Exploitation of the Caranday for Wax. Based on the accumulated information and the results of the survey and investigations reported here, it would appear that the exploitation of the caranday palm for wax should be technically feasible. Many of the largest stands of this palm are adjacent to the Río Paraguay, on which regular boat service is maintained and along which are situated towns and industrial plants. Roads, trails, and narrow gauge railroads extend from the river into the Chaco at various points, thus making it possible to reach vast numbers of palms without difficulty.

The relatively smaller height and higher density of the caranday palm as compared to the carnaúba palm should make the collection of the leaves relatively easy.

The problem of labor supply, especially for harvesting the leaves, is probably the greatest handicap to be overcome in developing a caranday wax industry. Such skilled workers, administrators, and technically trained individuals as are located in the towns along the Río Paraguay are generally employed by the quebracho processing plants. This is generally true of a large number of Indians who live in the bush and are engaged in cutting quebracho. Cutting and processing quebracho for tannin is a year-round operation and probably considerably more profitable than would be the production of caranday wax; consequently it is unlikely that labor would be diverted from this source for cutting and processing caranday leaves. There are also many Indians employed on the ranches who may or may not be available at times for harvesting palm leaves.

It may be possible to induce additional Indians from the interior to migrate, at least for the leaf-harvesting season, to the vicinity of the palm areas. Since many Indians have been trained to be excellent *hacheros* (axe-men), it should be possible to train others to be equally good palm *cortadores*.

An item of very considerable importance to the establishment of a new industry is the attitude of the government with respect to taxation, export duties, rates of exchange, and the amount and degree of regulation which may be imposed on it, especially during its developmental stages. Given favorable governmental consideration and with the development of an adequate supply of efficient labor, the exploitation of the caranday palm could in time equal or surpass the carnaúba industry. This new source of hard vegetable wax would remove the threat of a shortage of this product for many years to come.

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A Survey of Institutions Which Offer Training in Fat and Oil Technology in the United States

F. A. KUMMEROW, Department of Food Technology, University of Illinois, Urbana, Illinois

THE present survey of colleges and universities which offer training in fat and oil technology was compiled from replies to a letter of inquiry to members of the American Oil Chemists' Society[1] who are connected with these institutions. Additional names were obtained from a search of the current copies of the Journal for published articles which originated in college or university laboratories. Thirty-nine institutions were contacted and, on the basis of the data obtained, were divided into three groups. Those in group one offered no exclusive training or courses in fat and oil technology or did not reply. It was assumed that the latter group did not reply because they had no facilities or training available in this field. Those in group two offered specialized training in some aspect of fat and oil technology. Furthermore, research workers at these institutions have developed a phase of the field for which there may be no adequate substitute at another institution. However these institutions offered no course of study devoted exclusively to, or research involving broad phases of fat and oil technology. On the other hand, the institutions in group three all offered a specialized course or courses devoted exclusively to fat and oil technology and had a research program which involved both the chemical and biochemical aspects of fat and oil technology.

The basic undergraduate training at all of the 39 institutions surveyed, whether on a quarter or semester system, included one full year of general, quantitative, organic, and physical chemistry, and a year of physics and calculus. In most cases a course in biochemistry and bacteriology and a year of French and German were also required. A course in instrumental analysis, chemical literature, botany, zoology, political science, or economics was usually taken as an elective.

The first group was comprised of 22 institutions which offered no exclusive training in fat and oil technology (Table 1). However these institutions are important to fat and oil technology for two reasons. One, basic training in chemistry was available at all of them, and students graduating from these schools could serve as laboratory workers in industrial laboratories or as a source of graduate students. Two, at least one staff member of these 22 institutions is a member of the American Oil Chemists' Society or has published a paper in the Journal, indicating that

[1]Directory of Members, The American Oil Chemists' Society, July 1952.

