Margarine and Margarine Oils: Finished Product Quality[1]

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ABSTRACT

Finished margarine quality is presented in terms of the margarine manufacturer's needs as expressed by in-house quality control and oil blend specifications. The philosophy of adequate performance testing is discussed as are the needs for in-process controls. Without adequate and effective in-process controls, specification testing practices result in only after-the-fact information and defeat the real purpose of specifications, which is to insure quality production and not merely to assess whether or not it has been attained. Although margarine manufacturers have found effective means of applying these controls to their own production, they have been lax in applying them to their raw material receipts, an emphasis that is at least of equal importance to finished product quality.

Recently there appeared a review in *Book World* (1), concerning traditional Scottish foods; it reads, in part, as follows: "The first time I ever saw Scots porridge eaten *properly* was at an Inn on the Isle of Islay, where a bearded and irascible sea captain astonished me by sipping it dry from a dish and only occasionally dipping his spoon into a separate bowl of milk. Further, he salted each spoonful individually with a twist of his fingers from a salt dish, and from time to time washed it down with whiskey." The article continued: "I was used to porridge pre-salted, without whiskey, but with milk on top of it; also the porridge I knew was hot, and semi-liquid. The captain's was cold and so constructed that when any of it fell on the floor it bounced. It occurred to me then, that there was no single authentic recipe for anything: Plainly, true porridge could vary from sugary-gruel to alcohol-reinforced cement. It was a discovery that has made me cautious about traditional recipes ever since."

Margarine too is a traditional recipe for which we can well be equally cautious, not for the innovative products or margarine forms that have evolved over the past 20 years, but for getting what we ask for; from a margarine manufacturer's point of view, of consistently making the product he wants.

The quality of finished margarine as it is used by the consumer, whether a retail, institutional or industrial product, depends on the total product handling and storage situation from the time it leaves the margarine factory, the product's manufacturing or in-house experience, and the raw material from which it is made. More specifically, the latter refers to its oil blend formulation. For the margarine manufacturer the control, or lack of it, that he experiences with his products can be grouped into these three areas. The first, concerning finished product handling and storage after being made and shipped, is his area of least control. He can make recommendations and build certain tolerances into his product, but he can better focus on the other two areas which can be categorized as quality control and oil blend specifications. It is difficult to philosophically treat these two as separate entities. The manufacturer can, for convenience, write specific job descriptions for each, but they both must serve the same master, that is, finished product quality. This would seem to be significantly more critical for those margarine manufacturers—and they represent the majority—who do not have their own refineries; however the control over both written situations at least is very much in the hands of the margarine manufacturer. The question is, can he or does he write significant, meaningful specifications for his oil blend receipts and their subsequent processing into finished margarine products? Indeed is it possible for the margarine manufacturer to have control over all the quality contributing factors by either direct or indirect means?

In this short space it would not be feasible to give a definitive specification for margarine and margarine oils. Nor would it be practical to belabor the obvious and usual practiced specification criteria. These standards and their logical application to oil products have already been adequately described in the literature (2). We all have, in each manufacturing situation, specific needs that each can best appreciate. It is in this general situation that this discussion will highlight some important factors that are often overlooked or not considered in the formulation of these specifications, and will develop these ideas or suggestions in terms of both current and future products. With the latter, there is no intent to present new margarine forms or concepts, but to include the need of those already "born" and existing as comparative infants in today's marketplace.

Specifications for table and commercial margarine products involve essentially the same criteria. They can be separated into three arbitrary groups according to melting point, table margarines being the lowest, with cake margarines next and pastry margarines being the highest. The total solids content, i.e., solid-liquid fat ratio, of these products also follows in the same order. All margarines have an important performance requirement which is related to their existence in the marketplace. Specifications should therefore have a performance standard to measure this characteristic. Typically this would be spreadability for table grade margarines and baking or work-softening properties for the commercial products.

These rheological properties of finished margarines are expressed by terms such as consistency, texture, plasticity, hardness, structure and spreadability. Special needs of cake

[1]One of seven papers presented in the symposium "Fats and Oils in the Food Industry," Atlantic City, October 1971.

