APPLICATIONS OF PALM OIL AND PALM KERNEL OILS IN DIFFERENT FOOD PRODUCTS OF BANGLADESH

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Abstract : *Among the commonly used vegetable oils and fats, palm oil is by far the most versatile. After refining, palm oil possesses all the characteristics required for many uses without hydrogenation. By fractionating palm oil, its uses are further increased. Hydrogenation and interesterification increase its uses even further, especially in making specialized and sophisticated edible products. Its versatility makes it a suitable raw material for many applications both in edible and non-edible products. The functionality of shortenings to be used in cakes, "butter cream" fillings, biscuits and pastry is dependent on several factors, such as a smooth consistency to facilitate mixing and a fine crystal structure in the solid fat phase. This contributes to smoothness, and is essential in cake making and creaming applications.*

Keywords: *CBE, CBS, RBD, HPK Oil, Hydrogenation, Cocoa butter*

1. Introduction

Palm oil and palm kernel oil are ideal raw materials for the production of speciality fats. Palm oil contains about 50% of the long-chain saturated fatty acids of which palmitic acid constitutes about 44% (Table 1). Palm oil also contains a significant amount of the symmetrical SOS-type triglyceride which is one of the major triglycerides present in cocoa butter (Table 2). Palm kernel oil and coconut oil having the two lauric oils which are of commercial importance. These two oils are interchangeable in many applications because of their similarities in properties. However, palm kernel oil contains a higher amount of oleic acid than coconut oil (Table 3). This makes palm kernel oil very suitable oil for hydrogenation (hardening) for the production of speciality fats with different end-use melting points and hardness. Palm and palm kernel oils, like most of other vegetable oils in their original state, have a limited application when utilized as such. Hence their properties have to be modified in order to extend the range of utilization. Speciality fats are mainly food grade Oil/fats of the following types:-

- Cocoa Butter Equivalent (CBE)
- Cocoa Butter Substitute (CBS)
- Toffee Fat
- Non-Dairy Fat
- Cream Filling Fat
- General Purpose Coating Fat
- RBD Palm Oil/Olien
- HPK Oil
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2. Base Oil Modification Processes

The following processes are commonly used for the production of specialty fats:

- Fractionation,
- Hydrogenation, and
- Interesterification

Fractionation

By fractionation methods, oil is separated into liquid and solid fractions.

These are:

- Dry fractionation,
- Detergent fractionation, and
- Solvent fractionation

Hydrogenation

Hydrogenation is carried out to remove the unsaturation of fatty acids and hence to increase the oxidative stability and melting point of oils. Depending on the extent of hydrogenation, the oils and fats can be modified to products of various hardness,thus giving a wider range of utilization.

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Table 1 Fatty Acid Compositions (%)

Fatty Acids	Cocoa Butter	Palm Oil	Beef Tallow
14:0		1	3
16:0	26.5	44	26
18:0	35	4.5	19.5
18:1	35	39	40
18:2	3	10	3.5
18:3		0.5	0.5
Total Saturated	61.5	49.5	48.5

Table 2 Triglyceride Compositions (%)

Triglyceride	Cocoa Butter	Palm Oil	Palm Olein	Beef Tallow
SSS	3	8	< 1	8
S_2U	82	48	49.5	39
of which :				
SOS	75	33	34.5	25
SSU	0.5	6	6.5	11
SPS	6.5	9	9	3
SU_2	14	37	41	41
UUU	1	7	9	12

S = Saturated Acids, U = Unsaturated Acids,
O = Monounsaturated Acids,
P = Polyunsaturated Acids

Table 3 Fatty Acid Composition of Coconut Oil and Palm Kernel Oil

Coconut Oil	Fatty Acids	Palm kernel Oil
15%	Short Chain Saturated Acids	8%
48	Lauric Acid (12:0)	48
18	Myristic Acid (14:0)	16
9	Palmitic Acid (16:0)	8
2	Stearic Acid (18:0)	2
6	Oleic Acid (18:1)	15
3	Linoleic Acid (18:2)	3

Controlled hydrogenation of palm kernel oil with a melting point of about 27-28°C produces a useful range of hydrogenated (hardened) palm kernel fats with melting points of 32-41°C .

Interesterification

Interesterification (or rearrangement) is a process which alters the distribution of fatty acids in the glycerol moiety of triglyceride, thus producing fats with different melting and crystallization characteristics compared to the uninteresterified fat.

