

TRANS FATTY ACIDS FREE FOOD FORMULATION BASED ON PALM OIL AND ITS PRODUCTS

DI TERIMA
30 OCT 1995
PUSAT MAKLUMAT SAWIT
PORIM

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Abbre. title:

Trans Fatty Acids Free Food Form. Based on PO and its Prod.

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ISSN 0128-5726

Trans Fatty Acids Free Food Formulation Based on Palm Oil and its Products

INTRODUCTION

Palm oil is a natural food product that, on record, has been consumed for more than 5000 years. It is now used worldwide as a cooking oil and incorporated into fat blends for the manufacture of a wide variety of food products. As it is partially solid, palm oil has the advantage of having physical and chemical characteristics which are ideally suited for use in margarine, shortening and vanaspati formulations.

Fractionation of palm oil into liquid olein and solid stearin enhances these applications. Palm olein is especially suited for deep fat frying because of its extreme stability against oxidation. On the other hand, stearins of several melting characteristics are ideal solid-stock ingredients for margarine formulations. Many other vegetable oils have to be hydrogenated to attain these properties, and this process generates a range of trans fatty acids. Trans fatty acids have been found to impart negative effects on human health. Recent fat nutritional research suggests that it is desirable to minimize the amount of these fatty acids in our diet.

This brochure will show that palm oil products can offer a natural source of fat that is free of trans fatty acids for food product formulation.

WHAT ARE TRANS FATTY ACIDS FREE FOOD PRODUCTS?

- Food products containing no (zero) trans fatty acids.
- Food products containing no partially hydrogenated fats.
- Food products containing no animal and/ or dairy fats that naturally contain trans fatty acids.

HOW TRANS FATTY ACIDS ARE FORMED?

Though most naturally occurring fatty acids are found in *cis*-form, small quantities of trans fatty acids do, however, occur naturally in ruminant fats and dairy products. The majority of dietary trans fatty acids are formed during hydrogenation process where some of the mono-unsaturated and polyunsaturated fatty acids gain this conformation. This reduces the percentage of beneficial monounsaturates and polyunsaturates of a fat or oil.

WHY REQUIRE TRANS FATTY ACIDS FREE FORMULATION?

Some nutritional studies have shown that dietary trans fatty acids have an adverse effect on health. Trans

fatty acids have been confirmed to reduce the beneficial HDL-cholesterol, raise the atherogenic LDL-cholesterol and alter the LDL/HDL-cholesterol ratio detrimentally. Such factors enhance the relative risk of heart diseases for the general public by many folds. Of even greater concern is the ability of trans fatty acids to increase lipoprotein Lp(a) levels which is an independent and powerful risk factor for heart disease. Several other studies have implicated their roles in increasing the risk of cancer, interfering with fat metabolism and reducing the body's ability to rid itself of carcinogens, drugs and other toxins.

TRANS FATTY ACIDS FREE MARGARINES

Margarine was originally developed as an alternative to butter. The first margarines were made from animal fats, but today most margarines are formulated using vegetable oils. The product range now includes table margarines which fall in two main types i.e. packet and tub,

TABLE 1. PERFORMANCE REQUIREMENT OF MARGARINE

Type	Required performance
Tub	Spreadable at 5°C- 10°C
Packet	Spreadable at 15°C (in temperate climate) and 20°C-25°C (in tropical climate)
Industrial or bakery	Good creaming and cake baking
Pastry	Good "lift" in pastry

Source: Berger (1981).

bakery margarines and specialized puff pastry margarines (Table 1). Recently the range has been extended to include various "low calorie" spreads, which contain much higher levels of water (and lower levels of fat) than those legally required for margarine.

Formulations for trans fatty acids free table and bakery margarines are shown in Tables 2 to 4. These formulations have been tested and are found to be satisfactory. For pastry margarines, some formulations with promising solid fat contents are shown in Table 5.

