Some Aspects of the Edible Fat Industry in New Zealand[1]

Butter

BUTTER FIGURES MOST PROMINENTLY as a visible source of edible fat in New Zealand. Production for 1954 was 200,000 tons, of which approximately four-fifths were exported. The annual consumption within the country of 44.6 lbs./head is the highest in the world, being three times that of the United Kingdom and more than five times that of the U.S. This is partly explained by the fact that there is no table margarine, and by the very generous government subsidy of 1/–(14¢) per lb., enabling butter to be retailed at 2/–(28¢) per lb. as against 1/7d. (22¢) for cooking margarine. The high consumption of butter is indirectly assisted by the low price of bread, which carries a subsidy on the bread itself and on the flour used, so that it sells at 7d. (8¢) per 2-lb. loaf. This makes bread and butter with jam or in sandwiches an important part of the New Zealander's diet.

Margarine

Despite the low price of butter, margarine is still the chief fat used in biscuits, cakes, and pastry. Lesser amounts of dripping and lard are used both at home and in commercial bakeries, but they are of variable and, at the best, only fair quality. There is a certain amount of prejudice against margarine because a quarter of New Zealand's national income is derived from the export of dairy produce, and the farming interests as well as a large proportion of the general public look with an anxious eye on the competition of British-made margarine with New Zealand butter on the market in U.K. so that the very word "margarine" is something of a bogey. This prejudice against margarine is not shared by the bakers, who have come to appreciate its value, or by the enlightened who realize that margarine used in New Zealand means more butter for export. However, to placate the dairying interests, legislation governing its production and sale is unusually severe. Milk and coloring are prohibited, and the product can only be retailed in cubic or cylindrical form. (An earlier provision specifically allowing unlimited inclusion of mineral oil has been wisely revoked.)

The low price at which margarine must be sold severely limits the use of imported vegetable oils in any quantity, and in order to compete with butter the chief ingredients are oleo stock and oleo oil with lesser amounts of coconut oil milled in New Zealand from copra produced in the New Zealand territory of the Cook Islands and the United Nations Trusteeship territory of Western Samoa. Minor amounts of peanut oil are also used. There does not seem to be much possibility of growing oil seeds, mainly on account of the variable climate. Some consideration has been given to rapeseed, but the oil does not rate very highly for margarine production.

Salt in Margarine

When our company commenced manufacturing margarine 30 years ago, it was found that the product bleached and oxidized within a few days and could not be shipped any distance. It was some time before it was realized that the trouble was caused by the inclusion of salt. It is now known that salt can be prooxidant in butter, particularly that made from acid cream, and Hills and Conochie (1) of the Australian Council of S.&I.R., investigating this problem in 1946, found that salt was only significantly prooxidant in butter when the serum was definitely acid because, under acid conditions, the first traces of oxidation converted chlorine ions to free chlorine which, of course, promoted further oxidation. However this did not appear to help in the case of margarine as the aqueous phase (a solution of salt in mains water) had a pH of 8.5 and further the oxidation proceeded much more rapidly than in the case of Hills' butter. In a trial experiment however with salted margarine it was found, after a fortnight at room temperature, surface oxidation was quite definite and after a month there was a layer of about 1 cm. depth of bleached margarine. The pH of the aqueous phase of this oxidized portion had changed to 5.5 while that of the unoxidized portions in the middle of the block of margarine was still 8.5. It appears that we have one-half of the answer as we have the acid conditions which promote rapid oxidation, but we do not know why these acid conditions develop.

Hills and Conochie in an earlier paper (2) have recommended the addition of sodium carbonate to dairy salt to reduce oxidation, but in the absence of milk this gives rise to a soapy taste in the fat. Their work however explained why, in a series of parallel experiments, analytical grade salt promoted oxidation much more rapidly than commercial salt or salt to which magnesium or calcium chloride had been added. This was difficult to explain until it was realized that the analytical salt gave a solution in distilled water with a pH of 5.5. It is also worth noting that while Hills and Conochie found that the prooxidant effect of salt ran linearly with the amount added, McDowell of the N.Z. Dairy Research Institute (3) found that 1.75% salt promoted oxidation but 2.5% had very little effect. This experiment was repeated several times with the same result (4).

In the meantime our customers have become used to the saltless product, but our experiments are continuing in this interesting field.

Another effect noted with our milkless product, which is water-crystallized, as will be shown later, is that lecithin has the opposite effect to that expected, and its addition makes the margarine leaky, liable to mould attack, and, if anything, rather more inclined to sputter.

