Specialty Fats

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ABSTRACT

The scope of this presentation is limited to hard butters. Their production technology is reviewed briefly with emphasis on principal raw materials and processing. Hard butters are described in terms of composition, certain thermal properties, and end uses. Confectionery and imitation dairy applications are identified as the major world markets for hard butters.

INTRODUCTION

Fats and oils play a vital role in the formulation and preparation of a variety of foods. Foods like icings, mayonnaise, margarine, chocolate, confectionery coatings, imitation dairy coffee whiteners, toppings, cheeses, and dips possess desirable qualities that are attributed to the fats they contain. Certain confectionery and imitation dairy products require specialty fats for their formulation. These fats are replacements or substitutes for cocoa butter and butter fat in confectionery and imitation dairy products, respectively. They are hard and brittle at and below room temperature and melt completely, or nearly completely, at body temperature. They are known commonly as hard butters.

TABLE I

Crude Vegetable Oils Used Commercially in Hard Butters

Lauric	Nonlauric
Palmkernel	Illipe
Coconut	Shea
Tucum	Cottonseed
---	Palm
---	Soybean

TABLE II

Hydrogenated Hard Butters

	Oils	
Fatty acid	Soybean	Palmkernel
12:0	-	48.9
14:0	0.1	15.7
16:0	2.4	7.8
17:0	-	-
18:0	5.8	12.1
18:1	86.8	6.0
18:2	4.9	0.5
18:3	-	-
20:0	-	0.1
Iodine value	70.6	5.0
WMP (F)	102.1	104.0
% Trans	53.6	
SFI @ °F		
50	64.1	67.0
70	52.5	46.0
80	44.0	32.0
92	19.7	14.2
100	6.1	2.1
110	0	0

RAW MATERIALS

Today, hard butters are produced from a variety of crude oils and fats. These can be derived from animal or vegetable sources. A useful classification for vegetable oils is illustrated in Table I. Only oils which are used commercially in the production of hard butters are listed.

Palmkernel and coconut crude oils represent lauric oils which are readily available. Crude tucum oil is limited in supply and is extracted or pressed from the fruit of a species of wild palm.

Illipe and shea nuts are harvested from the wild and are processed to provide nonlauric crude oils. Crude illipe and shea oils are in short supply and are often of poor quality. The remaining crude oils listed are well known and readily available.

PRODUCTION TECHNOLOGY

Hard butters are produced from suitable refined oils which are modified by chemical and/or thermomechanical processes. Commercial technologies which are in use today are hydrogenation, interesterification, replacement or re-esterification, and fractionation. Modification of the natural oil to produce a desired hard butter is accomplished with one or more of these processes. A manufacturer's ability to produce an acceptable hard butter will depend on the nature of processing capabilities and on the crude oils available.

Two types of hydrogenated hard butter are described in Table II. One is produced from soybean oil which is hydrogenated under optimum "trans" conditions to an iodine value of ca. 70. It primarily is used in the preparation of confectionery coatings for the enrobing of soft cake goods. The other is produced by hydrogenation of palmkernel oil to an iodine value of 5.0 and a melting point of 104.0 F (40 C). It finds use as a dairy fat substitute in the

TABLE III

Hard Butters by Interesterification

Fatty acid	1	2
6:0	0.3	0.4
8:0	4.2	5.8
10:0	3.8	4.7
12:0	48.7	41.7
14:0	15.6	14.8
16:0	7.9	10.4
18:0	17.4	20.6
18:1	1.4	1.1
18:2	0.6	0.2
18:3	-	-
20:0	0.1	0.2
Iodine value	1.5	0.8
WMP (F)	95.0	100.1
SFI @ °F		
50	69.0	67.0
70	56.0	54.3
80	40.5	38.3
92	11.0	14.0
100	0.0	2.0
110	-	-

TABLE IV

Hard Butter from Fractionated Reesterified Coconut Stearine Fatty Acids

Fatty acid	% by wt
6:0	-
8:0	0.9
10:0	4.2
12:0	54.1
14:0	20.8
16:0	9.5
17:0	-
18:0	10.2
17:0	-
18:0	0.1
18:1	-
20:0	0.2

Iodine value	0.0
WMP (F)	97.8
SFI @ °F	
50	74.5
70	73.1
80	61.1
92	8.0
100	0.3
110	0.0

TABLE V

Stearine Fraction from Winterized Palmkernel

Fatty acid	% by wt
6:0	0.2
8:0	2.8
10:0	3.4
11:0	-
12:0	56.5
13:0	-
14:0	20.2
16:0	7.5
17:0	-
18:0	2.2
18:1	6.5
18:2	0.7
18:3	-
20:0	-

Iodine value	6.8
WMP (F)	89.6
SIF @ °F	
50	68.9
70	61.2
80	47.6
92	0.6
100	0.0
110	-

formulation of imitation dairy toppings. It also is a cocoa butter substitute used in low cost confectionery coatings. These hard butters are typical of those produced by hydrogenation.