TRANS FATTY ACIDS FREE BAKERY SHORTENING

Shortenings are anhydrous fats used in the preparation of foods to impart a "short" or "tender" quality to baked products such as cakes, cookies, pastry and bread. It can also be used as a frying medium. There are two main types of shortenings i.e. plastic and liquid shortenings.

Bakery shortenings need to have a smooth consistency to facilitate mixing. This could be achieved by ensuring that they solidify in a fine crystal structure. Beside contributing to smoothness, they are also essential in cake making and creaming applications. A further requirement for bakery shortenings is that they should not melt too quickly during baking, so that the air bubbles last until the cooking process has created structural materials from the other ingredients.

A number of palm based formulae for baking have been extensively examined and Table 6 gives those which are free of trans fatty

TABLE 2. TRANS FATTY ACIDS
FREE FORMULATION FOR TUB MARGARINES

Fats	Choices of Proportion (%)						
	1	2	3	4	5	6	7
PO	45						50
PO _o	40	40					
PO _s	7	10					
PKO	3						20
SFO	5					45	
SFO (Hybrid)							30
RSO		50	40				
Interesterified blend							
PO _s :RSO [70:30]			60				
PO _s :RSO:PKO [40:20:20]				100			
PO _s :PKO _o [60:40]					100		
PO _s :PKO _o :SFO [60:20:20]						55	
Melting Point (°C)	33.3	–	34.4	22.3	34.3	34.0	30.7
Solid Fat Content (%)							
10°C	24.5	13.3	22.3	26.3	31.8	16.0	27.0
15°C		8.3	15.5	16.9	23.3	14.0	15.8
20°C	8.9	4.0	9.3	8.6	15.6	11.0	8.3
25°C		1.6	7.3		10.8		5.5
30°C		0.5	4.6	1.4	6.3	5.9	2.6
35°C	NA	0.3			2.4		1.7
40°C		–	0.6	–	–	–	–



Tub and Packet Margarine

**TABLE 3. TRANS FATTY ACIDS FREE FORMULATION
FOR PACKET MARGARINES**

Fats	Choices of Proportion (%)				
	1	2	3	4*	5*
SBO	50		45		
RSO		40			
Interesterified blend					
PO:PKO _o [80:20]	50				
PKO:PO [30:70]			55		
POs:PKO _o [70:30]		60			
PO _o :PKO [70:30]				100	
POs:PKO [75:25]					100
Melting Point (°C)	29.8	35.8	33.2	33.5	32.5
Solid Fat Content (%)					
15°C	14.5	22.0	22.8	34.6	33.5
20°C	9.3	15.8	15.8	22.7	22.5
30°C	3.6	6.7	5.8	7.8	6.9
35°C	2.5	2.6	2.7		

*3 resembles block margarine made in Japan

*4 and 5 resemble block margarine made in Denmark

**TABLE 4. TRANS FATTY ACIDS FREE FORMULATION FOR
INDUSTRIAL OR BAKERY MARGARINES**

Fats	Choices of Proportion (%)					
	1	2	3	4	5	6
PO		60			90	54
PO _o			60	20		
POs	60	10	30	50	10	15
PKO		30				31
SBO			10	30		
RSO	40					
SFC (%)						
Temp.				SFI (%)		
10°C	36.5	55.4	44.7	36.5		
15°C	29.9	38.9	33.2	29.5	32.8	28.5
20°C	23.3	27.9	23.6	20.1	23.5	20.2
25°C	17.7	19.9	14.5	14.8	14.3	12.6
30°C	14.0	13.7	10.8	10.8	9.5	9.5
35°C	10.1	9.1	8.7	8.8	5.6	7.7
40°C	7.4	8.4	6.5	5.7		