TABLE I

Institutions Which Offer No Training in Fat and Oil Technology or Did Not Reply to Letter of Inquiry

Institution	Address
1. Columbia University	New York 27, New York
2. Cornell University	Geneva, New York
3. Detroit Institute of Technology	Detroit 26, Michigan
4. Illinois Institute of Technology	Chicago 16, Illinois
5. Institute of Applied Arts and Sciences	Brooklyn 1, New York
6. Iowa State College	Ames, Iowa
7. Lehigh University	Bethlehem, Pennsylvania
8. Rutgers University	New Brunswick, New Jersey
9. Stanford University	Stanford University P.O., Calif.
10. Syracuse University	Syracuse 10, New York
11. University of Detroit	Detroit 21, Michigan
12. University of Colorado	Boulder, Colorado
13. University of Iowa	Iowa City, Iowa
14. University of Maryland	College Park, Maryland
15. University of Michigan	Ann Arbor, Michigan
16. University of Missouri	Columbia, Missouri
17. University of Notre Dame	Notre Dame, Indiana
18. University of Pittsburgh	Pittsburgh, Pennsylvania
19. University of Rochester	Rochester 20, New York
20. University of Texas	Austin, Texas
21. University of Washington	Seattle, Washington
22. Western Reserve University	Cleveland 6, Ohio

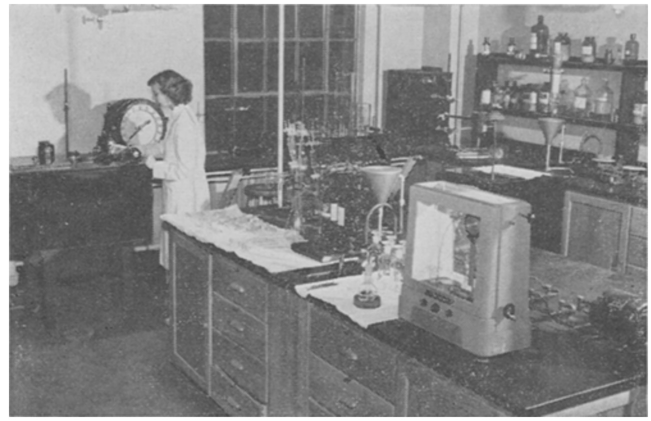
some interest in fat and oil technology must have been present.

The second group was comprised of 12 colleges and universities which offered specialized courses of interest to fat and oil technology or offered specialized training in some aspect of this field at the graduate level (Table II). These included work in nutrition, dairy products, fish products, cereals, oil seeds, meats, paints, varnishes, plastics, food and fat metabolism.

Among the specialized curricula is the training offered in nutrition at the University of Southern California under H. J. Deuel, Jr., the oil seed technology at Texas A. and M. college under C. M. Lyman, and the paints, varnishes, and drying oils program at North Dakota Agricultural College under R. E. Dunbar. The program at the last institution was started in 1903 by E. F. Ladd; to date, 300 paint specialists have been graduated from it.

THE third group was comprised of the remaining five institutions, which had each established a comprehensive program in fat and oil technology at the graduate level (Table III). This program of courses and research could therefore be classified as establishing a major in fats and oils. All of the institutions listed formal lecture courses or a seminar course devoted exclusively to fat and oil technology and/or to lipid chemistry. The undergraduate requirements for a B.S. degree called for approximately the same amount of organic chemistry and biochemistry at all five universities. However the graduate program varied somewhat, and it may therefore be more expedient to take up each one separately.

Ohio State University. The work in fats and oils at Ohio State has been carried out under the supervision of J. B. Brown, professor of Physiological Chemistry and director of the Institute of Nutrition and Food Technology. This laboratory was established in 1925



A section of the lipid laboratory at Ohio State University is shown above.

and has been the source of almost 100 papers on fats, oils, fatty acids, and new techniques.

Dr. Brown stated that a student working for the Ph.D. degree in Physiological Chemistry and specializing in fats and oils fulfills the general departmental course requirements for the degree, which includes advanced courses in organic and physiological chemistry with a minor in a biological subject such as bacteriology or physiology. Arrangements are also possible whereby a student who works in fats and oils can take his degree in agricultural biochemistry or in chemistry and do all or part of his work under Dr. Brown's direction in the fat laboratory. No formal course work in fat and oil technology is offered at either the undergraduate or graduate level, but several courses in the department and in agricultural biochemistry include the chemistry and/or the technology of fats. However Dr. Brown gives a seminar program on the chemistry of lipids every two or three years. Also F. E. Deatherage in Agricultural Biochemistry is interested in research in autoxidation of fats.