[1] Presented at fall meeting, American Oil Chemists' Society, September 24–26, 1956, Chicago, Ill.

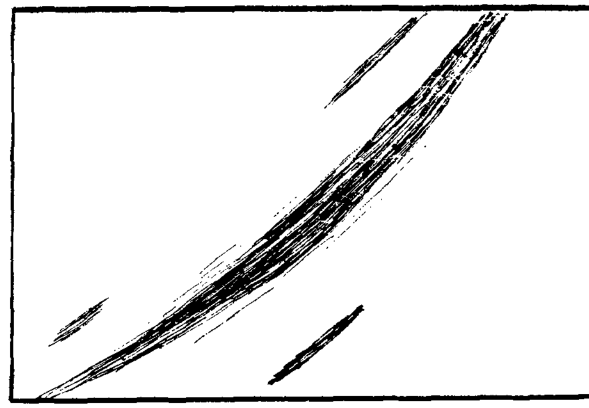

FIG. 1. Water-chilled (discontinuous)

FIG. 2. Brine-chilled (continuous). Typical appearance of beef fat margarines (x250). Shaded areas represent crystalline material.

Continuous Crystallizing of Margarine

Owing to the large proportion of beef fat in New Zealand margarine, discontinuous methods of manufacture and wet crystallization are still employed. Experiments conducted with various kinds of continuous equipment have all produced a margarine with a shortened plastic range and a decided tendency to go grainy in cold weather. This effect is intensified by a number of local factors. Few margarine users have any tempered storage; there is a wide variety of climatic conditions; and the necessity of centralizing manufacture in one place for economic reasons, combined with difficulties in transport, mean that there are long periods between manufacture and use—six months are not uncommon. Local conditions only underline the problem of continuous crystallizing of certain types of animal fats. These unsatisfactory results are noted in greater or less degree with all types of continuous equipment tried and with drum crystallizers, and, as far as we know, no subsequent working is effective in overcoming them. In fact, it appears to make them worse.

The shortened plastic range and the tendency to crumble or grain may not be connected as the latter effect is sometimes much more prominent and has been noted in dry fats as well as in margarine. Even our Votator-chilled, high-ratio shortening, which contains only 55% of beef fats, has a tendency to go grainy in cold weather though its plastic range is fairly satisfactory.

The method of chilling our beef margarine has an obvious effect on the microcrystalline structure, as revealed by examination at 250 magnifications under polarized light with a quartz plate above the nicols. The differences are shown diagrammatically in Figures 1 and 2; the first relates to our normal, water-chilled product and the other to a margarine of the same fat blend continuously extruded from an Australian "New Ways" extruder. The same faults of shortened plastic range and crumbliness have also been found with butter made by continuous process and constitute one of the chief reasons why such processes of butter manufacture have not gained acceptance either in New Zealand or Australia. (It should be noted that, so far as the writer is aware, neither the Cherry-Burrell nor the Creamery Package processes, apparently successful under American conditions, have yet been tried in New Zealand or in Australia.) Here again storage is an important factor as New Zealand butter is mainly manufactured for the export market, which is reached after holding and shipping in cool storage for a period of up to a year.

The production of a satisfactory beef fat margarine by a continuous process is both of practical and theoretical interest, but one of the difficulties of research is that it must be conducted on a macro scale. The fact that this problem does not occur with lard suggests a possible connection with ruminant fats, which are known to contain some unusual unsaturated fatty acids as well as branched-chain acids. In addition, because of the hydrogenation that goes on in the rumen the normal fatty acids may be combined in an unusual way. The prospect of synthesizing branched-chain acids on a sufficiently large scale to make a full-scale trial of margarine manufacture from vegetable fats with these acids added to them is a little overwhelming, and it may be left to the enterprising chemist to work in the other direction by making margarine from the fats of camels, deer, or other ruminants.

Antioxidants

Antioxidants are not permitted in New Zealand, and there is a small semi-official research team working on their possible toxicity. The research is at present directed toward determining a) the fate of BHA and BHT when fed in massive doses to small laboratory animals; b) the effects of very high doses of antioxidants on the animal; and c) the cumulative effect of repeated doses of antioxidant. The fact that this team is working tends to delay the official approval of antioxidants. (Some minor progress has been made in that the health authorities see no objection to the use of antioxidants in dog rations for the 1956–57 Antarctic expedition.)