Products Baked Using Industrial Margarine

TABLE 5. TRANS FATTY ACIDS FREE FORMULATION FOR PASTRY MARGARINES

Fats	Choices of Proportion (%)		
	1	2	3
PO	10		
POs	90	80	80
PKO		20	
SBO			20
Melting Point (°C)	43.6	—	43.3
Solid Fat Content (%)			
10°C	63.9	57.8	69.1
15°C	52.6	43.9	57.8
20°C	40.1	31.1	46.3
25°C	28.9	22.9	33.6
30°C	20.8	16.8	23.8
35°C	17.1	12.2	17.7
40°C	12.5	10.1	8.3



Products Baked Using Pastry Margarine



Products Baked Using Bakery Shortening

TABLE 6. TRANS FATTY ACIDS FREE FORMULATION FOR BAKERY SHORTENING

Fats	Choices of Proportion (%)			
	1	2	3	4
POs	50	60		
RSO (LE)	50			
SBO		40		
Interesterified blend				
POs:SBO [70:30]			100	
POs:CSO [60:40]				100
Melting Point (°C)	43.9	42.2	44.0	43.5
Solid Fat Content (%)				
10°C	29.5	35.0	44.5	33.5
15°C	23.5	28.5	34.7	28.7
20°C	19.5	21.3	26.8	21.7
25°C	16.0	16.2	21.5	17.5
30°C	13.0	12.0	14.8	13.1
35°C	10.0	9.7	13.7	11.9
40°C	8.0	7.5	9.6	7.9

acids and consistently produce the best results. All the samples have a slip melting point above 40°C and a solid fat content between 14%–26% at the temperature used as expected for a good cake shortening. All samples showed good baking performance, producing cakes which are comparable in volume, texture, structure, flavour and eating characteristics to the cakes made with a commercial control shortening.

TRANS FATTY ACIDS FREE FRYING OIL

The most important characteristics of a fat used for frying is its ability to withstand the high temperature without excessive chemical change. Oils containing significant levels of polyunsaturated fatty acid (linoleic and linolenic), unless they have been hydrogenated are not recommended for frying because they tend to get oxidized and either breakdown or polymerize quite rapidly.



Products Fried Using Palm Based Oils

Palm oil, with its moderate linoleic acid and very small linolenic acid content, and high level of natural antioxidants, is suitable for direct use in most frying applications. It has a high resistance to oxidation and does not leave an unpleasant room odour. So, it is a natural choice worldwide both in the domestic environment and large scale industrial frying operation. This is especially so in the light of the current controversy over the presence of trans fatty acids which are unavoidably produced in hydrogenated liquid vegetable oils.

To date, there are at least five types of palm oil and its fractionated products, palm olein, which contain no trans fatty acids and have been used worldwide for frying.

The five are:

1. RBD palm olein / NBD palm olein.
2. RBD palm oil / NBD palm oil.
3. Blends of palm olein with polyunsaturated oils.
4. Solid palm shortening.
5. Pourable palm oil.

3, 4 and 5 can be tailored-made according to the user's requests.



TRANS FATTY ACID FREE VANASPATI

Vanaspatti is an all purpose cooking fat originally developed as an alternative to the traditional butter fat ghee. It is now widely used in the Indo-Pakistan sub-continent, Middle East and South East Asia. It is required to have a coarse granular structure at ambient temperature, with crystals of 1-2 mm in size. Though it has a rather solid texture at ambient temperature, it is usually required to melt at 37°C-39°C.

Originally it was made from hydrogenated vegetable oils, hydrogenation being a necessary part of the process. This is a fairly costly process and at the same time, produce the undesirable trans fatty acids. Palm oil, which has similar physical characteristics such as melting point, melting profile and semi-solid consistency at ambient temperature to vanaspatti, does not require hydrogenation process. Though naturally it does not develop the desired granular appearance, it can be improved by using the technique of interesterification, to produce vanaspatti of satisfactory consistency. In addition, interesterification process can also increase the amount of palm oil and its products (especially palm stearin) in the vanaspatti preparation, leading to a trans fatty acids free formulation.

