The Research Fellowship of the National Cottonseed Products Association

CLIFTON E. SWIFT [1]
Southern Regional Research Laboratory[2]
New Orleans, Louisiana

THIRTY or more years ago a number of forward-looking members of the Interstate Cottonseed Crushers Association [3] realized that the cottonseed industry was inherently based on science. In fact, in 1918, in his presidential address [Cotton Oil Press, *2* (No. 2), 44 (1918)], Fielding Wallace indicated that the Association should consider building its own research laboratory. In those years, even as now, the industry frequently found it necessary to consult with and seek the assistance of scientists and technologists in various branches of the federal government and state experiment stations, especially of the U. S. Department of Agriculture and the National Bureau of Standards. To facilitate cooperation between agencies with respect to the problems of the industry, the Technical Advisory Committee, then the Committee on Cooperation in Research, was appointed. One of the first recorded activities of this committee was its meeting in 1921, under the chairmanship of E. R. Barrow, Memphis, Tennessee, with the chiefs and assistant chiefs of various bureaus of the U. S. Department of Agriculture. At this meeting a number of technical problems of interest to the cottonseed industry was discussed and a tentative research program outlined. Following this meeting, some of the research of the U. S. Department of Agriculture was more specifically oriented along the lines discussed at the conference. The thoughts and wisdom of the committee is evident from the outline of the projects contained in its report of 1922 [Cotton Oil Press, *6* (No. 3), 74 (1922)], from which the following is taken:

1. To develop varieties of cottonseed that will yield fiber of the maximum value and seed containing the maximum percentage of oil and to determine the effects of cultural conditions.
2. Isolation and identification of all constituents of crude cottonseed oil with special reference to refining loss and quality.
3. Continuance of work on rancidity with special reference to the nature and constitution of the products formed and their physiological effects. . . . It will lead to a knowledge of the methods of prevention and removal of rancidity from oils and fats.
4. Isolation and identification of constituents of cottonseed meal with special reference to feeding value.

In reviewing the progress of the research conducted by various governmental agencies the committee realized that the personnel available for work on the various projects was limited, and in 1926 it recommended that the Association establish a fellowship for conducting cooperative research with the Department of Agriculture in order to more actively participate in and contribute to the progress of such research as might be planned and undertaken. This recommendation met with the approval of the Association and the U. S. Department of Agriculture and led to the establishment of the fellowship program. The fellowship, under the direction of the committee and in cooperation with the U. S. Department of Agriculture, has been active in conducting fundamental investigations on cottonseed and cottonseed meal and oil for more than 20 years (1926-1947), the results of which have been reported in some 26 scientific and technical publications.

The Technical Advisory Committee of the National Cottonseed Products Association, although changed in title [4] several times during its history has changed but little in membership. The personnel of the committee reflects the various interests of the cotton oil industry, including oil millers, refiners, manufacturers of finished products, commercial chemists, and research and control laboratories.

The present membership of the committee is as follows: E. R. Barrow, chairman, Memphis, Tennessee; T. C. Law, Atlanta, Georgia; A. S. Richardson, Cincinnati, Ohio; H. S. Mitchell, Chicago, Illinois; Andrew Schwartz, Houston, Texas; R. H. Fash, Fort Worth, Texas; L. B. Forbes, Little Rock, Arkansas; J. I. Morgan, Jr., Farmville, North Carolina; C. W. Wallace, West Monroe, Louisiana; and Richard Blyth, Paris, Texas.