Our own experimental work with a variety of antioxidants, including most of those well known in the United States, leads us to believe that the ideal antioxidant for beef fat margarine has yet to be found. They give the usual lift in the aeration test and delay the development of peroxides, but they do not prevent the development of off-flavors in storage so that the results parallel those reported by other workers with other fats.

The whole subject has recently been reviewed by Ruys (5). In this connection the recent paper by Tollenaar and Vos (6) on the synergistic effect of mixtures of antioxidants in preventing organoleptic decomposition is of great interest, but there has not been sufficient time to test out their conclusions in our case. The effect of the water phase is also a complicating factor, not fully understood. The prohibition of antioxidants is not at present a serious matter, and our current policy is to grade all tallows by the aeration test before use and to carry out the usual steps of refining and deodorizing as quickly and as efficiently as possible. We find that, despite storage periods of more than six months without refrigeration or other precautions, complaints of oxidation are rare. This was the case even when shortages of beef tallow and a big wartime demand necessitated the admixture of a large proportion of mutton tallow, which, in general, gives much lower times in the aeration test. As a matter of interest, a typical aeration test for crude beef tallow is 11 hours while the refined deodorized product goes 23 hrs.

Improvement of Raw Materials

The prohibition of coloring in margarine is mitigated by the fact that a notable proportion of the beef killings at the packing houses is Jersey cattle with a good yellow color in the fat, and there is also a proportion of marrow fat from canneries associated with the packing houses. However the high-temperature deodorizing in current U.S. practice or hydrogenation as a means of improving flavor cannot be used as a white margarine would not be acceptable to the trade. We currently deodorize at 6 mm. and 340°F. in batch equipment, which reduces the color by approximately 15% in Lovibond yellow units. The two processes of high-temperature deodorizing and hydrogenation, as well as the use of antioxidants, are significant in vew of a probable future demand for a really bland shortening of high keeping-quality.

The limitation of readily available raw materials to beef tallow and coconut oil has naturally meant that much of our work has been directed towards making the best use of these fats. Our experimental work has confirmed the statements of Eckey (7) that neither directed nor random interesterification of beef fat will in itself produce a more plastic product nor can anything be achieved by interesterifying mixtures of beef and coconut fats.

One line of research has been to see how far coconut oil (C.N.O.) can replace peanut oil (P.N.O.) in our margarine mixes, and the results of some typical dilatometer studies are shown in Table I.

TABLE I

	A	B	C
P.N.O.	20	—	10
C.N.O.	—	20	10
Oleo stock	35	35	35
Oleo oil	45	45	45
Percentage of solids at			
8.5°C.	40.7	47.4	43.8
15°C.	30.7	31.0	30.2
29°C.	10.9	10.7	11.1
40°C.	1.5	0.9	1.1

The interesting point is that at 15° there is little difference between the three mixes although the temperature is well below the melting point of coconut oil. These results have been confirmed with margarine at least to the extent that at 15° and 29° the difference in softness between the three mixes is less than that which could result from the variation found in the oleo stock. Nevertheless the figures show that, for the lower temperatures frequently met with, coconut oil has only a limited use.

Shortenings

Owing to government import control and the high cost, shortenings based on hydrogenated vegetable fats are not used in New Zealand. Hydrogenated coconut oil has been manufactured in New Zealand for confectionery use for many years and is becoming increasingly popular for home cooking and frying. In 1954 we commenced the manufacture of a high-ratio shortening, based on oleo stock with minor amounts of coconut and peanut oils. At that time the only flour available in New Zealand was unbleached and of variable quality depending on the origins of the wheat, *viz.*, various Australian states, South Africa, and New Zealand. With this flour the usual mixings for high-ratio cakes give very poor results. Our first cakes were characterized by a deep depression in the center and a pronounced doughly bone inside. Some of our friends said they liked them that way, but we were not convinced ourselves. Our first joy came when we found our shortening to be right because it produced good results with U.S. or Australian bleached cake-flours. Further laboratory work showed that by slight reduction in sugar and liquor and, more important, by reduction of mixing times to an absolute minimum at the slowest mixing speed, quite satisfactory cakes could be made. We have seen cake batters in a commercial bakery mixed in a badly overloaded mixer for five minutes on the slowest speed, after which time the batter could not be considered uniform by any standard as it still contained lumps of shortening visible to the naked eye. Yet these cakes, without further mixing, were then baked and proved to have good eating qualities. They also proved quite musical in that they made the cash register sing because they were much better than cakes previously available.