Vanaspatti formulation based on interesterified blends of palm oil and its products with a variety of other vegetable oils are shown in Table 7. All the tested samples simulate the

TABLE 7. TRANS FATTY ACIDS FREE FORMULATION FOR VANASPATI (based on interesterified blend)

Fats	Choices of Proportion (%)				
	1	2	3	4	5
PO	80				
POs		70	60	70	50
RBO	20				50
RSO (LE)				30	
SBO		30			
CSO			40		
Melting Point (°C)	41.5	41.0	42.0	40.0	36.5

conventional hydrogenated vanaspatti, with respect to melting characteristics and physical appearance that includes granulation and phase separation.

TRANS FATTY ACIDS FREE CONFECTIONERY FATS

Chocolate products are regarded the world over as a special "treat". Their attraction lies in the unique flavour of the roasted cocoa bean, and in the characteristic brittle tex-



Confectionery Products

ture, the "snap" and the "crunch" experience in breaking and chewing. This texture, which is derived from the fat, must be accompanied by rapid melt-in-the-mouth sensation and no residual greasy feeling.

The desirable physical properties of cocoa butter resulted from its unique chemical composition, having a high proportion of the glyceride POS, which is not available from other natural sources. However a similar behaviour can be obtained from POP-mid fraction of palm oil (PMF) mixed with SOS, a fraction from a fractionation of Sal, Shea or Illipe fats. Examples of suitable formulation are given in *Table 8*.

TABLE 8. TRANS FATTY ACIDS FREE FORMULATION OF COCOA BUTTER EQUIVALENT FATS

Fats	Choices of Proportion (%)		
	1	2	3
Palm mid-fraction	100	70-80	60-65
Shea or Sal stearin		20-30	20-30
Illipe			15-20

Source: Berger (1981a)

They can be used 100% on their own in plain chocolate or used with milk fat for milk chocolate.

Cocoa butter-like fat can also be produced by interesterification process, chemically or enzymatically. For instance, a cocoa butter-like fat having triglyceride composition and melting profile comparable to that of cocoa butter can be produced from enzymatically interesterified palm

olein. Confectionery fats suitable for butter cream filling in biscuits for instance can also be prepared by means of interesterification process. The blends prepared for interesterification are shown in *Table 9*.

TABLE 9. CONFECTIONERS' BUTTER BY INTERESTERIFICATION

Fats	Choices of Proportion (%)			
	1	2	3	
POs (I.V. 10)	25	30		
POs (I.V. 8)			25	
PKOo (I.V. 22)	75	70	37.5	
PKO			37.5	
Melting Point (°C)	32.0	34.5	35.9	
Solid Fat	D 20	970	1110	710
	D 25	275	405	345
	D 30	20	105	130
	D 40	15	15	10

For use as chocolate flavoured coating on ice cream bars and deep frozen confections, palm or palm kernel oil is usually blended with other liquid oils, such as ground nut oil, to give the right physical behaviour.

TRANS FATTY ACIDS FREE IMITATION DAIRY PRODUCTS

In imitation dairy products, vegetable oils are used to replace milk fat. These products usually have better keeping properties than those containing butterfat, a particular advantage derived from palm oil usage.

Palm oil is used in "filled" milks, as either milk or condensed milk with or without sugar. Palm oil is also used in coffee whiteners or cof-