Under the direction of these or their predecessor members of the committee the work of the fellowship of the National Cottonseed Products Association has been conducted for approximately 20 years in collaboration with the Bureau of Agricultural and Industrial Chemistry.[5] A brief history of the fellowship and its accomplishments follows:

History and Accomplishments of the National Cottonseed Products Association Fellowship

For approximately 20 years the National Cottonseed Products Association has maintained one or more fellowships for the purpose of conducting investigations on cottonseed and cottonseed products in collaboration with the Bureau of Agricultural and Industrial Chemistry of the U. S. Department of Agriculture. The primary purpose of the fellowship's work has been to develop and supply fundamental data and information required by the cottonseed industry. To realize this purpose a collaborative program of research was agreed upon under which the Association assumed certain financial obligations with respect to salary, travel, and other expenses of the Fellow, and the Department of Agriculture made available the necessary physical facilities and technical supervision. From 1926 to 1943 the fellowship was maintained in the Bureau of Agricultural and Industrial Chemistry, Washington, D. C., after which it was continued at the Bureau's Southern Regional

[1] National Cottonseed Products Association Fellow, 1939 to date.

[2] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

[3] Became the National Cottonseed Products Association in 1929.

[4] Originally the Committee on Cooperation in Research, later the Basic Research Committee, and more recently the Technical Advisory Committee.

[5] Formerly the Bureau of Chemistry and Soils (1927-1939); Bureau of Agricultural Chemistry and Engineering (1939-1943).

Research Laboratory, New Orleans, Louisiana. During the period 1926 to date the fellowship was held by a number of individuals and the program of research underwent various changes in keeping with developments in the industry and advances in the field of fat and oil chemistry and technology.

There follows a brief description of the work and accomplishments resulting from the various collaborative investigations, brief biographical sketches of the Fellows, and a list of publications resulting from their efforts on behalf of the fellowship. The coauthors listed on many of the publications indicate the extent of the collaboration of the Bureau of Agricultural and Industrial Chemistry in the work of the fellowship. To these collaborators and to other scientific and administrative personnel of the Bureau of Agricultural and Industrial Chemistry no little credit is due for the successful outcome of the investigations undertaken by the Fellows of the National Cottonseed Products Association.

From 1926 to 1936 the fellowship projects were concerned principally with investigations pertaining to cottonseed meal; those from 1937 to date have been concerned with cottonseed oil with the addition that an investigation of means of increasing the feeding value of cottonseed hulls was undertaken in the year 1938-1939. Broadly speaking all of the investigations had similar objectives, namely, to improve the quality and utility of two of the primary products derived from cottonseed.

Investigations on Cottonseed Meal

The investigations on cottonseed meal were concerned primarily with a) the principal pigment of cottonseed, namely gossypol, a minor and physiologically active constituent of the seed, and b) with the nutritional value of cottonseed meal. The results of these investigations were of immediate practical value to the industry in promoting an increase in the consumption of cottonseed meal by the livestock industry. When the first investigations on gossypol were begun, extremely little was known concerning the chemistry or physiological activity of this constituent of cottonseed. The first phase of this investigation was conducted by E. P. Clark during the years 1926 to 1929 and was continued by Henry Stevens from 1929 to 1936.

Investigations on Cottonseed Meal, 1926-1929

The results of the investigations on cottonseed meal during the years 1926 to 1929 may be grouped for purposes of discussion as follows: a) chemistry of gossypol, b) physiological properties of gossypol, and c) nutritional properties of cottonseed meal.

a) Chemistry of Gossypol. An improved method was developed for the isolation of gossypol from cottonseed and attention centered on the determination of its structure. Elemental analyses and molecular weight determinations indicated that gossypol had a molecular formula corresponding to $C_{30}H_{30}O_8$. Since gossypol was found to form a dioxime, two of the oxygen atoms were assumed to be present in the form of carbonyl groups. Furthermore, since gossypol formed a hexa-acetyl derivative it was assumed that six of the oxygens were present in the form of hydroxyl groups. Of the six hydroxyl groups two differed from the other four in possessing acidic properties (1). Oxidative degradation of gossypol yielded isobutyric acid indicating that an isopropyl side chain was present in the molecule (3). This work laid the foundation for the elucidation of the structure of gossypol.

