Report from Germany: The Federal Center for Lipid Research, Münster (Westf.)

The Center for Lipid Research constitutes one of 16 laboratories under the jurisdiction of the Federal Ministry of Food, Agriculture and Forestry. The primary objective of all these research centers is to improve the production and utilization of agricultural products. The laboratories at Münster are concerned with edible fats and oils, their composition, physical, chemical and biological properties; technological aspects are investigated as well.

Organization and staff

The Federal Center consists of two institutes: The Institute for General and Analytical Chemistry, headed by A.Seher, and the Institute for Technology and Biochemistry–"H.P. Kaufmann Institute," headed by H.K. Mangold. The scientific staff includes physicochemists and organic chemists, biochemists, food technologists and pharmaceutical chemists, comprising a total staff of ca. 50 persons. Visiting scientists and scholars from overseas, as well as graduate students, are assigned to various sections of the center. The Federal Center is assisted by an Advisory Board which is chaired by J. Baltes, President of the German Society for Fat Research.

The laboratories at Münster are well equipped with modern instruments for chromatography, spectroscopy, mass spectrometry and radioactive work. Pilot plants and large units are available for technological operations, such as continuous reactions in heterogeneous phases, refining of fats and processing of margarine and other fatty foods. Rooms for keeping experimental animals and aquariums for work on freshwater fish are available. Facilities are also present for growing oil-bearing plants under natural conditions. A library and the adjoining documentation section offer a sizeable collection of the scientific literature.

Scientific activity

Analysis of major and minor components of fats and oils: The triglyceride composition of fats and oils is of consderable scientific and technological interest. Complex mixtures of triglycerides can be well resolved and analyzed by using a combination of argentation and reversed-phase partition chromatography. During the past years these techniques have been modified and employed in the characterization of a large number of commercial fats and oils.

During the course of studies on the identification of minor components, methods have been developed for the isolation of "total sterols" from vegetable fats and oils. The generally accepted procedure of precipitation with digitonin was found to be associated with some hitherto unknown errors. Mixtures of sterols and their derivatives have been analyzed by thin layer chromatography and gas chromatography. In contrast to commercial adsorbents, such as silica gel or alumina, a new adsorbent mixture consisting of magnesium oxide, aluminum oxide and gypsum has been found to afford excellent separations of steryl dinitrobenzoates. This is the only method that permits a separation of Δ5-sterols from the dihydro compounds. The new technique has been developed to a quantitative procedure which is based on the colorimetric determination of Meisenheimer-adducts of steryl dinitrobenzoates. Methods have also been evolved for the gas chromatographic separation of various methyl sterols and the Δ7-sterols, which are relatively rare and have therefore been often overlooked. Using the techniques described above, the following sterols have been identified in sunflower oils: cholesterol, stigmasterol, Δ7-stigmasterol and Δ7,24(28)-stigmastadienol; furthermore, Δ7-campesterol, Δ7,9(11),24(28)-stigmastatrienol and Δ7,24(25) stigmastadienol, which so far were not known to be present in sunflower oil, have been identified.

The Institute for Technology and Biochemistry, known as the "H.P. Kaufmann Institute."

During the past years methods have been developed for the isolation and quantitative analysis of emulsifiers in foods. A new procedure permits quantitative analysis of the components of modified partial glycerides; separation is accomplished by thin layer chromatography, and the individual fractions are determined quantitatively.

Systematic studies are in progress on the mass spectrometry of synthetic lipids of various homologous and vinylogous series, including unusual lipids of plant and animal origin such as diester waxes and alkoxylipids. Mass spectrometric studies on plant sterols have revealed the structure of some hitherto unknown sterols in vegetable oils, as mentioned earlier.

In a cooperative effort with E. Haahti of Helsinki, Finland, and H. Spaans of Delft, The Netherlands, a new instrument has been developed for quantitative thin layer chromatography. Mixtures of organic compounds are chromatographed in quartz or Pyrex tubes the internal surface of which is coated with a layer of adsorbent. Such a thin layer tube is driven through a scanning furnace; thereby the individual chromatographic zones are vaporized consecutively, either by pyrolysis or, if the adsorbent contains cupric oxide, by combustion in situ. The gaseous products are monitored in gas phase detectors, such as a flame ionization detector or thermal conductivity detector. The new instrument was found to be highly suitable for accurate and rapid analyses of complex lipid mixtures.