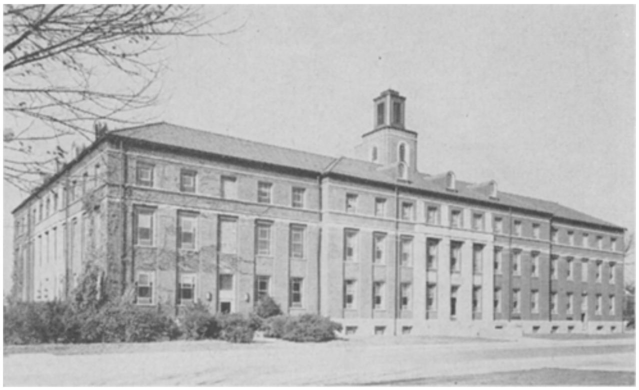
Purdue University. A program of research in fats and oils was begun in the Department of Agricultural Chemistry more than 20 years ago by H. R. Kraybill, and this has been continued by his successor, F. W. Quackenbush, department head during the past 10 years. The laboratory has published a number of papers, and the current program includes projects on the chemistry and analysis of fats, fat deterioration, biochemistry and nutrition of the lipids, chemistry of the carotenoids, and fat-soluble vitamins.

Graduate students in this program have available a wide selection of advanced courses in biochemistry, including a semester of lecture and laboratory devoted exclusively to the fats and other lipids. With his major subject, biochemistry, the student has two minor subjects. One is usually organic or physical chemistry and the other chemical engineering, bacteriology, or physiology.

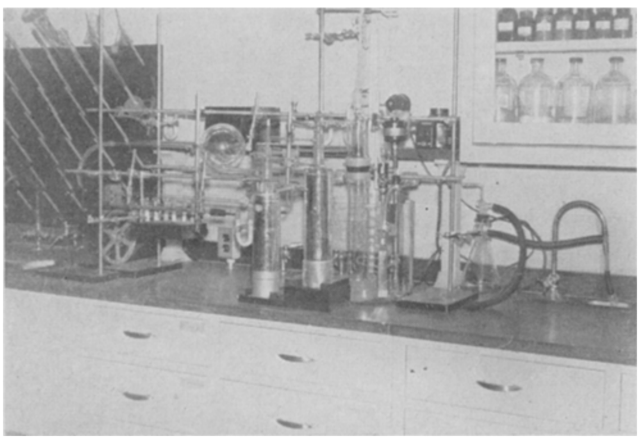
TABLE II

Institutions Which Offer Some Training in Fat and Oil Technology

Institution	Department	Field	Contact	Address
1. Massachusetts Institute of Technology	Food Technology	Nutrition	B. Procter	Cambridge, Mass.
2. Michigan State College	Food Technology	Dairy Products	J. R. Brunner	East Lansing, Mich.
3. North Dakota Agricultural College	Chemical Technology	Paints and Drying Oils	R. E. Dunbar	Fargo, N. D.
4. Northwestern University	Chemistry	Fat Metabolism	R. K. Summerbell	Evanston, Ill.
5. Oregon State College	Food Technology	Fisheries	R. O. Sinnhuber	Astoria, Ore.
6. Pennsylvania State College	Agricultural and Biological Chemistry	Cereals	H. O. Triebold	State College, Pa.
7. Texas A. and M. College	Biochemistry and Nutrition	Oil Seeds and Nutrition	C. M. Lyman	College Station, Tex.
8. University of California	Food Technology	Foods	G. Mackinney	Berkeley 4, Calif.
9. University of Chicago	American Meat Institute Foundation	Meats	H. R. Kraybill	Chicago 37, Ill.
10. University of Delaware	Chemistry	Plastics	E. Dyer	Newark, Del.
11. University of Massachusetts	Food Technology	Foods	E. Anderson	Amherst, Mass.
12. University of Southern California	Biochemistry	Nutrition	H. J. Deuel, Jr.	Los Angeles 7, Calif.



This is a view of the Agricultural Chemistry building at Purdue University.



