Joint meeting leaders (left to right): R. J. Evans, AOCS; Charles Tatter, AACC; and Jack Carter, CBPC.

Registration desk is a busy place.

"Lipids in Baking" Symposium Draws 240 to IIT

Societies Sponsor Joint Session

"Any organization that doesn't serve its members becomes an institution, and time is too precious to support institutions."

With this philosophy in mind, the North Central Section of the American Oil Chemists' Society in Chicago decided at its May 1966 Board of Directors Meeting to sponsor a joint fall meeting of the American Oil Chemists' Society, North Central Section; the American Association of Cereal Chemists, Midwest Section and the Chicago Bakery Production Club. Work began immediately and on Nov. 16, 1966, this ambitious dream became a reality.

The symposium was originally scheduled to be held in the Swedish Club; however, due to the tremendous interest that was generated following the initial announcement, the meeting was moved to the more spacious facilities of the new Illinois Institute of Technology Research Institute at 10 West 35th Street, Chicago, Illinois. This 20-story $10 million dollar Research Tower was just completed this year and has facilities ideally suited for a meeting of this type.

Those attending the meeting numbered approximately 240 with some of the registrants coming from as far away as Philadelphia, Pennsylvania; Wilmington, Delaware; St. Louis, Missouri; and Indianapolis, Indiana.

The program got under way at 3:00 PM with a short welcoming address by R. J. Evans, President of the North Central Section of the American Oil Chemists' Society.

Audience gathers at IIT Research Tower.

The first two papers were by members of the Chicago Bakery Production Club and were concerned with "Fats in the Baking Process as the Baker Sees Them."

J. L. DeKeizer, Bakery Products Development Manager of Kitchens of Sara Lee, Inc., gave us the bakers' viewpoint of the fats available to the cake baker today. He pointed out that even though the baking profession is the oldest in the world, dating back 10,000 years, it is still an art. Mr. DeKeizer reported that "baking is an exciting, vital industry full of challenge and opportunity." He expressed hope that the oil chemists would meet the challenge and assist the bakers in making better bakery products for the future.

G. D. Pappas of the Product Development and Quality Control Division of Jewel Company, Inc., recalled the many hours of his boyhood spent in his grandfather's bakery in Egypt and told us that the baker must get to know his raw materials better if the industry is to continue to make progress. He reminded us that fats are second only to flour on the list of primary ingredients of all baked goods. In addition to fat used as an ingredient, fats also have other uses in the bakery such as depanning, etc.

Following the two excellent talks by members of the baking profession, R. H. Forsythe, Professor and Head of the Department of Poultry Science of Iowa State University, spoke on "The Influence of Egg Yolk Lipoprotein-Carbohydrate Interactions on Baking Performance." Dr. Forsythe reported that the egg yoke lipid is the least understood of all baking ingredients. Egg yolk plays an important role in such basic baking functions as emulsifying, coagulating, leavening and viscosity control. Native egg yolk contains little, if any, easily extractable lipids. The most important functional fraction of egg yolk seems to be the low density lipoproteins constituting about 70% of the dry matter. The lipids of egg yolk do not function

Registration continues for baking symposium.

J. L. De Keizer

R. H. Forsythe

C. W. Hoerr

J. G. Endres

as free lipids which normally would be assumed to lubricate and tenderize baked products, until they are released late in the baking process as the yolk proteins are denatured. The most important role of egg yolk lipids seems to be their role as a complex emulsifying function rather than that normally associated with baking fats.

Mr. DeKeizer, Mr. Pappas and Dr. Forsythe were introduced by George McWhinney of the American Institute of Baking and the Chicago Bakery Production Club.

After a short coffee break, the program resumed with a paper by J. G. Endres, Associate Manager, Food Research Division, Armour & Company. Dr. Endres spoke on "Surfactants for the Baking Industry," stating that the surfactant usage in the bakery field is estimated to be about 60 million pounds per year, 50 million pounds of which are of the monodiglyceride type. Dr. Endres discussed the current Federal government regulations governing the use of surfactants in baked goods and the use of electronic computers for developing a complex, optimum surfactant system.

