Margarine Oils, Shortenings, and Vanaspati

K.-F. GANDER, Technical Director, Margarine-Union GmbH (Unilever), Hamburg, West Germany

ABSTRACT

The technology of processes aimed at the production of margarine has, on the whole, not changed dramatically during the past 20 years. However, a great number of technological modifications for quality improvement and adaption to market requirements have been achieved. These include tailor-made refining procedures for more flexible blend formulations, careful exclusion of oxygen in closed systems (for refining, dosing, emulsification, and cooling), and development of soft margarine, rich in linoleic acid and mostly packed in tubs. The processing of margarine is fully mechanized today and might be partly automated in the future.

As for vanaspati, there have been hardly any changes on the processing side, which includes a slow crystallization phase that hardly lends itself to mechanization and automation. Like margarine, more flexible blend formulations have been made available, and improvements in flavor technology have been achieved.

Shortening development has run completely parallel to margarine development.

Although the range of edible oil products has expanded in recent years, in most countries consumers tend to keep to their old habits where food and drink are concerned. Climate and agriculture play a major part here. So it is not surprising that new types of fat products–the majority based on vegetable fats–such as margarine, shortening, and vanaspati were regarded to begin with as substitutes for the corresponding types of products among animal fats. They have come to be regarded more and more as products in their own right.

The flavor, texture, and functional properties of margarine, shortening, and vanaspati at first had to be as much as possible like their prototypes–butter, lard, and ghee. Later, of course, it was possible to feature the specific plus-points of newer, vegetable fat-type products.

The influence of the consumer is reflected particularly clearly in the comparatively small area of Western Europe. In the north, down to the line between Paris and the Main region, more solid fat in general is consumed, particularly on bread. South of this line, far more oil is used, with solid fat consumption being comparatively low. In the northern margarine-consuming countries, we also note traditional differences in the composition of the products, e.g., the salt content (0.2-3.0%), the amount of flavoring used, and the incorporation of other ingredients which have an effect on the product's cooking properties. The very salty butter eaten in U.K. or Denmark and the slightly rancid flavor of Spanish butter have, of course, led to corresponding varieties of margarine being developed. English cake is usually sweeter than Continental confectionery, and allowance must be made for this in, for example, the high monoglyceride content of shortenings. Table I shows the regional consumption of oils and fats in 1974.

Despite the progress made on the Codex and the EEC regulations, there are still differences among national legislations on margarine and shortening. The latter products are made chiefly from imported raw vegetable fats and oils, at least in Western Europe, and have to compete with a greater or lesser volume of domestic agricultural fat products. This was the reason for the discriminatory legislation on product and packaging which has by no means completely disappeared even today. A few examples will illustrate this.

According to Article 36 of the German Milk Law, imitation milk products may not be sold, even if labeled as such. This means that the sale of any of the products listed in the Cheese Order, Milk Products Order, Milk Law, and the first "Abgabeverordnung" is prohibited if they are made from vegetable fat, with the exception of margarine and low fat margarine, even if they are adequately labeled to eliminate the risk that they will be confused with true milk products. According to Article 2 of the Margarine Law, margarine and low fat margarine may be sold only in containers of a specified shape. These containers must bear a red stripe, and, according to Article 6 of the Margarine Law, they must contain an indicator, e.g., starch or sesame oil, not exactly conducive to improving their quality. The German Ice Cream Order prohibits the use of vegetable fat in ice cream. Margarine and low fat margarine still suffer similar disadvantages under the laws of most other European countries. In some southern European countries, olive oil enjoys a preferential position in comparison to other edible oils.

However, the general positive trend in the development of margarine and shortening consumption continues, and it has spread to almost every country in the world. In terms of world economy, it has a sound basis in the comparatively high yield of oil-bearing seed per hectare. It helps to stimulate world trade and, in many countries, contributes towards squaring the balance of payments. In industrial countries with a particularly high standard of living and a nutrition-conscious population–in particular, the U.S., Sweden, and the Federal Republic of Germany–margarine has even overtaken butter in recent years. Butter-exporting countries like Holland and Denmark have been consuming much more margarine than butter for a long time now. Table II shows the per capita consumption of edible oils and fats in 1975 in various countries.

