FAC COMMITTEE—LIQUID AND SOLID ACIDS
List of Determined Values

	C. P. LONG			J. J. VOLLERTSEN			M. L. SHEELY			W. H. IRWIN		
	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
Iodine No. of sample	70.8	70.8	70.7	70.7	70.8	70.7	70.8	70.8	70.8	70.6	70.7	70.6
Thiocyanogen No. of sample	59.4	59.6	59.8	60.7	60.2	60.0	59.3	59.1	59.3	60.6	60.6	60.8
Iodine No. of fatty acids	74.1	74.1	74.0	73.7	73.7	73.6	73.8	73.8	73.8	73.9	73.9	73.9
Thiocyanogen No. of fatty acids	62.2*	62.5*	62.7*	63.0	64.0	63.2	62.9	63.1	63.3	63.5*	63.5*	63.7*
Per cent solid fatty acids (Twitchell)	45.0	41.5	43.9	42.5	42.4	42.6	42.4	41.9	42.5	41.6	42.2	41.6
Iodine No. of solid fatty acids	32.3	31.5	30.2	29.2	29.4	29.8	29.9	29.0	29.4	30.0	30.1	29.5
Thiocyanogen No. of solid fatty acids	31.9	28.2	30.1	28.6	28.2	28.4	29.4	28.3	29.0	29.7	28.7	28.6

*Calculated from Thiocyanogen Value of Glycerides.

tube registers 50-55°; then heat again and carry the temperature of the outer bath somewhat rapidly to 67°. Remove the burner. The melting point is reached when the fused substances become perfectly clear and transparent. A dark background placed about 4 inches from the apparatus will be helpful.

After determining the melting point, transfer the crystallized glycerides to a 50 c.c. beaker, add 25 c.c. of approximately 0.5 N alcoholic KOH, and heat on a steam bath until saponification is complete. Pour the solution into a separatory funnel containing 200 c.c. of water, acidify, add 75 c.c. of ether, and shake. Draw off the acid layer and wash at least 3 times with water. Transfer the ether solution to a clean dry 50 c.c. beaker, drive off the ether on a steam bath, and finally dry the acids at 100°. After about 2 hours, determine the melting point as directed above. If the melting point of the glycerides, plus twice the difference between the melting point of the glycerides and the melting point of the fatty acids, is less than 73°, the pork fat is regarded as adulterated.

THE APPLICATION OF FATS AND OILS TO THE BAKING INDUSTRY

By GEORGE F. GARNATZ

A PAPER PRESENTED AT THE FALL MEETING, OCTOBER 17-18, 1935

IT has been suggested that I discuss for you the application of Fats and Oils to the Baking Industry. Limitations established by personal experience, in my opinion, render such an attempt on my part presumptuous. I must, therefore, before I am fairly launched on my discourse, alter my subject, perhaps not greatly but certainly significantly, to read: "Some Applications of Fats and Oils to the Baking Industry." To be more specific, I propose to confine myself to the application of fats and oils in the production of bread, cakes, biscuits, and crackers.

The history of bread and cakes dates back far enough that one is unable to definitely establish when fats and oils were used in their making, and hence one cannot relate the circumstances nor the reasons for the incorporation of these enriching materials. While very probably the inclusion of a fat or an oil in a baked product was originally accomplished inadvertently, the practice, undoubtedly, was continued because of the pleasing results obtained.

There followed a period when apparently the role of fats and oils in baked products was hardly understood and their use was continued out of custom without much questioning. However, in that period when many manufacturing processes were taken from the home the Art of Baking also went "commercial." Eventually competition for the patronage of the consumer developed and became more and more keen. Bakers became quality conscious, and to meet the ever-present threat of competition from the home-baked product, sought more efficient means of utilizing materials and for carrying out processes.

Into this picture came the engineer, and, more recently, the chemist. Progress was made rapidly despite a multiplicity of factors to be reckoned with, not to mention the complex nature of the materials involved. Knowledge has been sought and found through the application of technical investigation and research so that today we are using our materials and developing our processes more intelligently, and more efficiently than ever before, even though, in many instances, the full scientific explanation is not yet at hand.

Despite the progress made, we have but crossed the threshold of the Science of Baking and many phenomena still remain either debatable questions, or subjects for considerable speculation and conjecture. Is it any wonder, then, that I approach my subject with becoming humility and respect, conscious of the fact that whatever I may say can, and probably will, find someone who will differ in my opinion.