C. W. Hoerr, National President of the American Oil Chemists' Society and Assistant Director of Research & Development of Durkee Famous Foods, officially welcomed everyone on behalf of the American Oil Chemists' Society, then spoke on "Crystallography of Fats for the Baking Industry." Mr. Hoerr reported that fats exist in several crystal modifications, each of which exhibits physical properties which influence the behavior of the fat differently in various applications. For example, certain crystal forms of fats provide the desired volume and texture of bakery products, whereas other crystal forms do not perform satisfactorily in this application. Crystal forms which fail to produce satisfactory baked goods may perform superbly in whipped toppings. The crystal forms in which fats exist and their rates of transformation from one modification to another are dependent upon their molecular composition and configuration. Processing procedures such as blending, hydrogenation, interesterification, fractionation, etc., markedly alter the molecular composition and configuration.

This concluded the afternoon work session and everyone moved into the lower level for a social hour and a delicious sirloin strip steak dinner.

After dinner, J. G. Ponte, Jr., Senior Research Chemist, Continental Baking Company, Rye, New York, spoke on "Studies on the Liquid System of Flour and Dough."

Mr. Ponte discussed two areas of interest relating to fats used in breadmaking: the lipids of wheat flour and the commercial fats that comprise one of the ingredients of bread dough.

He advised that wheat flour lipids have been studied for at least a century, but that their role in flour quality remains obscure. In the author's laboratory, recent attention has been directed to the specific association between lipid and protein in wheat flour, and the differences in lipid distribution were observed.

Another phase of research has been concerned with the notable bread improving effects that result when very small amounts of certain aliphatic hydrocarbons are added to dough. Added fat is essential for obtaining these improving effects, for without the fat the solvents cause dough deterioration.

Studies on fat requirements for continuous breadmaking indicate that a number of fats are satisfactory, provided that a certain level of hard fats, either hydrogenated cottonseed oil or tallow flakes, are present.

Congratulations to the men whose foresight and hard work made this meeting possible: Robert Evans and George Jackson, President and Program Chairman, respectively, of the North Central Section of the American Oil Chemists' Society; Charles Tatter and Paul Tack, *Chairman and Program Chairman*, of the Midwest Section of the American Association of Cereal Chemists; and Jack Carter and George McWhinney, President and Program Chairman, of the Chicago Bakery Production Club.

It was indeed a pleasure and privilege for the North Central Section of the American Oil Chemists' Society to sponsor this first meeting among these important groups who have so much in common; since the interest was so intense, they plan to have a similar meeting in the future with perhaps even more specific subject matter. Any comments or suggestions concerning this type of combined meeting will be appreciated. Please forward your comments to R. J. Evans, President, North Central Section, American Oil Chemists' Society, 35 East Wacker Drive, Chicago, Illinois 60601.

Following are abstracts of the five papers presented:

B. A. Greenwell

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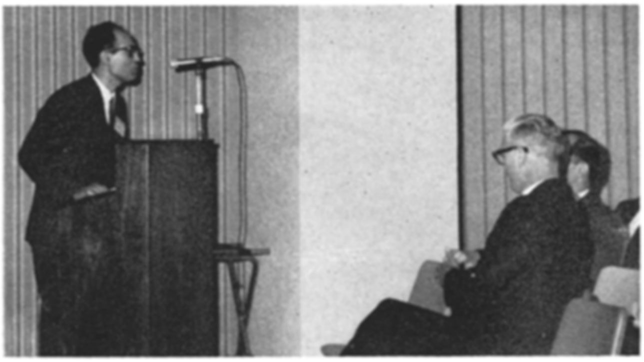

J. G. Ponte, Jr.

Earnest conversation during dinner hour.

• *Lipids in Baking . . .*

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Individual Reports

Performance of Fats in the Baking of Cakes

This paper refers to the viewpoint of a baker, not the viewpoint of the scientists or food technologists or chemists. I am stressing this point because I have been asked to speak to you today as a baker.

We know there are three basic fats available to the baker; namely, animal fat, vegetable fat, and butter. I would like to talk about butter first. Butter has many good characteristics, such as good texture, a very good eating quality, and its unique and excellent flavor. It has a few bad characteristics, too. To name one, a cake made with butter has a shorter shelf life than a cake made with hydrogenated shortening. We bakers use butter in order to get the highest possible quality in the finished product.