Investigation indicated that the residual gossypol remaining in cottonseed meal was largely inactive, and on the basis of these results a hypothesis was advanced that during cooking, pressing, etc., normally followed in processing cottonseed, a reaction occurred between gossypol and proteins to produce so-called "bound" gossypol (5).

b) Physiological Properties of Gossypol. Experiments with white rats indicated that gossypol was physiologically active when administered in certain concentrations (1) but that "bound" gossypol, i.e., the residual gossypol in expressed cottonseed cake and meal, was physiologically inactive (8).

c) Nutritional Properties of Cottonseed Meal. Biological experiments, based on the growth rate of white rats fed diets containing cottonseed meal indicated that the intelligent use of cottonseed meal as a protein supplement in a mixed feed should yield an excellent stock ration (8).

Investigations on Cottonseed Meal, 1929-1936

In the investigations carried on from 1929 to 1936 emphasis was placed on a) the nutritional properties of cottonseed meal and b) possible allergies which might be attributed to cottonseed.

a) Nutritional Properties of Cottonseed Meal. Nutritional studies involving the determination of the growth rates of white rats on diets containing cottonseed meal yielded evidence that the proteins of cottonseed meal possessed exceptionally high nutritional value (9). The results of these investigations also indicated that cottonseed meal is a good source of vitamins B and G (9).

These results were of two-fold importance because they supplied experimental evidence that cottonseed meal is highly valuable as a component of animal feeds and they provided essential information for establishing intelligent feeding practices with cottonseed meal.

b) Allergy. Clinical evidence bearing upon the occurrence of allergens in cottonseed was assembled and examined. Evidence was found that faulty interpretation of valid clinical data could lead to invalid conclusions (12). These results served to invalidate certain erroneous interpretations of clinical evidence which were current with respect to the existence of allergens in cottonseed oil and concerning the value of cottonseed meal as a protein supplement.

In the 10 years which have passed since the termination of the fellowship's work on cottonseed meal other workers have been conducting investigations along similar lines, with results which are interesting in the light of the work of the fellowship. At the present time no completely satisfactory or entirely acceptable structure of gossypol has been advanced. A large volume of recent work by a considerable number of nutritional, pharmacological, and toxicological laboratories indicates that spectroscopically pure gossypol is physiologically active but nontoxic in the commonly accepted sense of the word. This physiological activity varies markedly from one species of animal to another. This same work has shown that properly processed cottonseed meal possesses exceedingly high nutritional value.

Investigations on Cottonseed Oil

In October, 1937, the Technical Advisory Committee adopted for the fellowship [6] a project entitled "Investigation of the Factors Which Influence the Stability of Cottonseed Oil." The ultimate objective of this project was to improve the stability (keeping quality), utility, and economic value of cottonseed oil. Work on the project began in 1938 in Washington, D. C., where it continued until 1943 when the fellowship was transferred to the Southern Regional Research Laboratory, New Orleans, Louisiana. The investigation was continued at the new location under the title, "Improvement of the Stability of Cottonseed Oil."

The necessity for undertaking research of a fundamental nature on the stability of cottonseed oil was recognized from the beginning of the project since the information then available on the nature, reactivity, and properties of the constituents of cottonseed oil and their relation to keeping quality was too inadequate to permit a more practical attack on the problem.

To obtain this information entailed development of new analytical techniques, methods of isolating the components of cottonseed oil, and the determination of the reactivity of the various components, especially with respect to their reaction with oxygen under the influence of light and heat. Our knowledge of the composition of cottonseed oil, the stability of its predominant unsaturated acids, and the function of its natural antioxidants has been considerably enhanced as the result of the work of the fellowship during the past 10 years.

The first phase of the investigation of cottonseed oil was undertaken in 1938-1939 by R. W. Riemenschneider and has been continued from 1940 up to the present by C. E. Swift.

Investigations on Cottonseed Oil, 1938-1947

The work of the fellowship during the years 1938 to 1947 consisted of investigations on a) glyceride components and derived fatty acids and esters of cottonseed oil; b) antioxidants of cottonseed oil; and c) oxidation of cottonseed oil.

a) The Glyceride Components and Derived Acids and Esters of Cottonseed Oil. The investigations in this group were concerned with the identity and characteristics of the glyceride components, fatty acids, and derived esters of cottonseed oil, and with methods of preparing pure components and improved methods of analyses. Cottonseed oil was subjected to molecular distillation and low temperature fractional crystallization. The analyses of fractions indicated that the principal glycerides were oleo- and linoleo-dipalmitins, together with some trilinolein (18). The identification of the bromination and oxidation products of pure linoleic acid established the fact that only one form of linoleic acid occurs in cottonseed oil (14).