Classification and Production of Speciality Fats

Speciality fats can be classified according to their chemical compositions into three types, namely:

1. Symmetrical,
2. Lauric, and
3. High-*trans*

Symmetrical-type speciality fats contain predominantly symmetrical SOS-type triglycerides. The major triglycerides POSt, StOSt and POP in cocoa butter are often summarized as SOS triglycerides. Solvent fractionation of palm oil produces a mid-fraction with a high content of the POP triglyceride [1]. By blending this palm mid-fraction with Illipe fat which contains StOSt and POSt triglycerides a Cocoa Butter Equivalent (CBE) fat with physico-chemical characteristics similar to those of cocoa butter can be produced [2]. Lauric-type speciality fats are produced from oils containing mainly of triglycerides of lauric and myristic acids. For instance, hydrogenation of palm kernel oil produces a range of lauric-type fats with slip melting points varying from 32 to 41°C. Palm kernel oil can also be fractionated by dry, detergent or solvent fractionation to give a stearin with much better melting properties than the hydrogenated palm kernel fats. The palm kernel stearin with physical properties such as the high solid fat contents and steep melting profile resembling cocoa butter is usually described as Cocoa Butter Substitute (CBS). High-*trans*-type fats can be produced by selectively hydrogenating palm olein, or by a combination of selective hydrogenation and fractionation from liquid oils such as soya bean oil or blends of oils [3]. These fats are easily distinguished from cocoa butter by their content of *trans* acids (Table 4).

Table 4 Comparison of Fatty Acid Compositions (%) of Cocoa Butter and a High-*Trans*- Type Speciality Fat

Fatty Acid by carbon number	Cocoa Butter	High-*Trans* Fat
16 : 0	26	23
18 : 0	32	12
18 : 1 *cis*	34	16
18:1 *trans*	0	46

The melting properties of some high-*trans*-type speciality fats are given in Table 5. They are sometimes called cocoa butter partial replacers because they are more compatible with cocoa butter than the lauric-type CBS.

Table 5 Melting Properties of Some High-*Trans*- Type Speciality Fats

Speciality Fat	Solid Fat Content				
	20^0C	25^0 C	30^0C	35^0 C	40^0 C
Bakery Fat	74	62	40	19	0
Cream Fat	76	62	43	18	3
Soft Biscuit Fat	75	65	54	20	0
Candy Fat	75	64	44	22	3
CBR (LS)	74	58	38	17	0
Cocoa butter	80	76	50	0	

Applications of Fats/Oils in Food products

Non-Dairy Products

Un-hydrogenated (or unhardened) palm kernel oil and olein are ideal fats for the manufacture of non-dairy products. They can be used as fast-setting chocolate coating fats for ice cream and other deep-frozen confections. The coatings set quickly when applied on to ice cream. These palm kernel fats are more suitable and perform better than cocoa butter for this purpose because the coatings formed are hard but not brittle whereas pure chocolate coating (with cocoa butter) sets too hard, is brittle and flakes off easily. Ice cream coating formulation is given in Table 6.

Table 6. A Ice Cream Covertures Recipe

Ingredient	%
Cocoa powder (10 - 12%)	14
Icing (fine) sugar	25
Palm Oil Fat	5
Lecithin	60
	0.5

Coatings and Filler Creams

The hydrogenated lauric fats with melting points of 32-41°C can be used as coating fats. These lauric fats have high solids at room temperature and melt rapidly enough to produce fairly good quality coating systems. Hydrogenated palm kernel oil with melting point of 39-41°C is used for coating wafers, Chocolate Bar, Deposited Candy and Cream for Cake. However, those with high melting points melt above body temperature and therefore produce a waxy mouth feel. Coatings made from hydrogenated palm kernel oil and interesterified palm kernel oil have moderate resistance to fat bloom and the gloss is inferior to those based on fractionated palm kernel stearin. Palm kernel fats interesterified with/without a small amount of palm oil can also be used for the preparation of cheap and intermediate grade coatings with firm but not very brittle texture at ambient temperature and good melting properties. Hydrogenated palm kernel olein can be used in the formulation of bakery coatings and glazes for cakes and biscuit creams. Cream filling between wafers requires fats which set quickly and yet melt cleanly in the mouth giving a cool sensation on the palate. Hydrogenated palm kernel oleins are ideal for this formulation. In the batch recipe about 5-10% HPK Oil is used.

3. RBD Palm Oil

Refined bleached Palm Oil is used in bakery industry as shortening agent. During mixing of dough for cake, biscuits and crackers, PKOil with HPKOil mix is used with icing sugar and Skimmed Milk powder for cream formation and then forming the tender dough for bakery items as per recipe.

Toffee /Butter Scotch

Hydrogenated palm kernel oil or olein is largely used as a cheaper alternative toffee fat to replace the more expensive dairy butter, either completely or to combine with butter in the making of toffees. The inclusion of these fats in toffees retains the good texture by giving body to the products and offering resistance to moisture penetration. They also provide lubrication and chewiness to the products. Recipes for toffees are given in Table 7.

Table 7 Recipes of Toffee

Ingredient	Banglad eshi Recipe	**"Tropical" Recipe**
Granulated sugar	30%	15
Glucose syrup	32%	43
Skimmed sweetene condensed milk	20%	28
Vegetable fat	10%	11
Water	7%	3
Salt	0.3kg	0.4kg

Whipped Toppings

These products are regularly formulated using hydrogenated palm kernel oil, hydrogenated palm kernel stearin, or blends of the two (for economy) which impart an easy air incorporation during whipping and give high solids content required for foam stiffness Whipped product is used in cake, desert, and decoration of different sweetmeat in home made /commercial ready to eat products.