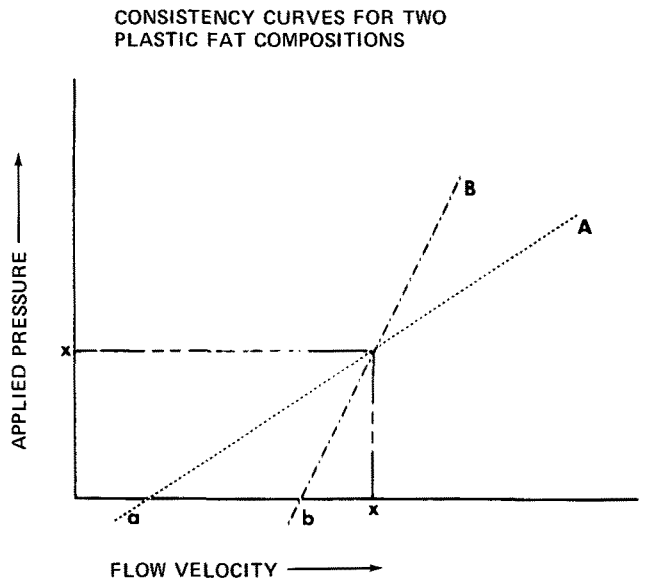

FIG. 1. Consistency curves for two plastic fat compositions (3).

and pastry margarine products, as they relate to their rheological properties, are an increasing future concern as the volumes of industrial margarine products increase in a highly automated end-use industry. Constant changes in food manufacturers' equipment sophistication result in specific work softening requirements for these margarine products. This places the burden on the margarine manufacturer to properly assess, in a reasonable testing time period, that his product will respond satisfactorily in his customer's equipment.

The application of specific test methods has been discussed in an earlier publication (3). Generally the sophistication of instrumental design for these measurements lags far behind the industry need. Whatever techniques are used, however, it is important to fully understand the observations being made. A case in point is shown in Figure 1. This is an elementary presentation, but it does illustrate the significance of proper physical property measurement. Margarine products are non-Newtonin materials, and our usual practice of single point measurements can result in anomalous observations.

These curves visualize the flow response to changing pressures applied to two margarines or plastic fat compositions, *A* and *B*, in, for example, an extrusion test to assess spreadability. An extrapolation of these curves to the abscissa gives rise to points *a* and *b* as yield values, representing the minimum force necessary to initiate product flow. If an arbitrary force *X* is applied to each of these fats, their flow responses (single points) would be similar. If a force less than *X* has been applied instead, it would be concluded that product *A* is softer than *B;* and if a force greater than *X* has been applied, the opposite conclusion would have to be made. In all three instances the interpretations would have been in error. The only correct way of measuring the flow characteristics of these two fat compositions would be to measure their response over a range of pressures. This would result in complete consistency curves, the slope of which would be characteristic of each and then represent a significant product characteristic. With fluid (two-phase) systems, the single point viscosity measurements will for this very reason often not agree with visual observations of fluidity.

The use of single point measurements for quality control purposes is not an unsound practice, as long as the empirical relationship between the response measurement and the product functional and eating qualities is understood in terms of oil formulation and processing variables. This requires, of course, that the oil formulation and processing conditions remain reasonably constant.

These physical and rheological properties are related to both the raw material, the oil blend and the margarine processing conditions. Any variability in finished product is attributable to either inconsistencies in oil blend formulation or variable processing conditions. If the raw material variant is recognizable, it may be practical to make minor compensating processing adjustments. Unfortunately this can only be done to a limited extent, and as a result the burden has to be placed on the raw material source to attain a high degree of uniformity. This was not so much a problem for the past as it is for today's high-speed lines, especially for cup and liquid margarine production where chilling and cold working have to be carefully controlled. These situations also place a greater responsibility on the margarine manufacturer to do a more uniformly consistent processing job. This, through the use of in-process controls, is easily achievable. As shown by Sambuc and Naudet (4), this starts with emulsion temperature control and carries through tempering of crystallized product. Their work showed, for example, that the rheological properties could be substantially evolved in the course of the first 48 hr of tempering.

An equally weighty responsibility, and a considerably more difficult task for the margarine manufacturer, is to write effective specifications for his oil blends. The margarine oil supplier also shares in this responsibility, and a good working specification is built around a common trust, one for the other. Nevertheless it is necessary for the margarine manufacturer to spell out his objectives. Since specific standards, that is, analytical numbers, are not always sufficient to describe his needs, it is necessary to add qualifying terms or phrases. Unfortunately these are either difficult or impossible to monitor, given today's analytical tools, and here is where trust becomes an important factor, at least to the extent of preventing bad product from being made.