The simple triglycerides, namely triolein and trilinolein, were synthesized from oleic and linoleic acid by an improved method, and their physical and chemical properties were determined. Three crystalline forms of triolein and two crystalline forms of trilinolein were observed (17). A method of preparing pure oleic acid and its methyl ester was developed. The procedure involved fractional distillation and low temperature crystallization of methyl oleate (15). A method of preparing methyl linoleate was developed whereby methyl linoleate is separated from the methyl esters of cottonseed oil by chromatography (21).

The methods of determining iodine numbers, thiocyanogen numbers, and residual saturated acids of methyl oleate, linoleate, and mixtures of these esters were investigated (16, 17, 19). As the result of this work modifications of available methods for determining thiocyanogen values and saturated acids were recommended and have been applied to improve the accuracy of determining the composition of cottonseed oil and derivatives.

b) The Antioxidants of Cottonseed Oil. An investigation of the naturally occurring substances which afford cottonseed oil a measure of protection against oxidative deterioration has yielded significant information relative to antioxygenic activity and methods of concentrating the tocopherols which comprise the chief natural antioxidants of cottonseed oil. The antioxidants of cottonseed oil were separated from the glyceride components by molecular distillation (18).

It was found that the natural antioxidant, alpha tocopherol, which is present in cottonseed oil functions effectively at a low optimum concentration and relatively ineffectively at higher concentrations. The rate of peroxide accumulation in the oil or other fatty substrate was found to be directly proportional, rather than inversely proportional, to the tocopherol content of the substrate (20).

Investigation of the substance responsible for the color which develops in cottonseed oil during oxidation yielded evidence that chroman-5,6-quinone, a red-colored product, is produced by the oxidation of gamma tocopherol, one of the naturally occurring antioxidants of cottonseed oil (22).

These investigations provided a basis for understanding the mechanism by which the natural antioxidants of cottonseed oil act to protect this oil and its finished products from the action of atmospheric oxygen.

c) The Oxidation of Cottonseed Oil. Information relative to the mechanism of the oxidation of cottonseed oil was first sought by investigating the oxidation of one of its derived products, namely the methyl ester of oleic acid. This phase involved a study of the formation and decomposition of the first oxidation product of methyl oleate, i.e., methyl hydroperoxido oleate. A method for the ready preparation of the hydroperoxide was developed, and the structure and some of the chemical and physical properties of this peroxide were determined (23).

The rate of formation and the characteristics of the decomposition products of methyl hydroperoxido oleate were investigated in the presence and absence of alpha tocopherol, a naturally-occurring antioxidant of cottonseed oil. It was found that at 75°C. the addition of alpha tocopherol to the hydroperoxide accelerated its decomposition. When the hydroperoxide or its decomposition products was added to methyl oleate and to alpha tocopherol-stabilized methyl oleate, the rates of oxidation of these substrates were accelerated by addition of the former product but not by the latter (24).

[6] During the year 1938-1939 W. H. Baldwin served as a second Research Fellow of the National Cottonseed Products Association to investigate the possibility of increasing the feeding value of cottonseed hulls by hydrolysis (13).

An investigation of the products resulting from the decomposition of methyl hydroperoxido oleate resulted in the identification of one of them as 2-undecenal (25), an odorous and unpleasant tasting unsaturated aldehyde. The identification of this product of decomposition of the peroxide together with evidence of the presence of homologs and analogs of 2-undecenal constitutes evidence of the source of some of the oxidation products which adversely affect the flavor characteristics of fats and oils which have undergone atmospheric oxidation.

