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TECHNICAL NOTE

INTERESTERIFIED BUTTER OIL

Improvement in the spreadability of butter should enhance its consumer acceptance. Spreadability is influenced by the composition and structure of the fat, the crystalline condition of the fat, and the distribution of moisture and nonfat constituents. In general, these factors can be controlled. However, the chemical composition and structure of the fat can not be controlled economically or technically within the present definition of butter.

The consistency of lard has been improved by rearranging the fat structure by either random (7) or directed interesterification (6), the improvement being greater with the latter method.

Interesterification is conducted in an inert atmosphere, using sodium potassium alloy catalyst. The reaction is random if liquid fats only are present, but directed if the temperature is low enough to allow formation of some solid fat. An inert solvent facilitates directed interesterification (3).

The improvement of lard by interesterification suggested a similar approach for improving butter oil. This note presents the results of such a study.

EXPERIMENTAL PROCEDURES

Several lots of butter oil were prepared by mixing butter with five to seven parts of water at 60° C. and passing the mixture through a separator. The separated oil was mixed with warm water and separated. The oil was thus washed three or four times and dried by heating it at 95-100° C. and 2-5 mm. pressure for 1 hr., with oxygen-free nitrogen bubbling through it to provide agitation.

In preliminary experiments sodium methylate was used as the catalyst and the ratio of solids to liquids was determined by a centrifugal method. The methods finally adapted were found to be superior.

For random interesterification, the butter oil was heated at 40-45° C. for 1/3 to 6 hr. during agitation in a nitrogen atmosphere, using 0.1 to 0.3% sodium potassium alloy catalyst. Shortly after the catalyst was added, an orange color developed which disappeared with reappearance of the original yellow color after the catalyst was discharged by passing into the oil a stream of moist carbon dioxide and adding a very slight excess of acetic acid. The treated oil was washed thoroughly with warm water.

For directed interesterification, the butter oil was treated as above, except as follows: Usually hexane or xylene, 11-23% by weight, was added prior to starting the reaction, in order to facilitate mixing and reaction at lower temperatures (3). The reaction was started at 25-38° C. and the temperature was dropped in three to five stages, with some mixing at each stage, until the mixture was rather stiff—usually to 10-25° C. The catalyst was discharged, the oil washed, and the solvent removed by distillation.

In experiments 1-DF and 2-DF, interesterification was carried out in a food mixer, without solvent. Some difficulty was experienced in maintaining an inert atmosphere for long periods and, therefore, this procedure was not used further.

Interesterified butter oil was deodorized by passing steam through it for 1 to 2 hr. at 200° C. and 5-10 mm. pressure to remove off-flavor, particularly bitterness.

ANALYSES

An indication of hardness was obtained by using a modification of a micro-penetration method (4) and a precision penetrometer.[1] The fat was tempered 1 hr. before the penetration measurement.

Other characteristics determined were as follows: cooling curve (5), dilatometry (2), iodine value (1), insolubility in hexane at 4° C. (3), solubility in 95% ethanol at 4° C., and capillary melting point.

The cooling curves and the dilatometric and penetration data shown in Figures 1, 2, and 3 are typical of the changes brought about by interesterification.

RESULTS AND DISCUSSION

In Experiment 2-DF, the iodine values before and after interesterification were 30.25 and 30.15, respectively, suggesting no over-all change in percentage of different fatty acids resulting from interesterification.

Directed interesterification brought about greater changes than random interesterification. Increases in melting point were greater in the presence of a solvent than in its absence. The melting point was raised about 15° C. by directed, and only about half as much by random, interesterification. Insolubility in hexane was about 41% with directed interesterification and about 3% with the control. The solubility in 95% ethanol was somewhat greater with directed than with random interesterification.

Increased insolubility in hexane reflects an increase in the quantity of higher melting, long-chain, saturated triglycerides, whereas increased solubility in ethanol reflects an increased quantity of short-chain glycerides.

[1] A Precision Penetrometer, made by the Precision Manufacturing Company, was used. It is not implied that the U. S. Department of Agriculture recommends this company or its product to the possible exclusion of others in the same business.

TABLE 1

Interestifying conditions and some properties of butter oil before and after interesterification

Experimental conditions							Properties				
Expt.	Wt. BO[b]	Cat.	Solv.	Temperature Start	Temperature Final	Time	M.P.	Hex-ane	Insol. M.P.	Fat I.V.	Ethanol sol. fat
(No.)	*(g.)*	*(%)*	*(%)*	*(° C.)*	*(° C.)*	*(hr.)*	*(° C.)*	*(% of BO)*			*(%)*
1-R	340	0.3		40	45	⅓	39.7 33.5[a]	11.2 3.0	54.5 52.1	6.35	10.6 7.25
2-R	600	0.1		55	55	3	40.6 33.6	8.6 4.4	53.0 52.6	4.87 6.26	12.1 6.55
3-R	600	0.1		55	55	4	40.7 33.6				
4-R	600	0.1		55	55	6	43.3 33.6				
1-DF	880	0.48		30	20	3	44.2 34.5				
2-DF	841	0.7		30	20	3	44.4 34.5				
1-DS	678	0.1	22.9 X	30	10	c	42.5 33.5				
2-DS	678	0.1	11.3 X	30	15.6	d	47.5 35.5	41.0 3.0	55.0 52.1	4.15	12.55 7.25
3-DS	443	0.6	20.3 H	38	25	e	47.4 35.6				
4-DS	328	0.3	16.3 H	25	10	f	48.5 33.5	41.4 3.0	54.0 52.1	9.86	14.0 7.25

[a] Underscored data are for the control butter oil.

