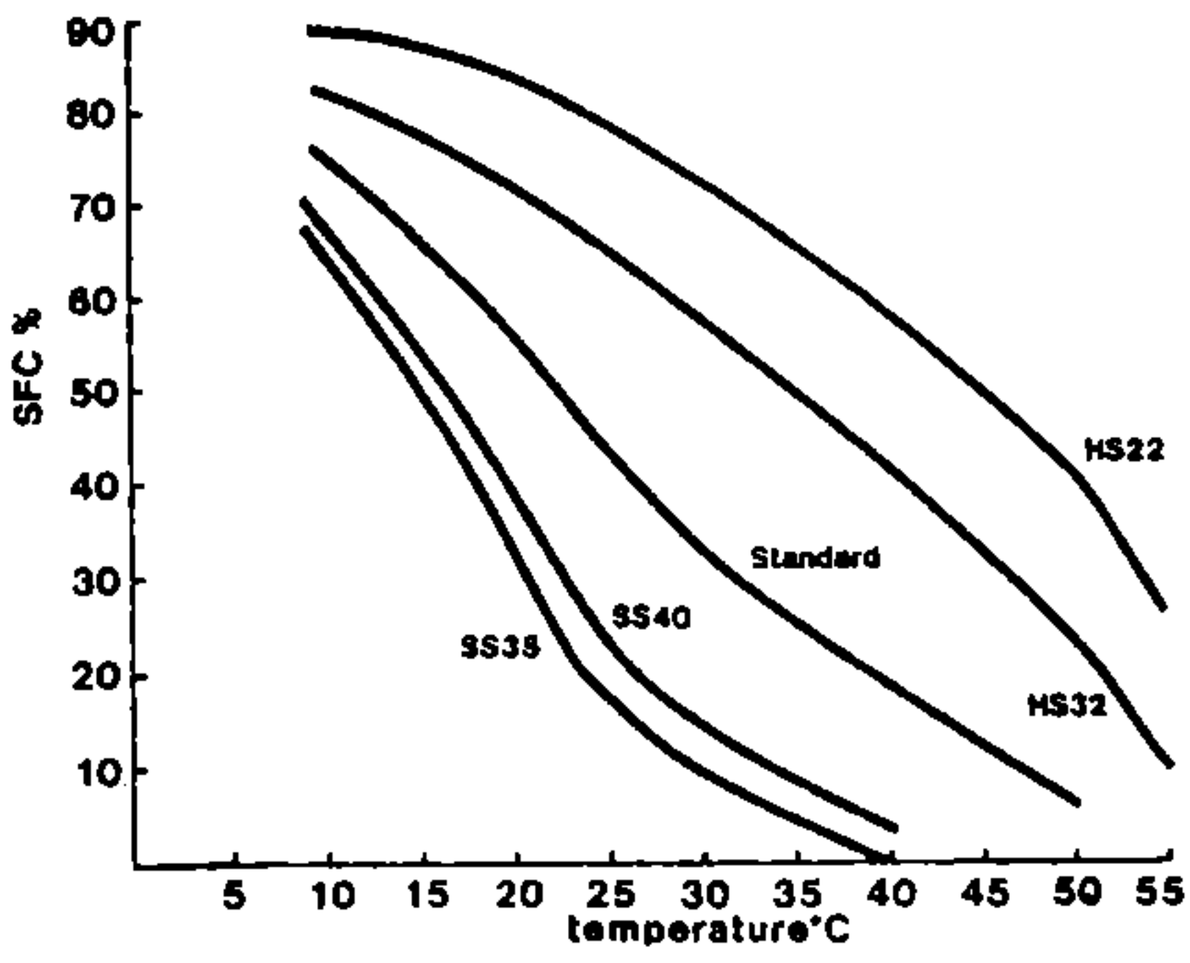

Figure 3. Solid content of stearins.

TABLE 9. QUALITY PARAMETERS OF RED PALM OIL

Carotenes	>89% intact
Tocopherols and tocotrienols	>89% intact
Free fatty acids	<0.1%
Peroxide value	<0.2
Phosphorus content	<2ppm
Moisture and impurities	<0.1%

TABLE 10. CAROTENE COMPOSITION (%) OF DEACIDIFIED AND DEODORIZED RED PALM OIL AND CRUDE PALM OIL

Carotene	Red palm oil	Crude palm oil
Phytoene	2.0	1.3
Phytofluene	1.2	0.1
cis-β-carotene	0.8	0.7
β-carotene	47.4	56.0
α-carotene	37.0	35.1
cis-α-carotene	6.9	2.5
δ-carotene	1.3	0.7
ξ-carotene	0.5	0.3
γ-carotene	0.6	0.8
neurosporene	trace	0.3
β-zeacarotene	0.5	0.7
α-zeacarotene	0.3	0.2
Lycopene	1.5	1.3
Total (ppm)	545	673

Cheese containing vegetable oils has a limited market in a number of countries. In an earlier publication, Nielsen and Pihl (1983), recommended a blend of 50% palm oil, 40% coconut oil, and 10% rapeseed oil to be emulsified with skimmed milk for cheese making. Recent laboratory studies have used palm kernel oil, palm oil, and red palm olein. The oils were homogenized with skim milk reconstituted from powder. Cheese was made by a standard process using a thermophilic and a mesophilic starter culture. Fresh milk and an emulsion of butterfat in skim milk were used as controls (Yusoff *et al.*, 1995).