If we start talking about animal and vegetable fats we should go back in history a bit and talk about the first known bakery product. 10,000 years ago man had developed a baking art. Later, it was the Egyptians who discovered that letting a dough made from cracked wheat and water ferment—to form gases—would make a lighter loaf, and letting bread absorb hot animal fat would make bread tender and "easier" to eat.

In 1675 the art of baking sweet goods and pastries was given a boost. The French pastry chefs roamed the streets selling ice cream and sweet cakes which were often flavored with anise to cover up some of the undesirable animal fat flavors. In 1780 the first school of baking opened its doors in the French capitol. It took the French revolutionists of 1789 to give the pastry chef a real future.

It was in 1823 when the "father of fat chemistry," Michel Eugène Chevreul, published his book. This and his interpretations of previous observations about fats cleared away many misconceptions and established facts about fats.

In 1896 research work began on the reaction of hydrogen with vapor of volatile organic materials. In the 1900's the manufacturing of hydrogenated shortening began.

I am pointing out some of the history of fats and baking to illustrate that the baker was and still is an artist; however, history shows that the baker cannot work without the aid of science. We bakers want to change: we want to become scientists as well, but we need your help. Today most manufacturers of fat and shortenings make suggestions to the bakers. Every manufacturer of bakery ingredients tells the baker what to do.

We must learn many things: what went on during the baking process; what was the performance of fat; what does fat do during the baking process; what was the performance of all the ingredients during the process—all these things we do not know. We have to find out first and then we may be able to convert baking from an art to a science. We may be able to make cakes and pastries on a continuous basis, like continuous mixing of cake batters, followed by continuous extrusion, continuous baking, chopping into pieces, continuous wrapping, etc., instead of making pieces first. We may be able to produce delicious pastries scientifically.

We may be able to bake and freeze any bakery product. We may be able to go beyond this point of preserving products, not through freezing, but through sterilization. We may be able to use many synthetic materials so there are absolutely no calories or nutritional values in a pastry which is eaten for pure enjoyment. But who knows the future?

Many of you scientists, manufacturing ingredients for the baking industry, have made tremendous progress in the last 100 years. The baking industry, however, did not hire scientists until a few years ago. Today, in many large bakeries we have analytical laboratories and experimental bakeries. Many bakeries employ mechanical engineers, electrical engineers, process engineers, industrial engineers, chemical engineers, food technologists and food chemists. We need an ever increasing number of scientists to help us convert the art of baking into a science. Maybe some of you scientists want to start working in a bakery and learn the art of baking, then apply your scientific knowledge to baking. This really can open up a great opportunity for young scientists. I am very thankful about the great work which is going on right now in research laboratories.

I hope I have indicated in some way that there is a very exciting industry here—the oldest industry in the world, with many, many opportunities—many areas of investigation, discoveries and challenges, and I sincerely hope that you gentlemen will help us in producing a better baked product.

J. L. De Keizer

Fats in the Baking Process

Looking momentarily into the past of the baker's craft and asking the question "What caused him to use fats and oils in his bakery products?" we can realize that either by accident or by design the bakers and pastry cooks of the world, through the use of added ingredients and techniques, developed the tremendous varieties we now make. From the Stone Age down to the recorded history of primitive bread products, it was the Romans of 240 B.C. that developed an interest in consuming fancy breads with additions of olive oil, milk and honey, thus creating the prelude to the present sweet goods and cakes.

Among the reasons that the modern baker uses lipids in their products, we may enumerate the following:

1) Physical effects of shorteners upon the grain and texture of the products made.
2) The ability to increase the moisture content and enrichment levels by the emulsifying properties provided by the lipids themselves or in their relative combinations with other ingredients.
3) The development of pleasant eating characteristics through tenderness, softness and palatability.
4) The products are easily digestible and of higher nutritive value.
5) Product flavor improvement either from the original flavor contribution of the particular oils used or through their coexistence with other ingredients present through the heat exposure of baking.

What other uses of fats and oils have we in the bakery?