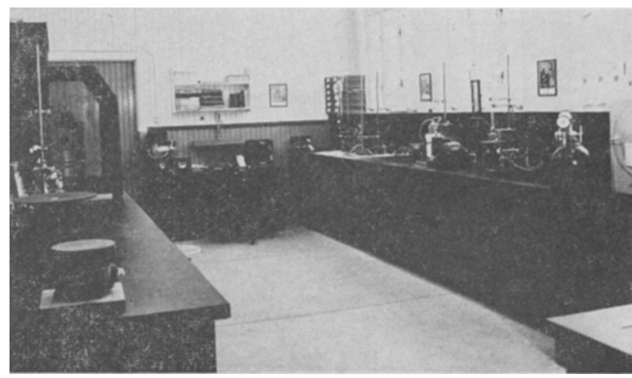
Here is apparatus for the autoxidation of unsaturated fatty acids in a typical laboratory at the University of Illinois.

University of Illinois. The work in fat and oil technology at the University of Illinois has been carried out under the supervision of F. A. Kummerow, assistant professor of food chemistry in the department of food technology. Dr. Kummerow has published 34 papers on the biochemistry and nutrition of lipids, fat deterioration, the autoxidation and polymerization of unsaturated fatty acids, and the composition of the lipids in cereals and other natural products.

At Illinois the student can take a full year of formal lecture and laboratory courses in fat and oil technology. In addition to the usual survey of lipid materials, the lecture courses include all the major phases involved in the industrial processing of fats and oils. The laboratory work includes experiments on high vacuum distillation, fractional crystallization, low and high pressure hydrogenation, and preparation of emulsifiers, detergents, and fatty acid derivatives. The student usually takes a minor in organic or biochemistry in the department of chemistry. Four units of advanced courses in chemistry are required. However split minors between chemistry and other subjects similar to those at Purdue are also possible.

University of Minnesota. W. O. Lundberg, director of the Hormel Institute and professor of agricultural

The Hormel Institute at Austin, Minnesota.



A typical laboratory in the Hormel Institute, Austin, Minnesota.

biochemistry, has supervised most of the research work in fats and oils. Each year he gives a lecture and laboratory course in the chemistry of lipids. Every second or third year a graduate lipids seminar course is also given under his direction. He has published approximately 50 papers on the biochemistry and nutrition of lipids, fat deterioration, antioxidants, and the autoxidation of unsaturated fatty acids.

W. F. Geddes, chief of the division of agricultural biochemistry, directs some research on fats and oils in the field of cereal chemistry.

A student working for an advanced degree fulfills the requirements for a major in the division of agricultural biochemistry and can minor in organic chemistry or in some other department. The thesis problem for an advanced degree can be pursued either on the farm campus at St. Paul or at the Hormel Institute in Austin. J. R. Chipault and O. S. Privett, both of whom are assistant professors of agricultural biochemistry, spend their full time in conducting research at the Hormel Institute in Austin, mostly in the field of fats and oils.

Lipid research is not confined to the department of agricultural biochemistry, and in the past such research has been carried out also in the departments of physiological chemistry, organic chemistry, and pharmacy. R. T. Holman, who is a member of the staff of

TABLE III

Institutions Which Offer Training in Fat and Oil Technology

Institution	Department	Contact	Address
Ohio State University	Institute of Nutrition and Food Technology	J. B. Brown	Columbus 10, O.
Purdue University	Agricultural Chemistry	F. W. Quackenbush	Lafayette, Ind.
University of Illinois	Food Technology	F. A. Kummerow	Urbana, Ill.
University of Minnesota	Agricultural Chemistry	W. F. Geddes	St. Paul 1, Minn.
	Hormel Institute	W. O. Lundberg	Austin, Minn.
University of Wisconsin	Chemistry	H. A. Schuette	Madison 6, Wis.

The Animal Sciences building at the University of Illinois in which the laboratories devoted to fat and oil technology are located.

the Hormel Institute, is an associate professor in the medical school's department of physiological chemistry. Dr. Holman supervises research both in Austin and the Twin Cities, not only in the field of lipid metabolism, but also on the chemistry of fats and oils. He has published about 50 papers dealing with the chemistry and biochemistry of fatty acids and lipoxidase.