Investigation of the reaction between the hydroperoxide and oleic acid revealed the fact that the hydroperoxide reacts with oleic acid at the double linkage to form an epoxide (26) and thus accounts for the observed presence in oxidized fats of such oxidation products as oxido-oleic and dihydroxystearic acids.

The above-described investigations on cottonseed oil have provided information on the nature, reactivity, and properties of the constituents of cottonseed oil and their relation to the keeping quality of this oil, all of which have advanced the ultimate objective of the National Cottonseed Products Association project to improve the keeping quality of cottonseed oil.

Biographical Sketches of the Fellows of the National Cottonseed Products Association

EARL PERRY CLARK, the first chemist to hold the fellowship of the National Cottonseed Products Association was appointed in 1926. Dr. Clark died November 7, 1943, and shortly thereafter C. A. Browne prepared an account of his life which was published in the Journal of the Association of Official Agricultural Chemists (Vol. 27, No. 2, 1944). The following excerpts are quoted from Dr. Browne's article:

"Clark was born at Portland, Oregon, on August 25, 1892. His first chemical experience was acquired while still a boy in the pharmaceutical laboratory of the Spokane Drug Company of Spokane, Washington. His duties here consisted in helping to prepare U. S. Pharmacopoeia and National Formulary products and in doing some analytical work, for which even at this early period he showed a remarkable aptitude. In 1912 he began an undergraduate course in chemistry at Washington State College but left in 1915 to become a chemist aid in the Carbohydrate division of the Bureau of Chemistry. He acquired here his first experience in preparing the rarer sugars and their derivatives. In May, 1916, Clark accepted a fellowship at the Rockefeller Institute for Medical Research, where for the next four years he conducted investigations on carbohydrates, nucleic acids, and other physiological products. His desire for varied activity prompted him in 1920 to become an associate technologist at the National Bureau of Standards, where he continued his research work on the rarer sugars. He resigned this position in 1922 to take graduate work in chemistry at the State University of Iowa, from which he received the degree of M.S. in 1923 and of Ph.D. in 1924.

"After acquiring his doctorate Clark worked two years as research chemist in the Department of Biochemistry at the University of Alberta, Edmonton, Canada, where he conducted investigations on the hormones of the parathyroid gland. In December, 1926, he accepted a fellowship at the Bureau of Chemistry in Washington, under a grant of the Interstate Cottonseed Crushers Association, for the purpose of investigating the chemistry of gossypol . . . . An attractive opportunity for studying the chemistry of other physiologically active plant substances induced him in July, 1929, to join the staff of the Division of Insecticide Investigations of the Bureau of Chemistry, where he remained until 1934, when this Division was transferred to the Bureau of Entomology and Plant Quarantine. He remained until his retirement with this Bureau, where he continued his investigations on naturally occurring insecticidal substances."

HENRY STEVENS succeeded Dr. Clark as the National Cottonseed Products Association Fellow in 1929 and held the fellowship until 1936. He was born at St. Albans, Vermont, February 11, 1896. He obtained a B.S. degree at the University of Wisconsin in 1921 and a M.S. degree at the same institution in 1923. From 1926-29 he was an assistant in the Department of Pathology and Bacteriology, Rockefeller Institute for Medical Research. While serving as the National Cottonseed Products Association Fellow he completed work for a Ph.D. degree at George Washington University, which was granted in 1934. After serving approximately seven years as the Fellow of the National Cottonseed Products Association he resigned to assume the direction of the Allergen Research division, Bureau of Agriculture and Industrial Chemistry, U. S. Department of Agriculture, in which position he has continued his investigations on the chemical and the physiological constituents and dietetic properties of cottonseed and its derived products.

ROY WILLIAM RIEMENSCHNEIDER was appointed to the fellowship of the National Cottonseed Products Association in 1938 when the investigations on cottonseed oil were inaugurated. Mr. Riemenschneider was born in Illinois, May 7, 1903. He obtained an A.B. degree at the University of Illinois in 1927 and a M.S. degree at the University of Maryland in 1930. During this period he served as a Fellow in the Department of Chemistry, University of Maryland (1927-30). From 1930 to 1936 he was a junior chemist in the Bureau of Animal Industry, U. S. Department of Agriculture, later assistant chemist (1936-38) in the same organization, which position he resigned to fill the Fellowship of the National Cottonseed Products Association in 1938.