Table 8 Formulation for Whipping Toppings

Ingredient	**kg**
Icing Sugar	43
Skimmed Milk Powder	20
HPK Oil	20
Corn starch	5
Water	10
Salt 1	0.1
Fruit Flavor	0.1
Fruit Acid	

Substitute Chocolates/Compound Coatings

Palm kernel stearin based CBS is suitable for the manufacture of solid or hollow-molded products with excellent mold release, good snap, steep melting characteristics and good flavour release and resistance to fat bloom. Although substitute chocolate formulated from lauric fats forms stable crystals on rapid cooling without tempering which simplifies production plant and reduces costs, palm kernel stearin based CBS forms eutectic mixtures with cocoa butter, i.e. the fat is not compatible with cocoa butter. It can only tolerate a limited, small, amount of cocoa butter,[4,5] and therefore must substitute for all the cocoa butter in the recipe if a good chocolate is to be made. Hence in substitute chocolate or other coating formulations, the CBS based coating must be formulated with low-fat cocoa powder in order to avoid incompatibility with cocoa butter. Coatings formulated with these fractionated lauric fats are very similar to real chocolate (made using cocoa butter) in set-up, shrink, snap and eating qualities. A typical substitute chocolate made with CBS is shown in Table 9.

Table 9 A Typical Substitute Chocolate Recipe

Ingredients	**Percentage**
Cocoa powder	10%
Icing sugar	40%
Skimmed milk powder	20%
Cocoa butter Substitute (CBS)	28%
	100 parts
+ Lecithin	0.7
+ Vanillin	0.1
+ OOOHI	1

CBE fat which is compatible with cocoa butter in almost any proportions can be used in "chocolate"/coatings. In certain countries where legislations allow, even up to about 15% of the cocoa butter in chocolate may be replaced by a CBE fat and the product may still be described as "chocolate". In terms of texture and flavour these products are very close to real (cocoa butter) chocolate. Typical formulations using CBEs are given in Table 10

Table 10 A Typical Formulation Using CBEs[7]

Ingredients	Milk Chocolate	Coating Chocolate	Dark Chocolate
Milk	25%	25%	15%
Cocoa Butter (CBE)	25%	35%	35%
Cocoa Powder	8%	10%	12%
Sugar	41.3%	28.8%	37%
Lecithin	0.7%	1.2%	1.0%

CBE = Cocoa Butter Equivalent

Double Refined palm oil in fried snacks

In Bangladesh, traditional oil fried snacks food are most popular among all age level people. Usually Chanachure, potato cheeps, Mug Dal, lentils, cow peas, green peas, and pea nut etc are deep oil fried ready to eat crispy products with high food value.

Table 11 A typical recipe is ethnic snacks food in Bangladesh

Ingredient	**Chanachure**	**Green peas**	**Mug/ Peanut**
Pulse Flour	38%	0	0
Lentils	4%	0	0
Cow peas/green peas	4%	60%	0
Rice flakes	2%	0	0
Roasted pea nut	5%	0	60%
Mug Dal	5%	1%	60%
Spices mix	1.2%	1%	1.5%
Red pepper	0.3%	0.2%	1%
Garlic	0.1%		
Zinger	0.01%	0	1%
Refined Palm Oil	34%	35%	0.2% 35%
Common salt	0.7%	0.8%	0.8%
Citric Acid	0.1%	0.2%	0.2%
Wheat flour	5%	0	0
Baking agent	0.2%	0	0

Stability of Speciality Fats

Speciality fats produced from palm and palm kernel oils, especially the hydrogenated fats, are very stable against oxidation. The oxidative stability of some palm kernel products, determined by a Rancimat apparatus, is shown in Table 11. The only serious disadvantage of using palm kernel and other lauric fats is that in the presence of moisture and enzyme lipase, hydrolytic fat splitting can occur, liberating the short-chain fatty acids (C6:0 to C12:0) which may give rise to unpleasant soapy off-flavour. In view of this sensitivity of lauric fats to hydrolysis good manufacturing practices, such as using fresh and good quality raw materials and precautions to prevent post- infection, are needed when using lauric fats in food products.

Table 12 Oxidative Stability Determined by Rancimat

Names	Time in hours at 120ºC
Soyabean oil	4
Palm kernel oil	11
Hardened palm kernel olein (MP = 35^0C)	16
Hardened palm kernel oil (MP = 40^0C)	41
Hardened palm kernel stearin	42

4. Conclusion

The unique properties of palm and palm kernel oils have made these two oils particularly attractive to the food processing industry. Palm and palm kernel oils, with modification, are undoubtedly commercially ideal raw materials for the production of various speciality fats which include RBD PkO, CBE, CBS, toffee fats, non-dairy fats and cream filling fats. These fats are used in products such as chocolates/coatings, toffees, coffee whiteners, whipped toppings as cream in cake, Chocolate bar, Cake, Candy, Jelly, fried Snacks such as chanachure, potato chips, sweetmeat , filler creams and non-dairy products. Although kernel and coconut oils are interchangeable in application it appears that the utilization of palm kernel based food grade fats is increasing at the expense of coconut based fats. With continuous increase in production of palm and palm kernel oils these two oils are expected to remain available in quantities sufficient to meet the demands by speciality fat users.

5. References

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