Hydrogenation may be combined with interesterification to produce other useful hard butters. Table III lists the composition and properties of two such hard butters. The lowest melting, number 1, is produced by interesterification of hydrogenated palmkernel oil. The low melting point and steep SFI (Solid Fat Index) profile make it desirable for the formulation of imitation dairy products and pastel coatings which require hard butters with rapid "melt away." The higher melting hard butter, number 2, is produced from an interesterified blend of hydrogenated palmkernel and hydrogenated palm or cottonseed oils. It is used as a cocoa butter substitute in formulating confectionery coatings for enrobing biscuits, crackers, cookies, and various centers in low-cost enrobed bars. Products formulated with these hard butters possess better eating qualities than similar products formulated with the hydrogenated hard butters of Table II.

Hard butters with further improved characteristics and

TABLE VI

Hard Butters from Winterized Stearine Fraction, Hydrogenated Palmkernel, and Hydrogenated Palm

Fatty acid	% by wt
6:0	0.2
8:0	2.9
10:0	3.5
11:0	-
12:0	55.8
13:0	-
14:0	19.9
16:0	7.5
17:0	-
18:0	3.7
18:1	5.9
18:2	0.6
18:3	-
20:0	-

Iodine value	6.1
WMP (F)	92.4
SFI @ °F	
50	69.2
70	61.4
80	46.7
92	1.5
100	0.0
110	-

broader utility can be produced by either fatty acid replacement reactions or by reesterification with fractionated fatty acids from split coconut stearine. Table IV lists the composition and properties of a hard butter produced from split, hydrogenated coconut oil. Coconut oil is first hydrogenated to an iodine value of 3 or less. It is then "split," and the resultant free acids are fractionated by distillation to remove most of the short chain acids of carbon number 6-10. The remaining acids are reesterified with glycerol to produce the hard butter described in Table IV. It exhibits a melting behavior which makes it a desirable cocoa butter substitute in confectionery and pastel coatings. Unlike the hard butters previously described, it has tolerance to butter fat and may be used in light or milk confectionery coatings. It is also an ideal fat for formulating imitation dairy products. Obviously, palmkernel stearine may be used in place of coconut.

There is still another commercial process for modifying fats. This is the process of fractional crystallization. It may be accomplished in a number of ways.

When fractionation is carried out via partial solidification of a melt of the fat or oil and followed by separation of the solids by hydraulic pressing, the process is termed "winterization," and the resultant top, hard fraction is called a "pressed butter." A similar continuous and slightly more efficient process involves the formation of an emulsion or dispersion of the partially solidified fat in water with the aid of an added detergent. The dispersed solids are separated more easily now in a centrifugal basket filter. The latter process is often termed a "detergent process." Table V lists the composition and thermal properties of a typical stearine fraction which can be separated by either process. Table VI lists the composition and properties of the hard butter produced by blending appropriate amounts of hydrogenated palmkernel and hydrogenated palm oil with the stearine fraction of Table V. The resultant hard butter is used primarily in the formulation of pastel coatings. After addition of appropriate levels of crystal modifier, the hard butter can be utilized without tempering.

Fractionation also is accomplished by crystallization of a solution of a fat in an organic solvent, followed by separation of the solids from the liquid, and finally removal of the solvent from the separated fractions by steam stripping. This process is called solvent fractionation, and it is the

TABLE VII

Hard Butters Produced from Solvent Fractionated and Hydrogenated Fractions of Palmkernel

Fatty acid	1	2	3
6:0	0.1	0.1	-
8:0	3.0	3.0	-
10:0	3.0	3.0	-
11:0	-	-	-
12:0	55.1	55.1	-
13:0	0.2	0.2	-
14:0	21.5	21.5	-
16:0	9.3	9.0	-
18:0	3.5	9.1	-
18:1	4.8	-	-
18:2	0.5	-	-
20:0	-	-	-
Iodine value	5.0	0	0
WMP (F)	95.0	98.1	95.1
SFI @ °F			
50	76.1	80.1	79.6
70	71.0	80.0	79.0
80	59.9	76.2	74.2
92	1.9	16.1	10.0
100	0.0	0.0	0.0
110	-	-	-

TABLE VIII

Hard Butters from Palm and Shea Fractions and Whole Refined Illipe Oils

Fatty Acid	1	2	3	4
12:0	-	0.4	0.3	0.2
14:0	1.1	0.7	0.2	0.4
16:0	53.1	40.9	4.3	32.3
16:1	0.2	-	-	-
17:0	0.2	-	-	-
18:0	5.9	21.3	54.3	30.2
18:1	33.0	32.3	35.4	33.0
18:2	5.9	3.5	4.5	3.0
18:3	0.2	-	-	-
20:0	0.4	0.9	1.0	0.8
Iodine value	39.3	33.8	36.0	34.0
WMP (F)	99.5	95.0	97.4	96.5
SFI @ °F				
50	59.0	84.3	85.0	88.0
70	39.4	74.2	81.0	81.0
80	22.5	59.4	68.2	67.2
92	8.0	4.1	9.8	7.3
100	2.0	0.0	0.0	0.0
110	0.0	-	-	-

most versatile of the production techniques described thus far.