After about a year and a half of active work as Research Fellow, Mr. Riemenschneider became a member of the staff of the Bureau of Agricultural and Industrial Chemistry but continued for the next two years to be associated with the work of the fellowship in a collaborative capacity. In 1941 he transferred to the Oil and Fat Division, Eastern Regional Research Laboratory, Philadelphia, Pennsylvania, where he is presently in charge of the Composition and Quality Section.

WILLIS HARFORD BALDWIN was appointed Fellow of the National Cottonseed Products Association in 1938 to serve simultaneously with Mr. Riemenschneider. During the period of his service Dr. Baldwin investigated various means of increasing the feeding value of cottonseed hulls. Dr. Baldwin was born in Havre de Grace, Maryland, in 1914, and obtained his higher education at the University of Maryland, receiving

a B.S. degree in 1935, a M.S. degree in 1937, and a Ph.D. degree in 1942. He was a Fellow at the U. S. Bureau of Fisheries Technological Laboratory from 1935-1938. After serving as Fellow of the National Cottonseed Products Association during the year 1938-1939 he resigned to accept a position as a research chemist with the Fish and Wildlife Service, U. S. Department of Interior. He resigned this position in 1942 to become associated with the E. I. du Pont de Nemours and Company. During the above-mentioned period Dr. Baldwin's research was concerned with proteins, carbohydrates, cottonseed hulls, and fish oils.

CLIFTON EUGENE SWIFT, the present encumbent of the fellowship, succeeded Mr. Riemenschneider in 1939. He was born in Washington, D. C., August 4, 1911. He was granted a degree of B.S. in Chemistry by the University of Maryland in 1934. In 1936 Mr. Swift was appointed as Industrial Fellow in the Technological Laboratory, U. S. Bureau of Fisheries, at College Park, Maryland, a position he resigned in 1939 to enter on the fellowship work of the National Cottonseed Products Association in the Bureau of Agricultural and Industrial Chemistry, Washington, D. C. When the fellowship work was transferred to the Southern Regional Research Laboratory in 1943, Mr. Swift resumed activity in New Orleans where he is presently located. During his encumbency of the fellowship he has published or prepared for publication nine articles dealing with the composition and stability of cottonseed oil and its derived products.

PUBLICATIONS OF THE NATIONAL COTTONSEED PRODUCTS ASSOCIATION FELLOWSHIP, 1927 to 1947 [1]

1. Studies on Gossypol. I. The Preparation, Purification and Some of the Properties of Gossypol, the Toxic Principle of Cottonseed. CLARK, E. P., J. Biol. Chem., *75*, 725-739 (1927).

2. Studies on Gossypol. II. Concerning the Nature of Carruth's D Gossypol. CLARK, E. P., J. Biol. Chem., *76*, 229-235 (1938).

3. Studies on Gossypol. III. The Oxidation of Gossypol. CLARK, E. P., J. Biol. Chem., *77*, 81-87 (1928).

4. Studies on Gossypol. IV. Apogossypol. CLARK, E. P., J. Biol. Chem., *78*, 159-166 (1928).

5. The Composition and Toxic Effects of Gossypol (Progress Report). CLARK, E. P., Oil and Fat Ind., *5*, 237-277 (1928).

6. Studies on Gossypol. V. The Action of Chromic Acid Upon Some Gossypol Derivatives. CLARK, E. P., J. Am. Chem. Soc., *51*, 1475-1478 (1929).

7. Studies on Gossypol. VI. The Action of Boiling Hydroiodic Acid as Used in the Zeisel Method Upon Gossypol and Some of Its Derivatives. CLARK, E. P., J. Am. Chem. Soc., *51*, 1479-1483 (1929).