[b] Abbreviations: BO = butter oil; Cat. = NaK catalyst, % of BO; D = directed interesterification; F = using food mixer; H = hexane; I.V. = iodine value; M.P. = melting point; R = random interesterification; sol. = soluble; Solv. = solvent; X = xylene.

[c] 182 hr. in five temperature stages.

[d] 159 hr. in four temperature stages.

[e] 40 hr. in three temperature stages.

[f] 61 hr. in five temperature stages.

The cooling curve data in Figure 1 indicate a wide distribution of all fatty acids in the original butter oil. During directed interesterification higher melting fatty acids concentrate on the same glycerides, yielding considerable crystals which melt within a narrow range. This is responsible for the upturn in the cooling curve.

The pattern of percentage of solid fat distribution at different temperatures (Figure 2) was altered slightly by random and considerably by directed interesterification. For the latter, the relatively broad temperature range of 5 to 25° C., where the percentage of solid fat changes but slightly, is noteworthy.

Penetration and dilatometric data (Figures 2 and 3) do not correlate well except within certain limited temperature ranges. Penetration data, an indication of hardness, show a more nearly linear relation with temperature than does the percentage of solids. Therefore, penetration should be of more value than dilatometry in predicting the spreadability of butter made from interesterified butter oil.

Changes in the percentage of solid fat resulting from mixing directed interesterified butter oil and normal butter oil in the ratio of 2 to 1 indicate that in the temperature range 10-30° C., the solid fat is as much as 3% more than the calculated value, but between 35 and 40° C. it is 10-12% less than the calculated value. The latter difference agrees in magnitude with values observed by Woerfel and Bates (8) for mixtures of lard and tallow at 10° C.

Some difficulty was experienced in removing the last traces of xylene. Hence, hexane is the preferred solvent.

An interesterified, steam-deodorized butter oil was recombined with skimmilk. It was scored 37 by a panel of experienced judges of milk

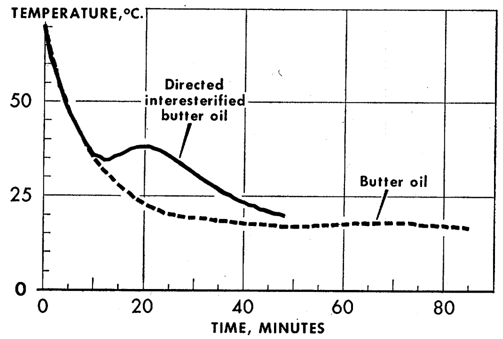

FIG. 1. Cooling curve for butter oil and directed interesterified butter oil. Room constant at 15.6° C.

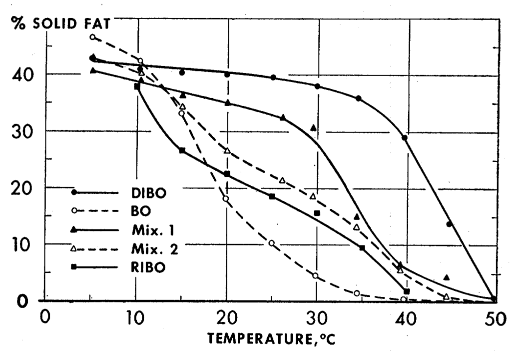

FIG. 2. Per cent solid fat in directed interesterified butter oil (DIBO), butter oil (BO), Mix 1 (one part DIBO and two parts BO), Mix 2 (two parts DIBO and one part BO), and random interesterified butter oil (RIBO).

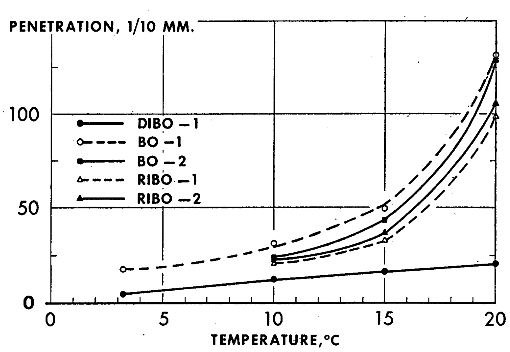

FIG. 3. Penetration data for butter oil (BO), random interesterified butter oil (RIBO), and directed interesterified butter oil (DIBO).

quality, which is as good as many market milks.

Pound and other cakes made with steam-deodorized, interesterified butter oil were inferior in flavor and texture to those made with untreated butter oil. Cakes made with steam-deodorized, untreated butter oil were similar in flavor and texture to those made with non-deodorized untreated butter oil.

The properties of interesterified butter oil, as well as mixtures containing one-third to two-thirds butter oil, suggested no application for general use in butter or other foods. However, removal of the higher melting glyceride fraction that separates during directed interesterification should yield a softer fat. The latter alone, or mixed with ordinary butter oil, should serve to make butter of almost any desired hardness.

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