In the production of bread, fats or oils make a definite contribution to the finished product. *By reason of the shortening effect, the crust is rendered tender and eating quality is improved because of the resultant softer crumb and finer texture. Keeping quality is enhanced since moisture is retained, the loaf is made softer and the tendency for the interior to become crumbly is retarded. Generally speaking, the use of fats or oils in bread doughs improves the volume and the symmetry of form of the loaf produced. Flavor is also affected, usually for the better, and no matter how bland the fat or oil may be, its influence on flavor cannot be discounted, particularly when used in conjunction with the liberal proportions of sugar that are currently employed. Last, but not

least, one cannot overlook the contribution that fats and oils make to the energy food value of bread.

Except for flavor and food value, these effects of fats or oils on bread rest upon the fact that the dough constituents are thoroughly coated with the fat or oil which thereupon functions in a purely mechanical fashion as a lubricant and waterproofing material. The dough is softened and rendered more pliable, manifesting greater extensibility when expanded by the gaseous products of fermentation. Moreover, in comparison with a dough containing no fat or oil, one carrying an ingredient of this nature will require less mixing.

The opinion more generally prevailing, is that the beneficial effects of incorporating fat or oil in bread are obtained when an amount up to 3% of the weight of flour used, or at the most, 4% is employed. With this I am not in agreement, even though I appreciate that there must be an upper limit beyond which loss in volume, sogginess, greasy texture, and greasy taste will be encountered. My experience has indicated that 6% can be used safely with attendant desirable results.

Formerly, considerable discussion was centered on the question as to when the fat or oil should be introduced into the dough mixer for best results. With the introduction of high-speed mixing and its consequent, greater efficiency this question has largely disappeared and considerable leeway is now tolerated. Emulsification prior to incorporation, either by homogenising or by creaming with bread ingredients other than flour, appears to possess some merit. I doubt, however, if it warrants the investment required by the former, and in the case of the latter, I suspect that superior inventory control, less labor in scaling ingredients, and less variation in the composition of the doughs, overshadow any advantages resulting from more complete dispersion of the fat or oil.

I am of the opinion that any sweet, wholesome fat or oil can be used satisfactorily as shortening in bread. This does not imply that the bread baker need not be discriminating in his selection, but does indicate that a variety of products are available to him. He is still interested in purity, uniformity, keeping properties, consistency, color, and flavor. His shortening must necessarily be pure because he is mindful of the fact that his finished product comprises a significant portion of the human diet; he insists on uniformity because this characteristic in each of his raw materials is only one precaution he must exercise to insure the same property in his rather complex finished product. Keeping quality is of more interest as it relates to the storage of shortener prior to use rather than to its behavior in the bread. Because bread is consumed within a relatively short time, no problem concerning the development of rancidity is encountered, provided the shortener was sound when used. Consistency is of some moment in the selection of shortening for bread making, not only from the standpoint of convenience in handling, but from the standpoint of incorporation as well. Obviously, a fat should not be hard, and should be uniformly plastic to insure thorough distribution. The color of the oil or melted fat is of interest and must be of such a nature as not to detract from the bright, creamy-white crumb color for which the baker is striving. Foreign or obnoxious flavors must be avoided. A normal characteristic flavor or a bland, neutral flavor is to be desired, although it is well also to satisfy oneself that the shortening selected does not contribute to the development of a "fishy" or "beany" flavor as the baked bread takes on age.

In the field of cake-baking, the selection of a suitable shortening is practically restricted to fats. This does not greatly simplify matters for the baker, since, in this application, shortening plays a relatively more important part than in its application to bread. Whereas the fat content in the baked loaf of bread ranges from 2 to 5%, that of cake will vary from 10 to 20% and sometimes more. Of course, I am referring to such types as pound cake, gold cake, white cake, and devil's food cake, and not to such foam-type cake as angel food cake and some varieties of sponge cake in which no shortening is used at all.

Not only does shortening make cake more tender, but it improves the grain and texture of the crumb, enhances keeping quality, contributes definitely to food value, and lends "richness" to flavor and taste. In these respects its functions are similar to those performed in bread, although by reason of the greater amount used, to a more noticeable extent.

In addition, however, shortening plays a very important part in building up the cake batter, and through its creaming and water-emulsifying properties, makes an important contribution to the volume and cellular structure of the finished cake. Pound cake is an excellent example of a product which depends on "creaming" and water emulsification solely for its leavening. Even in those instances where chemical leavening agents are employed, volume, grain and texture are governed by the degree of success that was attained in building up the cake batter. As a matter of fact, chemical leaveners are being used more and more sparingly as shorteners are improved in creaming action and capacity to emulsify water, and bakers learn how to mix their ingredients to utilize properly these properties to the fullest extent.

There are several methods by which a cake batter may be built up. Each prescribes a definite order in which the various ingredients should be introduced, utilizing two or three stages to effect satisfactory incorporation. The latest method advocated by L. H. Bailey is the single stage method in which all of the ingredients, except the acid reactant of the chemical leavening combination, are added and mixed. To this mass the acid material is finally added just prior to completion of the mix. Each method has its advocates and critics. Because cake making still is empirical, and craftsmanship is not without influence on the final results, each is entitled to his opinion. However, all of the methods have as their bases the formation of a smooth, stable emulsion and the incorporation of air.