1) Releasing features of special greases for bulk dough handling reasons.
2) Depanning abilities of special compounds used in the categories of cakes and allied type products.
3) Separation effects in process and makeup such as twin and clover leaf rolls, folded-over decorative-type effects in items such as Parker House rolls, butterflake rolls, and kaiser rolls.
4) Overall finishing of pastry products and especially in cakes in the form of butter creams, icings and toppings.

Lipid Content in Bakery Products Comparative Study

We often miss the opportunity to compare products from the standpoint of one major ingredient. Taking this opportunity, a chart was prepared comprising 25 representative bakery items with increasing amount of lipid content expressed as a total percentage of the raw base. Variations may exist in the trade and a different alignment of such products could be found in other representative positions.

Specific Functions of Lipids in the Production of Sweet Goods

At this point the baker is often confused, in my opinion, as to what choice he should make in preference to the many available varieties of shortenings as well as the

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classic use of margarine and butter. It is also conceivable that by proper selection the most desirable lipid contribution toward the product characteristics and quality required by the baker and the consumer, may very well result in considerable savings in material costs and in processing performance. Here we can make use of more specific and accurate recommendations. The baker aims at producing sweet goods varieties that will satisfy the consumer's many requirements with respect to:

1) Pleasant eating characteristics at the point of consumption, possibly through freshness.
2) The ability of the product to sustain itself in this ideal condition for some time.
3) The baker's interest and his ability to handle, either by hand or by mechanical means, the doughs that will make such products.
4) Knowledge of specific functions of the fats and oils as required by the baker in, i.e., a) shortness; b) dispersing and emulsifying abilities; c) plasticity.

G. D. Pappas

Influence of Egg Yolk Lipoprotein-Carbohydrate Interactions

While many ingredients used in baking are relatively well understood, the complex mixture of proteins and lipids in egg yolk has only recently come under serious investigation. The emulsifying, coagulating, leavening and viscosity control functions of egg yolk play important roles in such products as sponge cakes, cream puffs or eclair shells, pound cakes, donuts, custards and mayonnaise.

Egg yolk is a mixture of granules, plasma and lipid-containing micelles averaging about 4,800,000 molecular weight with a diameter of approximately 240 Å. The granules, making up about 20% of the total yolk solids, consist of high density lipoproteins and phosvitin. The plasma is a mixture of water-soluble proteins, minerals and other minor ingredients. The most important functional fraction of egg yolk appears to be the low-density lipoproteins constituting almost 70% of the dry matter. A globule type micellar structure consisting of a core of triglycerides, a shell of phospholipids, primarily lecithin, and restraining bands of protein is suggested. Native egg yolk contains little if any easily extractable lipids.

Egg lipids in pure egg yolk become extractable when about 50% of the water is removed during drying or if temperatures of 150–160F are attained for any appreciable length of time during processing. The effect of water removal is to reduce the effectiveness of the protein-phospholipid hydrogen bonds in stabilizing the structure of the micelle, while the heat treatment results in denatured protein molecules incapable of holding the micelle in a stable configuration. Upon disruption of the micelle, the resulting free egg oil severely damages the foaming power of the egg yolk and the disrupted micelle reduces the emulsifying power of the low-density lipoprotein fraction.

The addition of carbohydrates such as sucrose, maltose, or mixtures of carbohydrates such as found in low dextrose equivalent corn syrups, added at levels of 10–15%, protect the egg yolk by apparently entering into the hydrogen bonds broken on the removal of water during drying and, therefore, maintaining the micelle stabilizing structure during heating and drying. The fat extractability of dried egg yolk to which these sugars have been added remains near zero during drying and storage in sharp contrast to plain egg yolk solids.

The preparation of eclair shells from heat-damaged whole egg and the subsequent attempts at correction of the defects observed are described. It is possible to reduce the effect of overheating by reducing the fat in the formula of the eclair shell or by adding emulsifiers to the formula, therby reducing the emulsifying demands on the egg. This experiment is a practical example of the usefulness of such model systems in explaining practical observations and predicting practical solutions.

Another practical application is the control of viscosity in dried donut mix preparations that can be achieved by controlling the viscosity of the egg yolk during the manufacturing steps. Viscosity control in donuts is related to the amount of water required for rehydration. As the low-density lipoprotein micelle is disrupted, the water-binding characteristics of the structural protein is altered.