Application of solvent fractionation to the modification of lauric and nonlauric oils provides a spectrum of hard butters of the greatest utility and market value. Table VII lists data which describe two hard butters produced from a stearine fraction separated from palmkernel oil by solvent fractionation. Hard butter number 1 is ideally suited for use in pastel coating applications. Hollow molding characteristics of pastel coatings made with 1 are excellent. Hard butter number 2 is a type which is widely used as a cocoa butter substitute in confectionery coatings. It exhibits good tolerance to butter fat and is best suited for the preparation of molded bar goods. Number 3 is 2 with 3% by wt of added sorbitan tristearate. This addition permits confectionery coatings formulated with 3 to be used without tempering.

The fractionation of palm and shea oils produces fractions which alone and/or blended together with or without whole illipe produce hard butters that are similar in composition to cocoa butter. Table VIII lists the composition and thermal properties of four cocoa butter-like hard butters which are typical of commercial products. Hard butter number 1 is a palm fraction which may be used to extend cocoa butter at 10% (3.33% chocolate basis) and 5% (1.67% chocolate basis) in dark chocolate and milk chocolate coatings, respectively. It is unsuited for use as a cocoa butter substitute or replacer in confectioner's coatings. Number 2 is a blend of palm and shea fractions which may be used to extend cocoa butter beyond 15% (5% chocolate basis) and 10% (3.33% chocolate basis) in dark chocolate and milk chocolate, respectively. It is also suitable for use as a cocoa butter replacer in chocolate liquor bearing confectionery coatings. Although suitable as a cocoa butter substitute, it cannot compete economically with fractionated, hydrogenated lauric hard butters in this application. Number 3 is a fraction of shea oil which can be used to extend cocoa butter at up to 15% (5% chocolate basis) in both dark and milk chocolate. It also is a suitable substitute and replacer but is too costly for these purposes. Number 4 is a mixture of shea fraction and palm fraction further blended with refined illipe oil. It is capable of extending cocoa butter beyond 15% (5% chocolate basis) in both dark and milk chocolate. It is compatible in virtually all proportions with cocoa butter. Like 2 and 3, it is also a suitable but very expensive cocoa substitute or replacer.

TABLE IX

Hard Butters from Hydrogenated, Fractionated Cottonseed and Soybean Oils

Fatty acid	1	2	3
12:0	0.6	0.2	0.2
14:0	0.7	0.6	1.0
16:0	18.7	17.5	23.4
16:1	0.4	0.4	0.4
17:0	0.2	-	-
18:0	13.3	14.4	11.7
18:1	62.1	66.1	62.0
18:2	3.4	0.4	1.1
18:3	0.1	-	-
20:0	0.5	0.4	-
Iodine value	60.0	57.8	55.8
% Trans	43.4	45.2	
WMP (F)	103.0	101.0	98.2
SFI @ °F			
50	69.5	73.4	77.0
70	58.6	63.6	70.3
80	50.0	56.0	63.2
92	21.3	26.2	27.3
100	4.3	4.5	0.0
110	0.0	0.0	0.0

Limited availability of shea and illipe oils has fostered another development in hard butter technology. This approach combines hydrogenation of vegetable oils like soybean and cottonseed with solvent fractionation to produce hard butters of high cocoa butter compatibility Table IX lists data describing three such hard butters Number 1 is designed for use as a cocoa butter replacer in certain confectionery coatings that are used in the biscuit cracker, and soft cake industry. It has limited chocolate liquor tolerance without the brittleness characteristic of chocolate or other fractionated hard butters. Number 2 is a fraction from hydrogenated soybean and cottonseed oil. It is a cocoa butter replacer which is compatible with up to 20% cocoa butter (6.67% coating basis) and is designed for use with chocolate liquor. Confectioner's coatings formulated with 2 are too waxy for molded goods and are used exclusively for enrobing. It is suitable as an extender in dark chocolate at up to 10% (3.33% chocolate basis) and in milk chocolate at up to 5% (1.67% chocolate basis) Number 3 is lower melting than 2 and has greater compatibility. It is a cocoa butter replacer in confectioner's coatings that is compatible with up to 30% (10% coating basis) cocoa butter. It produces an excellent eating coating for coverture applications, and it is designed also for use in molded bars. It is a suitable extender at 15% (5% chocolate basis) and 10% (3.33% chocolate basis) in dark and milk chocolate, respectively.

In closing, it is certain that the hard butters produced from the described raw materials and by the described production method will remain commercially the most important of specialty fats.

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