Soft Margarines from High Stearic Acid Soybean Oils[1]

Sir:

Previous reports from our laboratory described the physical properties of soybean oils high in saturated acids (1), and other published work indicated that these oils have potential uses in soft margarine formulations, either by blending with harder components and/or interesterification of their glyceride structures (1,2). A recent publication by Kok *et al*. (3) described formulation of soft margarines from interesterified soybean oils high in both palmitic and stearic acids. We wish to describe some properties of soft margarine prepared from soybean oils from the HS-1 cultivar developed by the Hartz Seed Company (Stuttgart, AR) (4). Three separate lots of HS-1 showed stearic acid contents ranging from 16–21%, palmitic acid from 9–10%, oleic acid from 19–22%, linoleic acid from 42–44%, and linolenic acid from 4–6%; dropping points ranging from about 15–17°C; and typical solid fat indexes (SFI) of 8–10 at 10°C and essentially zero at 21.1–33.3°C. After random interesterification of the neat HS-1, as described previously (1,5), dropping points (6) increased to 34–36°C and SFI (5) values ranged from 5–8 at 10°C, 2–3 at 21.1°C, and 1–2 at 33.3°C.

Soft margarine was formulated in the laboratory from an emulsion prepared from 8,010 g interesterified HS-1 or hydrogenated soybean oil, 1,970 g skim milk, 10 g fluid lecithin, 20 g mono/diglycerides, 10 g salt, and 0.003% β-carotene. The emulsion, at 40°C, was pumped from an air-driven impeller-agitated tank to an Armfield (Armfield, Inc., Denison, IA) scraped surface heat exchanger (model FT 25B) at a rate of 6 L/h. The brine temperature controlling the "A" unit was 0°C. The "A" unit, or crystallizer, was operated at 400 rpm as was the "B" unit (pin worker). Product pressure was 4 psi. Controls were prepared from a commercially blended, hydrogenated, liquid soybean oil blend having a dropping point of 32°C and SFI values of 11–13 at 10°C, 4–5 at 21.1°C, and 1–2 at 33.3°C. Temperatures were monitored throughout the formulations and were as follows: temperature of emulsion into the "A" unit or scraped surface unit 32°C, out of the "A" unit to the "B" unit or pin worker 9–11°C, out of the "B" unit 9.5–11°C. Products emerging from the pin worker were placed in 8-oz plastic tubs, placed in a refrigerator held at 45°F (7.2°C), and held for 12 h prior to testing. The experimental margarines were evaluated by a trained sensory panel consisting of 10 members. Panelists were asked to rate the products for spreadability (0 = easy to spread, 10 = hard to spread) by spreading a 4-g sample onto small bread squares with a plastic knife. Mouth melt was determined by measuring the time, in seconds, necessary for a 2-g sample to melt in the mouth. Panelists were asked to rate the sample for graininess or texture on a 10-point scale (0 = smooth, 10 = gritty). Other tests included softness or penetration by the American Oil Chemists' Society official method and an oil-off test where a 25-g sample is stored for 4 d at 70°F (21.1°C) on a wire screen and the amount of water or oil lost from the emulsion is noted (7). In addition to the experimental margarines formulated in the laboratory from HS-1 and hydrogenated soybean oil, two commercial margarines (80% fat) purchased from a local supermarket were evaluated. These products were formulated from blends of hydrogenated and liquid soybean oils having SFI profiles and dropping points nearly identical to that used in the laboratory formulations. The properties of the experimental and commercial margarines are shown in Table 1. Margarines formulated in the laboratory from hydrogenated soybean showed penetration values ranging from 136–185 depending on the speed (rpm) of the pin worker or "B" unit with the softest products obtained at the highest rpm. By contrast, the margarine from interesterified HS-1 had penetrations of 75–92, indicating a harder product. The commercial margarines, which are softer than the interesterified margarines, but harder than the hydrogenated products prepared in the laboratory, showed penetrations of 104–137. Spreadability, as determined by the sensory panel, was plotted against penetration values and the results are shown in Figure 1. A significant correlation (r = 0.814) was found. The HS-1 margarines showed spreadability values of over 6 compared to 3–5 found for commercial samples. However, the HS-1 samples were spreadable directly out of the refrigerator. Sensory evaluations showed that little or no graininess was detected in either the commercial or interesterified margarines. Mouth-melt data indicate that the interesterified products are comparable to commercial products. Oil-off tests showed that interesterified products perform as well as the commercial products since no water loss occurred and oil losses were small in both types of samples. Attempts were made to induce texture defects in the experimental margarines by removing them from the refrigerator and allowing them to stand at room temperature (70°F) for 2 h. They were placed back in the refrigerator for 12 h. This procedure was repeated four additional times for a total of five cycles. Results showed that no visible texture defects occurred, nor was any increase in graininess detected by the sensory panel. No significant in-