Following the changes in raw materials used for margarine, shortening, and vanaspati is most interesting. After Normann invented fat-hardening at the beginning of this century, the tallow or oleomargarine suggested by Mege Mouries was replaced to a large extent by hardened whale and fish oil. Coconut fat, because it is easy to transport in the form of copra and easy to refine, became a very popular raw material. The coconut fat also gives a pleasantly cool sensation when it melts in the mouth. Up to 50% of it was used in margarine blends, and the so-called slab fats consisted solely of coconut fat. As early as World War I, rapeseed oil became one of the important raw materials in the production of margarine in Europe. In the U.S., where

TABLE I

Regional Consumption of Edible Oils and Fats in 1974 (.000 M tons)

	Europe	North America	Overseas
Butter/butterfat	1,880	602	584
Margarine	1,774	1,176	645
Vanaspati	-	-	636
Shortenings/compounds	596	1,795	450
Lard/other animal fats	761	403	740

TABLE II

Per Capita Consumption of Edible Oils and Fats in 1975 (kg)[a]

Country	Total edible fats and oils	Total DT	Butter and butterfat	Margarine (incl. vanaspati)	Shortenings and compounds	Lard and other animal fats	Oils
U.S.	24.4	8.4	2.2	4.9	7.8	1.4	8.0
Germany	28.1	16.3	6.9	8.2	3.3	5.6	3.8
Sweden	26.1	18.5	5.2	16.5	1.1	0.4	1.6
France	22.7	16.0	8.6	3.2	0.8	0.3	9.8
Netherlands	30.9	19.7	2.2	13.4[b]	7.7	---	4.6
U.K.	25.6	13.0	8.8	5.0	2.1	3.6	6.0
Japan	9.4	3.1	0.5	1.3	0.9	0.9	5.9

[a]Unilever estimates.
[b]Excluding 3.0 low caloric spread.

shortenings account for the greater proportion of fats consumed, cottonseed oil started to gain in importance alongside lard.

Later, in the '20s, exports of peanuts from India yielded a fat which, when hardened to ca. 30 C, provided an excellent base with stable flavor for the production of margarine and shortening in Europe. The largest margarine brand in West Germany, with annual sales sometimes reaching over 200,000 tons, is a good illustration of how things developed.

At the end of the '20s, peanut oil was the sole raw material. At the end of the '50s, there was scarcely any Indian peanut oil available, and ca. 50% U.S. cottonseed oil (some of it hardened), 40% coconut fat, and 10% palm oil became the new basic blend. Today, Russian sunflower oil and both American and Brazilian soybean oil are used in the manufacture of this product, which has undergone changes following the general trends for margarine.

The last two decades in the 100 year history of margarine have again been particularly important ones for its development.

1. Among consumers in many countries, there has been an increasing need for more information on raw materials. The development of margarine from pure vegetable raw materials has helped to meet this need. Vegetable margarine soon came into its own, especially since a connection was quickly established between its lack of cholesterol and efforts to reduce the level of cholesterol in the blood, though the amount of this exogenous cholesterol is certainly of no great physiological importance.
2. There was a rapid increase in the production of vegetable fats, supplies of lard were no longer adequate, and whale oil became extremely scarce. The amount of fish oil available fluctuates greatly. This is another reason why most of the margarine produced in Europe today consists solely of vegetable fats.
3. As the result of epidemiological studies, people everywhere came to realize more and more that, with eating habits changing—especially in industrial countries where fat often accounts for 40% of the calorie intake—it would be advisable to increase the proportion of polyunsaturated fatty acids (PUFA) and to reduce that of the saturated fatty acids. By doing so, a substantial contribution can obviously be made towards reducing the risk of heart attacks. The proportion of PUFA in some special types of margarine rose to 60%, and today, in the Federal Republic of Germany, for example, it averages over 20%.
4. The fact that in most developed countries there is a refrigerator in almost every home gave rise to the need for margarine which can be spread at temperatures of 5-10 C, as is usual today.
5. Retailers usually sell margarine from a chilled cabinet, and this reduces the risk of oxidation of the fat.
6. New or improved refining and hardening processes are making it easier for oils such as soybean, rapeseed, and palm which had hitherto been regarded as second-class products, to be used to an ever increasing extent in high quality margarine and shortening. In the case of rapeseed, we also have a growing number of new varieties with a low erucic acid content.
7. Interesterification on a large scale can be regarded as the greatest technological advance of recent years. It permits truly tailor-made fats to be produced, at the same time allowing almost limitless variation of the basic raw materials. Advantage has also been taken of this, of course, in the development of new shortenings. Taking the Federal Republic as an example once more, here the quantity of fat interesterified is certainly > 250,000 tons, some of it having been hardened beforehand.
8. In all its variations, the Votator process—the process used in all margarine production today—has made it possible for margarine and shortening to be produced untouched by human hands; if desired, practically free from atmospheric oxygen; and, when suitably packed, capable of being stored for several years.
9. Tubs made from plastic or coated paperboard have replaced the former wrappers to a very large extent and make it easy to pack very soft margarine and shortening on the machines newly developed for this purpose. This not only affords the product better protection but also improves its display value in the store.
10. The market was prepared to sell special developments, such as single-oil margarine made from corn oil or sunflower oil, dietic margarine with a PUFA content of > 50%, and low calorie margarine containing only 40% fat.