These investigations show that the lipids of egg yolk do not function as free lipids which normally would be assumed to lubricate and tenderize baked products, until they are released late in the baking process as the yolk proteins are denatured. It would seem that the most important role of the lipids in egg yolk is their role as a complex emulsifying function rather than that normally associated with baking fats.

R. H. Forsythe
J. R. Schultz

Surfactants for the Baking Industry

The surfactant usage in the bakery field is estimated to be about 60 million pounds. Well over 50 million pounds of the surfactants used are of the mono-diglyceride type. The purpose of this paper is to define what is meant by the term surfactant in contrast to the term "mono" or emulsifier, to describe current Federal government regulation of the use of surfactants in baked foods, to present briefly the chemistry of the FDA food approved surfactants; to elucidate the function of surfactants in the baking process and to capsualize a report on the use of computor technology for the optimization of a surfactant system.

J. G. Endres

Crystallography of Fats for the Baking Industry

We know from experience that different kinds of fats behave differently in different kinds of food systems. For example, liquid oils do not ordinarily by themselves produce an acceptable cake product. With the introduction of hydrogenation, it was found that certain partially hydrogenated vegetable oils produced lighter, finer grained cakes than the animal fats which were available at the time. When catalytic interesterification process was applied to lard, it was found that the product performed more satisfactorily in many bakery applications than does ordinary lard. These and many other processing methods, in one way or another, are responsible for altering the crystal structure of fats.

We know that fats exist in several different crystal forms which transform more or less readily from one form to another and that some fats appear to exist only in certain crystal forms and not in others. In fact, it has been over 30 years since Malken published his first papers on x-ray diffraction which proved that triglycerides exist in more than one crystal form. However, there is yet no real agreement among the various investigators regarding the number of crystal forms in which glycerides exist. Some investigators insist that glycerides exist in only three crystal forms, whereas others insist that glycerides exist in four. We have some hints that under certain conditions they may exist in even one or more additional forms. The literature now contains at least six different systems for naming the different types of glyceride crystal forms.

X-ray diffraction patterns of the four glyceride crystal forms identified by the speaker are discussed. The orientation of glyceride molecules is postulated for the different crystal lattices. Such studies enable us to understand why some fats exist in several different crystal forms which transform more or less readily from one form to another and that some fats appear to exist only in certain crystal forms and not in others.

From studies such as these, we can interpret differences in the performance of fats in various types of bakery products. For example, there is a direct correlation between crystal structure and aeration of cake batters. Fats in the lower melting crystal forms exist in very small crystals which provide the desired degree of aeration necessary to produce high volume, fine-grained cakes. Fats

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• *Lipids in Baking . . .*

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in the higher melting crystal forms do not provide proper aeration of cake batters, although in other applications they may perform better than the lower melting forms.

As we gain more knowledge about the performance of specific crystal forms in the different kinds of bakery products, we can design specific fat systems with the desired characteristics by deliberately manipulating the molecular composition of the fat by proper choice of raw material and manner of chemical processing.

C. W. Hoerr

Studies on the Lipid System of Flour and Dough

The baking industry is vitally interested in fats for many reasons. For the purpose of this paper, two areas of interest, related to breadmaking, are singled out: the lipids of wheat flour, and the commercial fats that comprise one of the ingredients of bread dough.

Wheat flour lipids have been studied for at least a century, but their role in flour quality remains obscure. The earlier literature on lipid research has been confusing and contradictory; hopefully, with the improved methodology available today and the current interest in lipids by a number of laboratories both here and abroad, both the complete identification and functionality of the flour lipids will be determined. By reference to a thin-layer chromatogram showing a typical class separation of flour lipids, the distribution of lipids as presently known is briefly summarized and discussed. Comparison of the distribution of lipids from a number of commercial flours shows little differences; attempts to show relationships between lipid quantity and flourbaking quality in the literature have generally been fruitless.

In the author's laboratory, recent attention has been directed to specific associations between lipid and protein in wheat flour; surprisingly, little previous work has been done in this area. Wheat flour gluten was fractionated into three components by each of two routes; the fractions were freeze-dried, then analyzed for lipid distribution by quantitative thin-layer chromatography. Differences in lipid distribution were observed; some of the implications of these findings are discussed.