8. Studies on Gossypol: A Progress Report. CLARK, E. P., Oil and Fat Ind., *6*, 15-19 (1929).

9. Nutrition Studies on Cottonseed Meal. STEVENS, H., Oil and Fat Ind., *2*, 215-216 (1930).

10. Photographic Records of Vitamin D Line Tests. STEVENS, H., and Nelson, E. M., Ind. Eng. Chem., Anal. Ed., *4*, 200-201 (1932).

11. Cottonseed Allergy and Gin. STEVENS, H., J. Allergy, *6*, 393-396 (1935).

12. Some Observations on Food Allergy. STEVENS, H., Oil & Soap, *13*, 162-165 (1936).

13. Hydrolytic Treatment of Cottonseed Hulls. BALDWIN, W. H., and LeClerc, J. A., Oil & Soap, *16*, 178-180 (1939).

14. The Probable Identity of α- and β-Linoleic Acids. RIEMENSCHNEIDER, R. W., Wheeler, D. H., and Sando, Chas. E., J. Biol. Chem., *127*, 391-402 (1939).

15. The Preparation and Properties of Highly Purified Methyl Oleate. Wheeler, D. H., and RIEMENSCHNEIDER, R. W., Oil & Soap, *16*, 207-209 (1939).

16. Methods of Analysis of Mixtures of Oleic, Linoleic and Saturated Esters, and Their Application to Highly Purified Methyl Oleate and Methyl Linoleate, RIEMENSCHNEIDER, R. W., and Wheeler, D. H., Oil & Soap, *16*, 219-221 (1939).

17. Preparation, Properties and Thiocyanogen Absorption of Triolein and Trilinolein. Wheeler, D. H., RIEMENSCHNEIDER, R. W., and Sando, Chas. E., J. Biol. Chem., *132*, 687-699 (1940).

18. Molecular Distillation and Low Temperature Crystallization of Cottonseed Oil and the Stability of the Molecularly Distilled Fractions. Riemenschneider, R. W., SWIFT, C. E., and Sando, Chas. E., Oil & Soap, *17*, 145-148 (1940).

19. The Thiocyanogen Values of the Methyl Esters of Oleic, Linoleic and Linolenic Acids, the Application of These Values in the Analysis of Mixtures. Riemenschneider, R. W., SWIFT, C. E., and Sando, Chas. E., Oil & Soap, *18*, 203-206 (1941).

20. Factors Affecting the Stability of Cottonseed Oil. A Study of the Antioxygenic Activity of Alpha Tocopherol. SWIFT, C. E., Rose, W. G., and Jamieson, G. S., Oil & Soap, *19*, 176-180 (1942).

21. The Preparation of Purified Methyl Linoleate by Chromatography. SWIFT, C. E., Rose, W. G., and Jamieson, G. S., Oil & Soap *20*, 249-250 (1943).

22. Gamma Tocopherol as a Precursor of a Red-Quinoid Substance Developed in Cottonseed Oil During Oxidation. SWIFT, C. E., Mann, G. E., and Fisher, G. S., Oil & Soap *21*, 317-320 (1944).

23. The Oxidation of Methyl Oleate. I. The Preparation, Properties and Reactions of Methyl Hydroperoxido Oleate. SWIFT, C. E., Dollear, F. G., and O'Connor, T. R., Oil & Soap *23*, 355-359 (1946).

24. Some Properties and Reactions of Methyl Hydroperoxido Oleate. SWIFT, C. E., Transactions of the First Conference on Biological Antioxidants, held under the auspices of the Josiah Macy, Jr., Foundation, October 10, 1946, New York.

25. Decomposition of Methyl Hydroperoxido Oleate. SWIFT, C. E., Dollear, F. G., and O'Connor, R. T., J. Am. Oil Chem. Soc. (In manuscript.)

26. The Oxidation of Methyl Oleate. II. A Reaction Between Methyl Hydroperoxido Oleate and Oleic Acid. SWIFT, C. E., and Dollear, F. G., J. Am. Oil Chem. Soc. (In manuscript.)

[1] The names set in caps and small caps in the bibliography are those of the National Cottonseed Products Association Fellows.