Preparation and Properties of Zero *Trans* Soybean Oil Margarines

G.R. List[a,*], T. Pelloso[b], F. Orthoefer[c], M. Chrysam[d] and T.L. Mounts[a]

[a]Food Quality and Safety Research, USDA, ARS, NCAUR, Peoria, Illinois 61604, [b]Nabisco Foods, Indianapolis, Indiana 46268, [c]Riceland Foods, Stuttgart, Arkansas 72160 and [d]Nabisco Food Group, East Hanover, New Jersey 07936

ABSTRACT: Experimental margarines were prepared in the pilot plant from interesterified soybean oil–soybean trisaturate blends and compared to a product made from hydrogenated soybean oil. Penetration, yield values, and water/oil off-data were determined. Margarine prepared from an interesterified soy–soy trisaturate blend (80:20) tended to crystallize slowly after votation and resulted in a somewhat harder than desirable product. However, addition of 20% liquid soybean oil to the interesterified oil yielded a softer product. The experimental products showed excellent oil and water loss properties under accelerated storage conditions.
JAOCS 72, 383–384 (1995).

KEY WORDS: Interesterified oil, margarine, oil off test, penetration, pilot plant, solid fat index, soybean oil, yield values.

Previous reports have described potential preparation of zero-*trans* margarine and shortening oils by random interesterification of liquid and completely saturated triglycerides (1,2). This paper describes some preliminary pilot-plant studies on formulation of soft tub margarines made from interesterified soybean oil–soy trisaturate blends.

EXPERIMENTAL PROCEDURES

The interesterified soybean oil–trisaturate blend (80:20) was prepared in pilot-plant equipment.

A 6 ft × 30 in. stainless-steel rearrangement vessel (1000-lb capacity), equipped with an overhead agitator, was charged with 500 lb of oil. The oil mixture was heated under vacuum and brought to 100°C, after which 0.3% sodium methoxide catalyst was added. The rearrangement was carried out for 30 min and verified by Mettler drop point determination (3). The drop point of the 80:20 interesterified oil is 35.6°C. The catalyst was neutralized, and the oil was washed with warm water, dried, bleached, filtered, and deodorized.

The compositional properties of the 80:20 interesterified oil are as follows: *trans*, 0.3%; iodine value (IV), 107; C16:0, 10.6%; C18:0, 19.3%; C18:1, 19.0%; C18:2, 44.9%; C18:3, 5.3%. Solid fat index (SFI) at 10, 21.1, and 33.3°C = 7.4, 3.9, 2.6, respectively. The control oil was a hydrogenated soybean oil blend: 13.2% *trans;* IV, 100; C16:0, 10.7%; C18:0, 6.9%; C18:1, 39.6%; C18:2, 30.9%; C18:3, 1.9%. SFI at 10, 21.2 33.3°C = 9.3, 5.2 and 2.0, respectively.

The margarines were prepared in pilot-plant equipment manufactured by Cherry-Burrell Process Equipment (Louisville, KY). The unit is a 0.1 scale of standard margarine manufacturing equipment (500 lb/h). The margarines were 80%-fat products that contained 0.2% emulsifier and 0.1% lecithin. The fat phase was brought to 57°C in an emulsion tank, and the aqueous milk phase was slowly added until the temperature reached 49°C.

The contents of the emulsion tank were pumped to two "A" votator units operating at 400 rpm. After passing through the two "A" units, the product was passed through a blender ("B" unit) operating at 200 rpm. Product coming from the blender was then passed through a third "A" unit operated at 400 rpm, after which it was filled into 8-oz. (227-g) plastic tubs and placed into 4.4°C storage. Exit temperatures for the three "A" units are as follows: (i) 25.6–26.6°C, (ii) 13.3–14.4°C, (iii) 6.7–7.8°C.

Penetration measurements were made according to the AOCS Official Method (3) with a 20° cone. Values reported are the means of six determinations per sample. Yield values (g/cm^2) were calculated according to Haighton (4). Oil off, or the tendency of a margarine emulsion to break down at summer temperatures, was determined according to Sieden (5).

RESULTS AND DISCUSSION

The properties of the experimental margarines are shown in Table 1. A survey of commercial tub margarines, taken from grocery shelves, showed penetration values that ranged from 155 to 279, which equate to yield values ranging from 217 to 539 g/cm^2 (4). According to Haighton (4), the spreadability range of margarine equates to yield values of 200–800 g/cm^2. However, most premium soft table margarines, formulated from hydrogenated soybean oil, showed yield values in the 200–550 g/cm^2 range. Stick margarines and the so-called softer spreadable sticks show values in the 1680–2800 and 960–1360 range, respectively.

Margarine prepared from the interesterified 80:20 blend showed a yield value of 1961 g/cm^2, which, while spreadable, is too hard for a soft tub product and more in line with stick

*To whom correspondence should be addressed at USDA, ARS, NCAUR, Food Quality and Safety Research, 1815 N. University St., Peoria, IL 61604.

TABLE 1
Properties of Experimental Margarines

Sample	Oil component	Penetration[a] × 1/10 mm	Yield value g/cm^2	Water loss (mL) 21.1°C	Water loss (mL) 30°C	Oil loss (mL) 21.1°C	Oil loss (mL) 30°C	Water (%)	Salt (%)	LFRA[b]
Pilot-tub	Hydrogenated soybean oil	187	407	0	0	0	2.7	16.7	1.7	80
Pilot-tub	Interesterified soybean oil[c]	70	1961	0	0	0	3.1	16.6	1.8	160
Pilot-Tub	80% Interesterified 20% Soy oil	137	670	0	0	0	1.0	16.3	2.1	120

[a]AOCS Method Cc 16-60 (Ref. 3).
[b]Texture reading, LFRA = Leatherhead Food Research Association, 40° cone, 5-g load, 4-mm drop, 1/2 mm/s.
[c]80:20 Soy and soy tristearin.

products. The 80:20 margarine had a slight tendency to pull away from the tub after filling and final 4.4°C storage. However, blending the 80:20 feedstock with an additional 20% liquid soybean oil (SFI at 10, 21.1, and 33.3°C = 5.0, 3.0, and 0.6, respectively) alleviated this problem and resulted in a softer product with a yield value of 670 g/cm^2.

The hardness of the margarine prepared from the 80:20 interesterified oil is somewhat surprising, considering the low 10°C solid content (SFI at 10°C = 7.4). Commercially prepared soft tub products typically contain 10–13% solids at 10°C and have yield values in the 200–550 g/cm^2 range.

The experimental margarines were subjected to an oil off test, which involves storage for 4 d at 21.1°C and 1 d at 30°C to determine the stability of the emulsions (5). No oil or water loss was observed after 4 days' storage at 21.1°C. After 1 d at 30°C, no water loss was observed, and only small oil losses were evident; the interesterified margarines performed as well as or better than the hydrogenated control.

Results presented here suggest that interesterified fats crystallize more slowly than hydrogenated oil processed under the same conditions. Margarine emulsions that crystallize slowly in the absence of agitation (i.e., after filling into tubs) favor the formation of a strong network between water, fat crystals, and liquid oil, which leads to hard products (6).

Nonetheless, results presented here clearly show that tub margarines, with suitable spreadability and emulsion stability, can be produced from interesterified soybean oil.

ACKNOWLEDGMENT

Ray Holloway assisted with the experimental work.

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[Received July 26, 1994; accepted November 16, 1994]