Authorized by the Ministry of Food, Agriculture and Forestry, the Federal Center for Lipid Research has actively participated during the past 10 years in work on the *Codex Alimentarius.*

Synthesis of lipids: Aliphatic methanesulfonates (mesylates) are excellent starting materials for the synthesis of

lipids, such as saturated and unsaturated hydrocarbons, bromides, aldehydes, nitriles, acids and ethers. During the past 2 years, some further reactions have been worked out which widen the field of application of mesylates. Thus wax esters can be obtained in almost quantitative yields by reacting mesylates with the sodium or potassium salts of fatty acids. Also the C-alkylation of sodium malonic ester can be accomplished with mesylates at high yield. Saponification of the alkyl malonic ester followed by decarboxylation of the corresponding alkyl malonic acid provides a fatty acid having two methylene groups more than the starting mesylate.

Diester waxes have been found recently in sebaceous secretions of various animals. One research group is working on the synthesis of these unusual lipids; further studies will include the action of the diester waxes on human skin. Also ether-ester and diether analogues of diester waxes are being synthesized with the aim of employing these partially hydrolyzable and nonhydrolyzable compounds in biochemical studies.

Trialkylglyceryl ethers have been prepared from triglycerides of soybean and rapeseed oils. The trialkyl ethers of glycerol resemble the triglycerides with regard to physical behavior and organoleptic properties; however, in contrast to triglycerides, they are neither hydrolyzed in the gastrointestinal tract nor absorbed. Currently possibilities are being explored of using the trialkylglyceryl ethers as "nonfattening fats."

Biochemistry and nutrition of fats and other lipids: One group is studying the biosynthesis of cyclopentenyl fatty acids. A few tropical varieties of Flacourtiaceae, which are known to synthesize these acids, are being grown in a green house. Moreover cell cultures of these plants are maintained for metabolic studies.

In collaboration with E.J. Staba, Minneapolis, Minn., studies of lipids in callus cultures of oil-bearing plants have been in progress for 2 years. Nutritional aspects of plant cell cultures, especially of soya and rape, will be studied in animal experiments.

Most foods contain a wide variety of lipids other than triglycerides, such as long chain alcohols, aldehydes, ketones, wax esters, hydroxy acids and their esters, as well as alkyl diglycerides. The metabolism and nutritional properties of these unusual lipids are being studied. It has been found that the lipid composition of the intestine and the physiological properties of the intestinal mucosa can be influenced by dietary measures.

One research group is working on the culture of freshwater fish. Carps have been kept for 18 months on a feed which contained up to 30% rapeseed. During this period detrimental effects due to feeding of rapeseed were not observed. The use of rapeseed and defatted rapeseed meal as feed for freshwater fish opens a new avenue for the efficient production of valuable protein from inexpensive vegetable materials.

Processing and technology of fats: Considerable work is devoted to problems in the technology of oilseeds and edible fats. Several scientists are engaged in the improvement of processes for the recovery of fats and oils from plant and animal raw materials. Processes are being evolved to improve the quality of rapeseed meal and to develop protein-rich animal feed and food for human consumption.

Various aspects of the process of solvent extraction are being studied. One group is investigating the effects of composition of the solvent on the properties of extracted oil and on the residual solvent content of the extracted meal. Also work is in progress on the detection of carcinogenic hydrocarbons in solvents employed for the extraction of edible fats.

Another group is working on a new process for the continuous deodorization of fats. The main features of this process are optimum utilization of direct steam and short duration of oil in the deodorizer.

The Institute for General and Analytical Chemistry, one of the two laboratories which comprise the Federal Center for Lipid Research in Münster.

Refining processes and their effect on the sterols present in fats are also being investigated. It has been found that in the course of technical processing, especially during bleaching, plant and animal sterols are chemically altered.

With the goal of accomplishing a selective hydrogenation of the linolenate moiety in vegetable oils by a continuous process, a large number of stationary catalysts has been evaluated during the past years. It has been found that stationary catalysts containing copper are very suitable for the selective hydrogenation of trienoates to dienoates. Currently work is being undertaken to develop a process for the selective hydrogenation of "low erucic rapeseed" oils that contain more than 10% linolenic acid, which impairs their keeping properties.

Environmental safety: Several activities of the center are closely associated with the environmental safety program of the Federal Government. The German Association of Engineers has formed a commission on the "Prevention of Air Pollution from Plants for the Processing of Oils and Fats." The Federal Center coordinates the activities of this commission.

Cooperation with scientific societies and international organizations: The Federal Center maintains close contact with the German Society for Fat Research. Together with this society the center conducts short courses. The next course is scheduled for the spring of 1973.

Visitors from foreign countries, including AOCS members, stop frequently at Münster. The exchange of ideas with these guests has always been most rewarding and is highly appreciated.

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