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TABLE 1
Preparation and Properties of Experimental Margarines

Sample	Oil component (80% fat)	Votation conditions: Temperature (°C) Emulsion	Temperature (°C) Brine	rpm A unit	rpm B unit	Pressure (psi)	Penetration[a]	Spreadability[b]	Graininess[c]	Mouth melt[d] (s)	Oil off[e] Water	Oil off[e] Oil
Laboratory	Hydrogenated soybean	40	0	400	400	4	179	3.2	0.4	42	0	0
Laboratory	Interesterified HS-1 soybean	40	0	400	400	4	92	6.4	0.5	43	0	0
Commercial	Hydrogenated soybean/soybean	—	—	—	—	—	104	3	0.5	58	0	0
Commercial	Hydrogenated soybean/soybean	—	—	—	—	—	137	4.9	0.5	30	0	1.02

[a]AOCS method (6), 20° cone.
[b]10 Point scale, 0 = easily spread, 10 = hard to spread.
[c]10 point scale, 0 = smooth, 10 = gritty.
[d]Seconds to melt 2 g sample.
[e]25 g sample stored 4 d at 70°F (21.1°C). All values represent the means of duplicate tests.

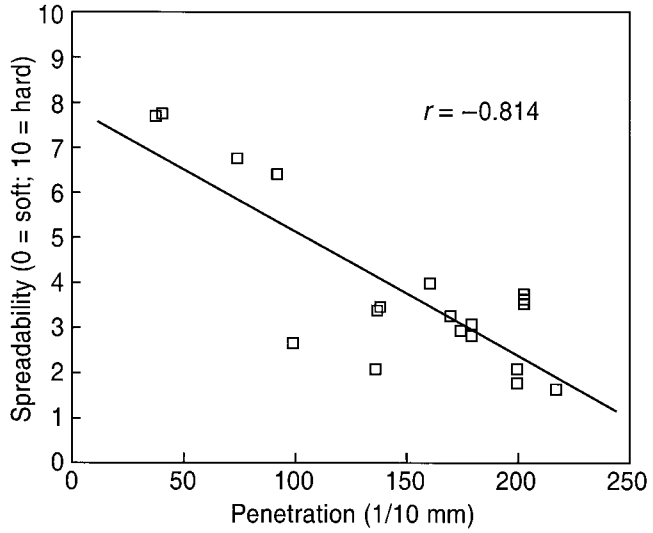

FIG. 1. Relationship between spreadability determined by sensory testing and penetration values by the American Oil Chemists' Society Official Method (6). Data represent soft and spreadable stick commercial margarines and spreads and the experimental margarines.

crease in spreadability was noted, but mouth-melt time showed a slight increase from 42 to 45 s. The particular lot of HS-1 used in this study had the lowest SFI values of the three lots and, based on the results presented here, softer products could be obtained by incorporating additional unhydrogenated liquid oil in the formulation. Stearic acid contents beyond 16% appear excessive. Traditional SFI guidelines, used for hydrogenated oils, may not apply to interesterified oils. Indeed, the dropping points are about 2–4°C higher than typical hydrogenated margarine oils.

Although further work is required to determine optimal fatty acid composition, triglyceride profiles and processing conditions, these results clearly indicate that interesterified oils, high in stearic acid, can be processed into softer margarines having suitable spreadability, sensory characteristics and acceptable oil-off properties. Such products should be desirable where low *trans* acid contents are required.

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