University of Wisconsin. H. A. Schuette, professor of chemistry, has supervised the training in fat and oil technology at both the undergraduate and graduate level. He has given a lecture and laboratory course in fat chemistry, has published some 60 papers on this subject, and has supervised the thesis work for 30 Ph.D. candidates. Dr. Schuette has been most interested in the chemical aspects of fats and oils chemistry. His work has included the characterization of fats and oils, waxes, and the physical constants of fatty acids.

A student working for an advanced degree under Dr. Schuette fulfills the requirements for a major in the department of chemistry and usually takes a minor in organic chemistry or agricultural biochemistry. The latter department has furnished strong support to this program and is justly famous for its many studies on the biochemical and nutritional phases of fats and oils.

Summary

A survey of 39 colleges and universities in the United States indicated that five universities offered formal course work or seminars and research training in fat and oil technology. These five institutions were Ohio State University, Purdue University, the University of Illinois, the University of Minnesota, and the University of Wisconsin.

Letter to the editor

Iodine Values of Acidulated Coconut Oil Soapstock

THE J.A.O.C.S. for June 1953 contains an article of great interest to refiners of coconut oil: "Iodine Values of Acidulated Coconut Oil Soapstock," by S. R. Kuber and Wales H. Newby.

The comparatively high iodine values of this acidulated soapstock have for decades been the basis for arguments or even litigation between buyer and seller, and a clarification is needed.

Copra is a heterogeneous product, widely varying in free fatty acid content of the individual pieces within the same cargo. While pieces of white, sound endosperm may contain oil with only 1-2% FFA, the yellow and brown pieces may contain oil with 10% FFA, and spoiled pieces may even run considerably higher. There may also be minor differences in the saponification and iodine values as well as melting points.

Evidently the heterogeneity of copra may be due to many circumstances: varying ripeness of nuts, exposure during drying and storage, time of storage before and after shipping, conditions during shipping and general handling.

It is obvious that much more of the oil pressed from pieces of poor quality than of that from sound pieces goes into the soapstock during the alkali refining, but this *per se* does not explain the high iodine values of the acidulated soapstock.

The main contributory factor to these higher iodine values is to be found in the "dust" and other small particles invariably present in any shipment of copra. This dust, if removed from the copra by screening, sifting, or blowing, is found to contain oil which may have up to 50% FFA. The amount of dust may constitute 1.5%, or even more, of the total weight of copra and the oil derived from it about 0.95%. Assuming a yield of 64.5% of oil from copra, it is seen that the dust-oil may amount to almost 1.5% of the yield.

The dust is comparatively low in fat and protein. Due to its physical nature it does not respond well to hydraulic pressing, and the cakes are found to contain 11-12% fat and may have up to 25% ash. The expressed oil, as stated, may contain up to 50% FFA. It is dark and smelly and, when originating from smoke-dried copra, has a fluorescence. Its iodine value may be as high as 25, and it would be higher if the dust did not also contain particles of the endosperm.

The content of dust in copra is due to the disintegration caused by insects and molds in combination with the abrasion from handling during drying, shipping, and storage. Like other finely divided material from oil-bearing seed, it deteriorates rapidly under hydrolysis of the oil. The high iodine value of the oil is mainly due to the content of seed-coat (testa) in the dust. Testa oil may have an iodine value of over 50. Since most pieces of copra are curved toward the endosperm, it is obvious that the testa is particularly exposed to abrasion during handling, but, of course, most of the testa remains on the copra as this enters the crushing equipment so that the crude oil actually contains much more of the testa oil than that originating from the dust. It is also realized that the above mentioned 1.5% dust removed by sifting does not represent a complete removal.

In view of the above it is quite understandable that acidulated soapstock has a high iodine value as compared with that of the refined oil and that the latter is lower than the crude. It also explains why the differences between refined and acidulated are greatest with low-acid crude where the amount of soapstock is comparatively small, and therefore the content of dust-oil in the acidulated is proportionally greater.

J. JAKOBSEN
Palo Alto, Calif.
June 17, 1953