TABLE 11. SOLID FAT CONTENT (%) OF SOME ICE CREAM FATS

Temperature	–5°C	0°C	+5°C	+10°C
Palm oil	82.4	78.6	69.5	54.6
Butterfat 1	75.7	72.5	66.0	52.2
Butterfat 2	71.6	68.2	61.7	46.9

TABLE 12. SOLID FAT CONTENT (%) OF BLENDS FOR WHIPPING CREAM

		Interesterified		
Temp. °C	HPKO 100	HPKO:POS 70:30	HPKO:POS 68:32	HPKO:POS 66:34
5	92.6	90.7	89.0	90.8
10	92.8	89.5	89.5	90.2
15	88.6	87.4	88.0	89.0
20	82.0	80.1	79.2	79.9
25	57.9	63.7	61.6	64.2
30	33.3	43.0	42.5	45.0
35	13.8	20.9	22.4	23.4
37	10.0	11.2	13.0	14.7
40	8.1	3.2	3.6	6.2

Mesophilic culture did not produce acceptable cheese from the vegetable-oil based milks. Cheese of satisfactory acceptability compared with the controls was produced with a thermophilic culture at 5% concentration. The results with all three experimental oils were similar.

TABLE 13. HEIGHT OF LEAKED SERUM ON STORAGE (cm)

			HPKO:POS					
	HPKO		70:30		68:32		66:34	
Temp.	Storage time							
°C	4 h	20 h	4 h	20 h	4 h	20 h	4 h	20 h
25	0	0	0	0	0	0	0	0
30	0	0.2	0	0	0	0	0	0
35	0	0.5	0	0.5	0	0.5	0	0.5
37	0	1.0	0	0.5	0	1.0	0	0.5
40	0.2	1.0	0.1	1.0	0.2	1.0	0.1	0.5

REFERENCES

BERGER, K G (1990). Recent developments in palm oil. *Oleagineux 45*: 437-447.

BERGER, K G (1990). Utilization de los aceites de palma y palmiste en la fabrication de helados y otros productos a base de crema batida. *Rev. Palmas 11*: 55-57.

BERGER, K G; TEAH, Y K and IDRIS, N A C (1989). The use of palm oil products in frying and baking. *Proceedings of International 'Chevrul' Congress*, (Angers, ed.). ETIG, Paris, France. p. 1227.

CHOO, Y M; MA, A N; YAP, S C; OOI, C K and BASIRON,Y (1993). Production and applications of deacidification and deodorised red palm oil. *Palm Oil Developments 19*: 30-34.

IDRIS, N A (1995). Application of palm oil products in salad dressing. *Palm oil Developments 23*: 1-3.

IDRIS, N A; BERGER, K G and ONG, A S H (1989). Evaluation of shortenings based on various palm oil products. *J. Sci. Food Agric. 46*: 481-493.

KHEIRI, M S A (1986). Interesterified vanaspati. *PORIM Research Report.*

KHEIRI, M S A (1985). Palm oil products in cooking fats. *J. Amer. Oil Chem. Soc. 62*: 410-416.

MAJUMDAR, S and BHATTA CHARYYA, D K (1986). *Trans*free vanaspati from palm stearin and vegetable oils by interesterification process. *Oleagineux 41*: 235-240.

NESARETNAM, K; ROBERTSON, N; BASIRON, Y and MACPHIE, C S (1993). Application of hyrdogenated palm kernel oil and palm stearin in whipping cream. *J. Sci. Food Agric. 61*: 401-407.

NIELSEN, V and PIHL, N H (1983). Vegetable fat blends for imitation cheese. *Nordiste Mejeri Industri 10*: 57.

RAIE, M Y; REHMAN, S and QURESHI, M M (1992). Characterization of *cis. trans* monoenoic acids in vanaspati ghee. *Proc. Pakistan Acad. Sci. 29*: 69-76.

TAN, B K (1989). Novel fractions and fats from palm and palm kernel oils. *Proceedings of International Conference on Fats.* Auckland, New Zealand, (R C Cambieed.), G 4.

YAP, P H; DEMAN, J M and DEMAN, L C (1989). Polymorphic stability of hydrogenated canola oil as affected by addition of palm oil. *J. Amer. Oil Chem. Soc. 66*: 1784-1781.

YUSOFF, M S A; SAMMY, M and AHMAD, K (1995). Palm-based imitation cheese. *Palm Oil Developments 23*: 4-6.