Probably the most widely used or orthodox method is that one in which the shortening and sugar are creamed together. The second stage consists of further creaming upon addition of the eggs. The third stage consists of alternate additions of liquid (in the form of milk or water) and flour into which the other ingredients such as salt, baking powder, etc., have been sifted.

In the first stage the shortening distributes itself in a film about the particles of sugar. The sugar particles, by means of the mixer action, behave much like tiny impellers and carry into the system a quantity of air which is thus entrapped. As the result, the mass increases in volume and becomes light and fluffy in nature. While

basically the creaming efficiency is dependent upon the plastic properties of the fat, it is well known that temperature conditions have a profound modifying influence. While manufacturers have done much with plastic shorteners to compensate for seasonal variations in temperature, there still exists a challenge for the oil chemist who dares to see what can be done to build into shorteners greater tolerance to temperature changes in their plastic properties. This is definitely needed, particularly during the summer season. The particle size of the sugar also influences the creaming results. Ordinary granulated sugar gives satisfaction, but the "berry" sugar of more recent origin produces superior results. On the other hand, powdered sugar will not do, probably because it does not have the sharp corners necessary to draw the air into the mass.

Creaming is continued with the addition of eggs, and, by reason of the moisture present, the emulsifying action is also started. If the eggs be added slowly and cautiously, a water-in-fat system is built up that is smooth in appearance. When the eggs are added too rapidly a fat-in-water emulsion results which is curdled. While no great harm is done when this latter type of emulsion is obtained, it has been my observation that on a large scale basis, some sacrifice in cake quality is experienced. Adequate capacity for dispersing water is, therefore, quite desirable in a shortener because it not only assists in obtaining cake quality, but insures greater uniformity of results through setting up more tolerant conditions during the mixing operation.

Emulsification continues in the third stage when flour and liquid are added alternately. In order not to destroy the water-in-fat structure, one must carefully adjust the increments of flour and liquid, otherwise the curdled fat-in-water dispersion will result. Another advantage that shorteners with good emulsifying properties possess is that they assist cake flours in carrying the large proportions of sugar that consumers apparently desire, without placing the cake under structural handicaps. They will not, however, function in this direction unless the flours, themselves, have good sugar carrying capacities.

Careful manipulation of the mixing operation will bring the batter to the oven in the form of a smooth, stable emulsion, which, under the influence of heat, increases in volume through the expansion of the entrapped air, the vaporized moisture and the carbon dioxide liberated by the baking powder. When the temperature of the mass is sufficiently elevated, the gluten from the flour is coagulated, and the form and size of the cake is established.

We may conclude, therefore, that shortening is a very important cake ingredient, and must needs be carefully chosen. All of the factors that apply to shortening for use in bread apply in the case of cakes, including keeping quality. In addition, shortening must have the ability to "cream" well and to emulsify water. While these properties are most desirable and even necessary, they are to no avail if they are not present uniformly from day to day. Experience has indicated that shorteners do offend, not infrequently, through the lack of uniformity which should serve to emphasize the value of technical control in their manufacture.

In their application to the production of crackers and biscuits, oils and fats function in much the same fashion as has already been discussed under bread and cake. Crackers and shortbreads utilize shortening in much the same way as bread, while cookies of the wire-cut variety, as for example, the vanilla wafer, bring into play the properties of shortening made use of in producing soft cakes.

However, because of the greater stress to which the oil or fat is subjected by the oven conditions, under which these products are baked, as well as their relatively longer shelf life, the attention of this branch of the baking industry has been focused on the ability of an oil or fat to resist the development of rancidity. This is of particular importance in the case of crackers, since because of their neutral flavor, the effect of rancidity is so readily noticeable. In those products carrying significant proportions of sugars, the development of rancidity does not take place as rapidly as with crackers since, as Bohn has observed, sugar, in generous amounts, appears to exercise a retarding effect.

Nevertheless, the development of rancidity is a factor to be seriously reckoned with, especially since crackers are produced in such volume as to be approximately equal to the combined volume on all other biscuit items. The oil chemists associated with the production of plastic vegetable shorteners were among the first to assist the cracker baker in extending the life of his products. Earlier efforts resulted in a somewhat harder fat which, despite its shortcomings from the standpoint of incorporation and creaming, met with favorable acceptance. Since, further progress has been evident. Not only have the shorteners been still more improved in their keeping properties, but a desirable degree of plasticity and creaming quality has been restored. More recent developments growing out of studies on rancidity suggest the probability that, by means of appropriate packaging, more can be accomplished in retarding the development of rancidity through this agency than has been the case thus far.