A primary factor controlling product quality is the solids content or solids-liquid ratio of the margarine oil blends. It is generally recognized that margarines depend on careful hardening control to achieve the solids quality which governs its melting characteristics. The hazards and shortcomings of the SFI method as a means for controlling solids has been adequately treated in the literature (5). Hopefully the AOCS subcommittee recently formed to study the comparative merits of SFI vs. NMR vs. DCS will come up with a better working alternative. The caution for SFI usage is in the context that a variety of fat components can be put together to meet a particular SFI specification. This can of course be done with entirely different components; or, as we more often than not experience in everyday production, it is the blending of varying amounts of similar components to an SFI specification range. This constant adjusting of quantities of individual components is expedient because the components themselves vary from batch to batch in their preparation. The result is that a variety of oil blend solids slopes can result within the SFI specification range, and this can translate into variable finished margarine products. The particularly vulnerable area would be the soft, tub products being manufactured on today's high-speed production lines.

As a quality control tool, and with all things being equal, the SFI method is very satisfactorily used. This subject does, however, suggest the unpopular proposal that margarine oils could best be formulated from specific quantities of components, each prepared to specific SFI or solids content specifications. This would minimize the slope variations. These blending variations are difficult for the margarine manufacturer to control and, in the absence of his own in-process control, they might well go unnoticed or at least unappreciated. However, as his own in-process control becomes more finely tuned, these variables will probably cause him some difficulties. Therefore it is prudent to include in raw material specifications statements indicating *how* an oil blend is to be formulated and that no change in this formulation is to be made without the purchaser's approval.

Another area of increasing concern for margarine oils is liquid oil quality and content. One aspect of this concern has to do with potential labeling requirements, and margarine oil specifications will therefore have to include fatty acid compositional standards in terms of analyses by gas liquid chromatography (GLC), lipoxydase and perhaps *trans* isomer content. The increased use of liquid oils to meet the demands for higher P/S ratio or higher linoleic acid content margarine oils will be associated with decreases in product flavor quality.

Blending in this direction, for either labeling or softer product consistency purposes, is always a compromise situation. The liquid oil will obviously have to be either a natural liquid oil, such as safflower, soybean, sunflower or corn oil, or a winterized oil derived from cottonseed oil or lightly hardened soybean oil. From a physical property point of view, the natural oils pose no particular problem, but the winterized oils, especially the hardened winterized soybean oil, will be difficult to define in terms of a

relationship between their crystallizing solids and their response to values obtained from SFI or cold test determinations, or both. Flavor stability is, however, the important quality variable experienced with the use of these liquid oils.

What the margarine manufacturer needs is a test that will indicate or predict the shelf life of his oil blend, i.e., a test that will reflect both the nature of the oils' travels from the seed to the margarine factory and to what extent it has been properly processed by the margarine oil supplier. Of course we do not have such a test. However we do know that proper selection and subsequent proper processing of crude oil into its finished deodorized stage will provide the most stable oil possible. How does one build this requirement into a raw material specification for margarine oil receipts? The margarine manufacturer, providing he does not have his own refinery, now has the option of exercising trust, that is, faith in his supplier's ability to properly handle oils; or he can emphasize his faith in a contractual way by including in his specifications some in-process controls describing how a certain crude oil shall be processed and protected. The margarine manufacturer has to impose a minimum oil processing standard that he knows will provide him with the best possible oil.

As we look to the future of an industry that will obviously be producing more fractionated fats for a variety of specialized products, it may well be desirable to provide specific fractions for margarine oil formulations, or at least be utilizing the byproducts of such processes in margarine oil formulations. Indeed the latter potential is available to the industry now with the large quantities of hydrogenated-winterized soybean oil products being manufactured. These stearine fractions generally do not exhibit a high degree of uniformity. Interesterification, which has been a much more important margarine oil manufacturing practice in Europe than in the U.S., offers an excellent leveling tool for this stearine variability, and these byproducts could become a valuable raw material for margarine oil components. They also have the potential of being inferior substitutes. An effective way to monitor both the use of these stearines and the application of interesterification is provided by carbon-number distribution analyses, that is, temperature-programed GLC of the triglycerides.

The myriad of specification criteria poses a real dilemma for the margarine manufacturer and his oil blend supplier, in that they generally feel obligated to test every shipment or receipt for every stated specification standard. This is really not necesary, nor should it be necessary to unduly restrict the number of specification standards to a list that can be analyzed for completely every time a shipment is made. Finished product and raw material specifications should contain a sufficiently complete set of standards to completely describe these products and materials. The routine testing schedule for these specifications can, however, involve only a limited number of these standards, sufficient to maintain the quality and integrity of product and raw material production. This provides adequate description without burdening a testing program.

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