All these developments not only served to stabilize sales of margarine and shortening but also helped to establish its image as a product tailor-made for present-day requirements.

The interaction of these developments taking place in the market, in technology, and in agriculture, including new varieties, has finally resulted in the present order of importance, in terms of volume, of the major raw materials used in fat production in Western Europe: soybean oil (U.S., Brazil), palm oil (Malaysia, Africa), coconut fat (Philippines), and sunflower oil (USSR).

In principle, vanaspati is a shortening and can be considered as a substitute for ghee just as margarine is for butter. Ghee is butterfat obtained by making butter from the milk of goat, sheep, buffalo, etc., and then heating (boiling) it and draining off the aqueous phase. In India with the still biggest ghee consumption, the moist butter is often dried over a fire of cow's mist and thus obtains a typical smoky flavor. The fat then cools down slowly and is

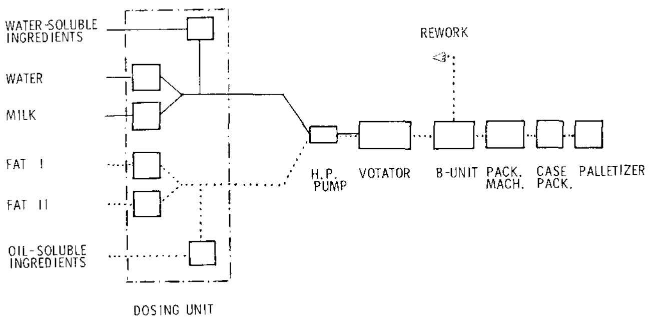

FIG. 1. Low pressure dosing.

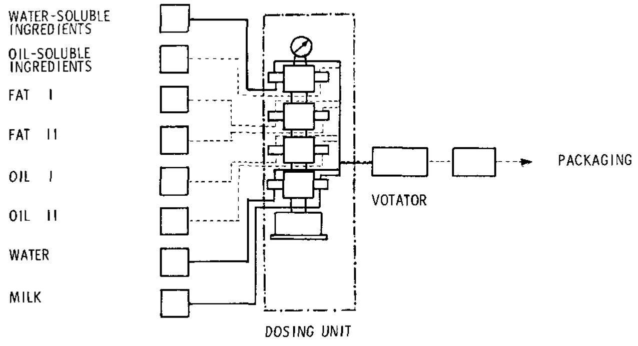

FIG. 2. High pressure dosing.

kept for some time, whereby additional, mainly rancid, flavors are developed on storage. Vanaspati is a mostly vegetable fat composition with a melting point of 35-40 C (sesame oil, 5%, to be added in India). In its liquid state, it is filled into tins and allowed to crystallize very slowly under well-controlled conditions (small temperature differences between product and cooling air). In this way, large crystals develop. In some areas, where finer crystallization has been accepted, the process is much quicker and more mechanized, with suitable Votator arrangements being applied. The fat blend is flavored, where permitted, with a ghee-like rancid flavor. Consumption of vanaspati is mainly restricted to India, Pakistan, Turkey, East Africa, and some other Middle East countries. Tonnage estimates for these countries are 708,000 tons for 1969 and 636,000 tons for 1974. No information is available on consumption in areas like China and Siberia.

There have been no decisive changes in the technology of margarine and edible fat production in the past two decades, which shows that it is hard to improve upon the present processes.