I am mindful of the fact that I have omitted any mention of the application of oils and fats to "rolled in" doughs, deep fat frying, icings, fillings, coatings, etc. Such discussion must necessarily be deferred until another time to be handled by a more competent speaker. I believe the material

NOTICE

The Journal Committee is desirous of obtaining some missing numbers of our former publication OIL & FAT INDUSTRIES in order to complete the files. We have been unable to complete our work on the 10-year index because of the lack of the following numbers:

Oil & Fat Industries, No. 2—1925.

Oil & Fat Industries, No. 4—1926.

Oil & Fat Industries, Nos. 3 and 7—1927

Doubtless some of our older members have these journals tucked away somewhere in their files.

The Journal Committee will much appreciate it if you will make a search and either give or loan us the missing numbers.

W. H. IRWIN, Chairman, Journal Committee.

discussed, however, covers the more important applications of your products to the baking industry, at least from the standpoint of volume. If I have lapsed too frequently in the vernacular of the baker, I crave your indulgence and hope that in some small measure I have been able to bring to you the baker's viewpoint concerning some of the products with which you are concerned. I also dare to hope that I may have contributed to your better understanding of the baker's requirements, and that this, coupled with a more intimate knowledge of your materials, will enable you to effect improvements in addition to those we in the baking industry already appreciate.

In closing, I desire to express my appreciation of the privilege that has made it possible for me to address you.

List of A. O. C. S. Referee Chemists for 1935-36

The following have certificates reading on analyses of all cottonseed products and similar materials covered by the methods of the A. O. C. S.

D. C. Picard, The Picard Laboratories, Birmingham, Ala.
G. K. Witmer, The Battle Laboratories, Inc., Montgomery, Ala.
L. B. Forbes, L. B. Forbes Laboratories, Little Rock, Ark.
T. C. Law and J. D. Evans, Law & Company, Inc., Atlanta, Ga.
W. M. Black, Augusta, Ga.
J. R. Mays, Jr., Barrow-Agee Laboratories, Inc., Shreveport, La.
S. Lomanitz, Oklahoma City, Okla.
R. M. Simpson, Chas. W. Rice & Co., Columbia, S. C.
G. W. Agee and E. R. Barrow, Barrow-Agee Laboratories, Inc., Memphis, Tenn.
G. M. Partee, Jr., Memphis, Tenn.
E. H. Tenent, Woodson-Tenent Laboratories, Memphis, Tenn.
N. C. Hamner, Southwestern Laboratories, Dallas, Texas.
P. D. Cretien, Texas Testing Laboratories, Dallas, Texas.
R. H. Fash and F. B. Porter, The Fort Worth Laboratories, Fort Worth, Texas.
C. M. Coguenhem, Shilstone Testing Laboratories, Houston, Texas.
F. R. Robertson, Houston Laboratories, Houston, Texas.

The following have certificates reading on analyses of cottonseed, cake and meal:

G. C. Henry, Law & Co., Cordele, Ga.
G. H. Kyser, Barrow-Agee Laboratories, Inc., Cairo, Ill.
B. L. Caldwell, Barrow-Agee Laboratories, Inc., Jackson, Miss.
J. C. Burt, Barrow-Agee Laboratories, Inc., Leland, Miss.
Thos. B. Caldwell, Law & Co., Inc., Wilmington, N. C.

The following have certificates reading on cake, meal, fatty oils, and soap stock:

R. G. Huffman, G. W. Gooch Laboratories, Ltd., Los Angeles, Cal.
P. W. Tompkins, Curtis & Tompkins, Ltd., San Francisco, Cal.
P. McG. Shuey, Shuey & Company, Inc., Savannah, Ga.
H. M. Shilstone, Shilstone Testing Laboratories, New Orleans, La.
Edw. G. Williams, New Orleans, La.
H. P. Trevithick, Bureau of Chemistry of the New York Product Exchange, New York, N. Y.
H. M. Bulbrook, Industrial Laboratories, Fort Worth, Texas.

The following has certificate reading on fatty oils and soap stock:

Laucks Laboratories, Inc., Seattle, Wash.

Collaborative Samples of Cottonseed and Crude Cottonseed Oil

In accordance with the general plan adopted at the last annual meeting of the A. O. C. S., the Referee Board began in October the distribution of both cottonseed and crude cottonseed oil samples to Referee Chemists for collaborative analyses. The National Cottonseed Products Association has definitely discontinued its policy of sponsoring these collaborative samples. The burden of work on the Referee Board has been unusually heavy during the current year, and specific plans for handling these samples were not worked out in time to permit advance notice in Oil and Soap. However, they are available to all members of the Society at actual cost of distribution, as indicated in the recent reports of the Referee Board, and the current samples are being sent to all who requested them.