The Health Department regulations have just been relaxed to permit chlorinated flour, and we shall have to impress on the baker that mixing times must practically be doubled if he is to gain the full benefits of increased volume and finer texture with the new flour.

Uses of Oleostearine

Oleo oil is the basis of our margarine, and in its preparation a melting point of 98–100°F. is aimed at, resulting in a yield of oleo-stearine of around 28%. There is a rather fluctuating demand for this by-product from various parts of the world. Before the war, when peanut oil was cheap, a bread compound was made containing one part of oleo stearine and three parts peanut oil, but now all the oleo stearine that is not exported is retained for hydrogenation. The hardened product mixed with hardened coconut oil is sold as a fairly tough confectionery fat. Alone it is used for a variety of purposes. At one stage during the war hydrogenated stearine was used as a substitute for paraffin wax, and it has also been used as a bonding and weather-proofing agent for cattle licks. Its chief use now is as a basis for the manufacture of monoglycerides. In this connection an interesting development originated in 1953 in Australia (8), where it had previously been found that addition of skim milk solids produced a poor, coarse, immature loaf. However it was noted that if small amounts of hardened stearine, glycerol monostearate, and potassium bromate were added with the milk powder, a good loaf could be baked. The procedure is to add to every 100 gal. (Imperial) of skim milk an emulsion of 4 lb. of fully hydrogenated stearine and 1 lb. of glycerol monostearate in a gallon of water, plus 9.5 of potassium bromate. The mixture is then spray- or roller-dried. For spray drying slightly better results are achieved by using 5 lb. of G.M.S. and no hydrogenated fat. The resulting powder is added at the rate of 6% to the flour in the dough mixer, and in this way the nutritive value of the bread is improved and skim milk more profitably used than in the usual feeding to hogs. This product has been very well received in Australia; well over 1,000 tons were used last year in Victoria alone, equivalent to 1 ton for every 100 tons of flour used in bread.

Acknowledgment

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Danish Fat and Oil Industry

(continued from page 4)

cholesterol contents of the tissues. The feeding experiments will be performed partly with chickens and rats, and the chemical analysis of the tissues of the experimental animals will be supplemented by histological examinations. For the analysis of the fats several methods are being used, *e.g.,* fractional distillation, ozone splitting, paper and gas-phase chromatography, and spectrophotometry in ultraviolet and infrared regions. Pilot-plant equipment for the production of the required special fats will be installed. This pilot-plant can be used not only to supply the materials for feeding experiments but also for a thorough study of certain technological processes used in the fat industry.

A Scandinavian anti-rancidity convention is planned for the fall of 1957 with the participation of members of research institutions in Scandinavia. This will be a continuation of the convention in Sweden in the year of 1952. Approval of various antioxidants and their application will be discussed along with other factors influencing the subject.

Private and official research is greatly stimulated and encouraged by research in the United States, and scientists and industry follow with the greatest interest articles in the Journal of the American Oil Chemists' Society, which in itself is of valuable assistance and support to everyone engaged in the fat and oil industry.

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Problem Corner

October 3, 1956

Question

I have read that sodium bicarbonate, if put in the cooker when loading it with pork fat, will neutralize the free fatty acids in the pork fat and produce an excellent grade of lard.

I understand that sodium bicarbonate is used to neutralize fat in the drip-rendering system. What percentage is used? Could you give me more detailed information on the subject?

From Philadelphia

Answer

If sodium bicarbonate is put in melters or cookers before rendering, it will not neutralize the free fatty acids present in the fat. It possibly reacts with the protein bodies present.

Drip rendering provides for two compartments in the rendering vessel, and soda is added to the lower compartment which contains the rendered lard. It thereby neutralizes the free fatty acids in the lard.

For details regarding drip rendering equipment, we are pleased to refer you to The French Oil Mill Machinery Company, Piqua, O.

J. P. Harris

Question

We should like to know the specifications for choice white grease.

From Massachusetts

Answer

Specifications for choice white grease are as follows:

FAC Color	13 to 11 B
Free Fatty Acids	4% maximum
Titre	37 minimum
MIU	Basis 1%

We find that two types of grease are permissible under the above specifications, and they are known as "all hog" and "blend." In other words, if you desire an all-pork product, you should specify "all hog."

We also find that stabilized choice white grease is available. We know of at least one producer who offers a 20-hr. AOM product, which shows satisfactory resistance to rancidity.

J. P. Harris