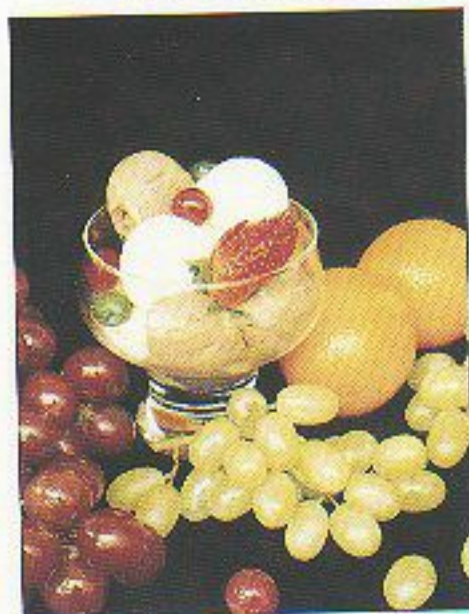


Palm Oil Based Filled Milk

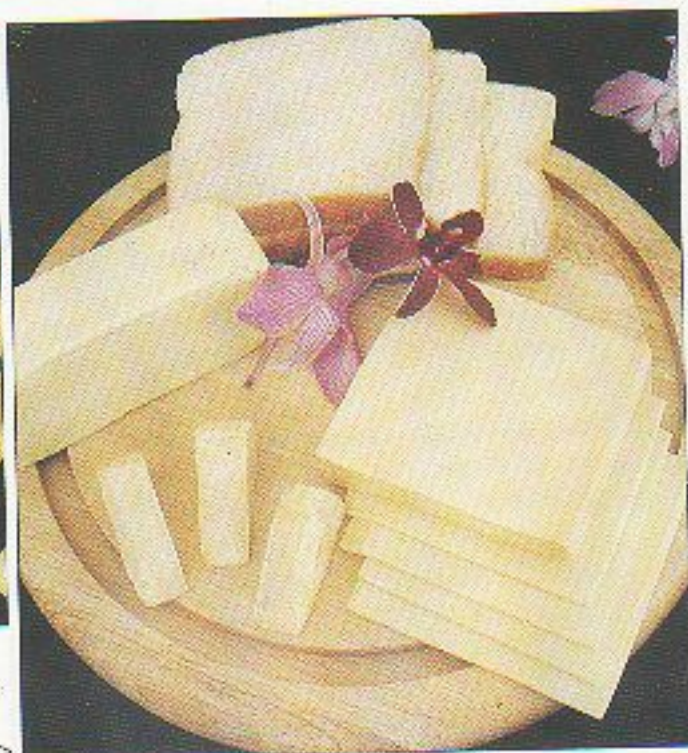
free creamer, presented either in powder or liquid form.

Palm oil and palm kernel oil are also a satisfactory alternative to butterfat in ice cream. Table 10 shows the solid contents of these oils and that of butterfat for comparison.

Palm oil can also be used in making imitation cheese. In making cheese, it is desirable to use a fat blend containing some short chain fatty acids similar to butterfat because part of the



Palm Oil Based Ice Cream



Palm Oil Based Imitation Cheese >

TABLE 10. SOLID FAT CONTENT (%) OF ICE CREAM FATS

Product	Temperature (°C)						
	-5	0	5	10	20	25	35
PKO	56.1	84.2	78.9	72.2	45.5	21.5	0.0
PO	82.4	78.6	69.5	54.6	23.2	13.7	6.0
Butterfat	71.6	68.2	61.7	46.9	26.0	18.0	8.0

final characteristic flavour of cheese is developed from these component. A blend of 50% palm oil, 40% palm kernel oil or coconut oil and 10% rapeseed oil or soya bean oil is recommended.

CONCLUSION

As can be seen, palm oil and its products exhibit versatile characteristics to enable them to be used in trans fatty acids free food products. Such trans fatty acids free food products will have tremendous benefits to the consumer and will go a long way towards promoting healthy living.

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ABBREVIATION

PO = Palm oil
 PO_o = Palm olein
 PO_s = Palm stearin
 PKO = Palm kernel oil
 PKO_o = Palm kernel olein
 SFO = Sunflower oil
 RSO = Rapeseed oil
 RSO(LE) = Rapeseed oil (Low erucic acid)

SBO = Soya bean oil
 CSO = Cottonseed oil
 RBO = Ricebran oil
 RBD = Refined, bleached and deodorized
 NBD = Neutralized, bleached and deodorized
 Temp. = Temperature
 SFC = Solid fat content
 SFI = Solid fat index