The refined oil passes by the shortest possible route from the deodorizer via intermediate coolers to the closed buffer tanks. If the refinery and the margarine factory are situated on different sites, all the more care must be taken in transporting the refined oil in road tankers; e.g., it must be protected by a nitrogen blanket.

On the way to the Votator, the fat-soluble ingredients are added to the oil via metering pumps in a closed system. The water or cultured milk is mixed with the water-soluble ingredients in exactly the same way. This can be done in a low pressure system (Fig. 1), or the most important components pass in a small number of substreams to a high pressure pump which feeds the Votator (Fig. 2).

Of course, the Votator itself has undergone many changes. This applies both to the sequence and arrangements of the tubes and to the design of the rotors, different arrangements of the blades, the speed of rotation, the diameter of the annular space, etc. For the purpose of cooling, which is done with ammonia or some other refrigerant, use is made of either the thermosyphon effect or forced circulation by means of pumps or injectors. In cases where viscosity is

FIG. 3. A modern, automated margarine plant.

particularly high, for example, in bakery margarine or plastic shortening, rotors in the form of a screw conveyor which also scrapes the cooling surface have their advantages (e.g., Astra cooler).

I can safely say that, so far, there is no machine better equipped than the Votator to accomplish the simultaneous tasks of cooling, crystallizing, and mechanically working the fat in its semiliquid state. With the versatile Votator, blends both practically free of solids, as for liquid margarine, and extremely firm shortening blends with a high proportion of solids can be produced. Emulsions, too, such as margarine or low calorie spreads with up to 60% aqueous phase, can be produced without difficulty in sufficiently fine dispersion if the proper emulsifier system and Votator arrangement are chosen.

The incorporation of gas, such as nitrogen, in fine or coarse dispersion can also be regarded as a standard process in the manufacture of special products. Here the pressure within the plant and the dosing method are of particular importance. None of these variants presents any problems today.

Nevertheless, one of the aims is still to achieve optimum conditions as regards heat transfer, crystal seeding, and crystal growth and processing in the final section of the plant.

As to the end product, the objective is, as a rule, to prevent as far as possible the release of the heat of crystallization and the occurrence of post-hardening. The processes going on in the B unit are of major importance here, and the number of different constructions is accordingly great. I should mention at this point that margarine is often filled into tubs in its semiliquid state; in this case, a crystallizer (shortening B unit) is used between the A unit and the post-crystallization unit (margarine B unit).

The Votators of today have a throughput of 1-5 tons/hr, and, accordingly, packaging machines must be designed which are capable of turning out up to 250 packs/min. The rest of the packaging process, ending with the palletizer, is also fully mechanized or automated.

Of course, the layout of the factory and the degree of mechanization will still depend on the production program and special requirements—bacteriological aspects, for example. These bacteriological aspects can be of decisive importance if, for instance, the margarine being produced contains milk but no preserving agent and has a low salt content.

There still remains the problem of processing fluctuating amounts of rework when breakdowns occur in the packaging machines. Technological solutions range from merely returning the rework to an open premixer, where it is added to the blend being run at the moment, to extremely sophisticated systems where the rework is returned directly to the high pressure pump which precedes the Votator. For bacteriological reasons, the use of buffer containers can generally not be justified unless the rework is subsequently pasteurized.

The means available for continuous checks on the water content during the manufacture of margarine—dielectric constants, density differential measurements, and so on—are still inaccurate and expensive. Also, a solution has yet to be found to the problem of complete automation of cooling in the Votator to comply with the specifications of the final product. The crucial point here is obviously the continuous control of the process of crystallization in the A or B unit.

We may safely say that the large scale production of margarine, shortening, and vanaspati is fully mechanized today (Fig. 3). The possibility of automation, including in-place cleaning, must be investigated from case to case in the light of capital expenditure and yield on capital employed, even if all the conditions have been fulfilled on the technical side. In recent years, the capital tied up in fixed assets has shifted more and more from the actual manufacturing plant to the packaging machinery.

This overall picture of scrupulous hygiene in the manufacture of margarine in particular, with microbial counts which are usually exceeded by comparable products, is helping to boost the consumer's image of margarine and edible fats. Today, these products are not only tailor-made but, compared with other food products, are also relatively free of the chemicals which taint out environment, including pesticides, and completely free of mycotoxins. Consequently, we may expect margarine, shortening, and vanaspati to become increasingly important in the future.