Another phase of research has been concerned with the notable bread-improving effects that result when very small amounts of certain aliphatic hydrocarbons are added to dough. Data are shown indicating a specific relationship between solvent carbon-chain-length and functionality in dough. Added fat is an essential requirement for the improving effects; without the fats, the solvents cause dough deterioration. "Binding" of lipid, phosphorus, and protein in dough, when solvents are present, suggest alterations in lipoprotein structure.

Studies on fat requirements for continuous-breadmaking indicate that a number of fats are satisfactory, provided that a certain level of hard fats, either hydrogenated cottonseed oil or tallow flakes, are present. Dilatometric studies show that lard has essentially no solids at 110F, a temperature often attained in proof boxes of continuous breadmaking plants, which may explain poor results when lard alone is used as a shortening; evidently a requirement exists for crystalline fats to prevent leakage of gas through cell walls of dough. Fat systems that promote formation of beta prime crystals appear to be desirable. Data are presented on the lipid binding of continuous-mix dough and bread in comparison to that of conventional dough and bread.

Continued study of flour lipids and added fat systems, as well as interactions between them and other dough components is indicated.

J. G. Ponte, Jr.

• *New Members*

Active

Marshall J. Chick, Chemist, Best Foods Division, Corn Products, Bayonne, N. J.

Gene M. Coxwell, President, Southern Technical Services, Inc., Clinton, Miss.

Chester A. Davis, Research Chemist, Toni Division, Gillette, Chicago, Ill.

William Patrick Donahoo, Technical Marketing Manager, The Griffith Laboratories, Chicago, Ill.

Rudolf Kohn, Research Chemist, US Army Natick Laboratories, Natick, Mass.

Glen Peter Krawiec, Quality Controller, Corn Products, Alameda, Calif.

Arthur Edward Krisinski, Chemist, Corn Products, Bayonne, N. J.

Holger Larsen, Chief Chemist, Corn Products, Alameda, Calif.

Bernard Lesieur, V. P. Engineering, Georges Lesieur et Ses Fils, Paris, France.

John E. Lowden, Head of Quality Control Laboratory, Capital City Products, Division of Stokely-Van Camp, Inc., Columbus, Ohio.

Daniel Joseph Meshnick, Assistant Production Manager, Industrial Division, Drew Chemical Corp., Boonton, N. J.

Patrick L. Parker, Assistant Professor of Chemistry, University of Texas, Port Aransas, Texas.

Jack Patt, Technical Director, Stan Sax Corp., Detroit, Mich.

Kunihiko Saito, Associate Professor, Department of Medical Chemistry, Kansai Medical School, Osaka, Japan.

Grace Y. Sun, Research Associate, Cleveland Psychiatric Institute, Cleveland, Ohio.

Thomas Edward Vickers, Assistant to the Quality Supervisor, Anderson, Clayton & Co., Foods Division, Durant, Okla.

Donald T. Warner, Research Associate (Biochemistry), The Upjohn Co., Kalamazoo, Mich.

Corporation Associate

Cincinnati Milling Machine Co., Donald W. Smith, Research Chemist, Cimcool Laboratory, Cincinnati, Ohio.

Active Junior

Ian Andrew de la Roche, Graduate Research Assistant, Department of Agronomy, University of Illinois, Champaign, Ill.

• *Names in the News*

A. C. Zettlemoyer (1948), research director and chemistry professor at Lehigh University, Bethlehem, Pa., has assumed the new position of first Vice-President for Research. Currently the Lehigh Institute coordinates more than 160 research projects at the University for US Government agencies, industries, foundations, and societies.

Francis Scofield (1937) is responsible for the overall technical activities and long range planning of the National Paint, Varnish and Lacquer Association in his new position as Vice-President—Technical Affairs. His work will include air and water pollution control programs. Scofield's former duties as Director of the Technical Division of NPVLA are being performed by R. A. Brown, who joined NPVLA after five years as plant manager and technical director of the Stanley Chemical Division of The Stanley Works, East Berlin, Connecticut.

N. M. Molnar (1964), founder and president of Fine Organics, Inc., at Lodi, N. J., has received a special citation for outstanding professional achievement from the Cooper Union for the Advancement of Science and Art in New York City.