Commentary:
Biotechnology for fats and oils

The following commentary was prepared by J.B.M. Rattray of the Department of Chemistry and Biochemistry at the University of Guelph, who serves as Associate Editor for JAOCS *News for Biotechnology.*

To introduce a regular column on biotechnology, it appears appropriate to reflect upon the importance of this technology to the fats and oils industry. Biotechnology has been proclaimed as the revolutionary technology of the 1980s. Just as computers and allied technology had a major impact on industrial practices in the 1970s, similar expectations are held now for biotechnology. Unfortunately, the needs of modern society and commerce to obtain rapid immediate success has resulted too frequently on bandwagon jumping without careful consideration of all the relevant factors. Biotechnology, as any technology, has its limitations as well as potential advantages and must be viewed accordingly.

It might appear that biotechnology began to have an impact on the industry around the time four pertinent symposia were held at the 1982 AOCS annual meeting in Toronto. These proceedings subsequently were published by AOCS as a monograph (*Biotechnology for the Oils and Fats Industry*, edited by C. Ratledge, P. Dawson and J. Rattray, 1984). It is worthwhile to note that 20 to 30 people attended these symposia. Two years later, approximately 200 registrants attended a general symposium on biotechnology at the 1984 AOCS annual meeting in Dallas. Then, in September 1987, 500 people from 40 different countries attended the World Conference on Biotechnology for the Fats and Oils Industry in Hamburg, West Germany. This highly successful meeting was cosponsored by AOCS and the German Society for Fat Research with the additional participation of the Institut des Corps Gras of France, the Japan Oil Chemists' Society and the Stazione Sperimentale degli Oli e dei Grassi of Italy. A symposium on biotechnology also is scheduled during the ISF-JOCS World Congress, to be held September 26–30, 1988, in Tokyo, Japan. International interest in this topic obviously is increasing.

A more objective analysis would reveal that biotechnological practices in the areas of fats and oils have existed from earliest times. Thus, mainly through trial and error, certain plant seeds were found more desirable than others as sources of edible oils, lamps oils and salves, and were used for these purposes over 2,000 years ago. These are among the earliest examples of the exploitation of biological systems to yield consumer-desirable products. Much interest and research now is being devoted to determining alternate sources such as crambe, cuphea and jojoba for novel oils and fatty derivatives as well as improving the quality and quantity of plant oils of present-day commerce. The adaptation of local plant varieties to environmental conditions still is of fundamental importance. This can and will be achieved by the adoption of the newer techniques of genetic engineering to complement rather than supplant the older practices of breeding. Plant sources will continue to be of primary importance for edible and industrial oils possessing desirable properties. Plant breeders, food technologists and industrial chemists, among others, cannot afford to ignore the potential advantages to be gained from better knowledge and greater applications of the newer biotechnological practices.

Traditionally, biotechnology has been associated with the brewing and pharmaceutical industries. Consequently, much attention has been focused on microbial systems and fermentation products. This parochial approach gradually is being replaced by an ever-widening interest in animal and plant systems that, coincidentally, have been of primary interest to the fats and oils industry. On the other hand, microorganisms (primarily yeasts and fungi) have been touted as possible sources of single cell oil although, for reasons of economics, its nature will have to be that of a specialty product such as γ-linolenic acid-rich oils and cocoa butter substitutes. Certain algal oils also may have a future as liquid fuels and high-resistance lubricants. Meanwhile, the potential of various microorganisms to produce commercially a variety of biosurfactants and surface-active agents awaits further evaluation.

More recently, many studies have indicated that microorganisms and selected component enzymes may have a high potential for applications in the transformations and modifications of fats and oils. In particular, consideration is being given to the possible use of various enzyme systems for specific hydrolysis, esterification and transesterification in the preparation of desirable fatty acids and triglycerides. It is noteworthy that the pharmaceutical industry for some time has used the enzymic activity of certain microorganisms to achieve the often difficult stereospecific substitutions involved in the chemical synthesis of various steroid drugs. More attention will have to be paid to the possible advantages of enzyme immobilization and enzyme-catalyzed reactions in apolar solvent systems. To adapt these procedures to industrial use, engineers and bioengineers will have to consider the major problems of scale-up and suitable reactor designs. Until all details are available on the possible commercial implications of enzyme applications, the industry would do well to submerge its general pessimism and keep an open mind on the topic.

Greater access to knowledge and new developments must be encouraged so that advances may be

made in the various areas of biotechnology. The exchange of information is essential. Proprietary interests still can be protected through patent legislation and semi-disclosures. It would be anticipated that a particular developed procedure would continue to function most effectively in the hands of the developer. In turn, the basic researcher must be prepared to respond to the particular needs of the industry but can do so only when suitably informed. Initial investigations should not be expected to be an immediate viable economic success. Thus, the industry as well as governmental agencies must be prepared to make the necessary venture investment. Collaboration at all levels is essential.

Biotechnology impinges on virtually all areas of the industry, ranging from basic fundamental research on analytical procedures, chemical practices and the biology, biochemistry and nutrition of fatty products to the more applied aspects associated with fats and oils processing, engineering, environmental controls, surfactants and detergents, and oilseed proteins and co-products.

It is the intention that this column will serve as a forum for the presentation and exchange of information for those associated with the industry who have interest in or curiosity about biotechnology.

The following items of relevance to biotechnology and the fats and oils industry are provided for information. Further communications of this nature will be provided in subsequent columns if sufficient interest exists. Comments and suggestions are welcome.

Conferences, meetings

American Chemical Society National Spring Meeting, Toronto, Ontario, Canada, June 5–11, 1988. The society's Division of Agricultural and Food Chemistry will provide topics on biotechnology. Contact: B.R. Hodsdon, 1155 16th St. NW, Washington, DC 20036.

International Symposium on Biotechnology and Biochemistry, Toronto, Ontario, Canada, June 13–14, 1988. Information: V.M. Bhatnager, Alena Enterprises of Canada, PO Box 1779, Cornwall, Ontario K6H 5V7, Canada.

6th Royal Show International Symposium, "Towards an Agro-Industrial Future," Coventry, England, June 28–July 4, 1988. Information: S. Taylor, Royal Agricultural Society of England, Stoneleigh, Kenilworth, Warwickshire, England CV8 2L2.

8th International Biotechnology Symposium, Paris, France, July 17–22, 1988. Information: C. Murphy, SFM/8th International Biotechnology Symposium, 28 Rue du Dr Roux, 75724 Paris, Cedex 15, France.

BISF-JOCS World Congress 1988, Tokyo, Japan, Sept. 26–30, 1988, biotechnology session. Information: Secretariat, The Japan Oil Chemists' Society, 7th Floor, Yushi Kogyo Kaikau, 13-11 Nihonbashi 3-Chome, Chuoku, Tokyo 103, Japan.

Books

Proceedings of the World Conference on Biotechnology for the Fats and Oils Industry, edited by Thomas H. Applewhite, American Oil Chemists' Society, Champaign, IL, 1988 (in press).

Basic Biotechnology, edited by J.D. Bu'Lock and B. Kristiansen, Academic Press, London, 1987, ISBN 0-12-140752-7.

Biosurfactants and Biotechnology, edited by N. Kosaric, W.L. Cairns and N.C.C. Gray, Marcel Dekker, New York, 1987, ISBN 0-8247-7679-8.

Proceedings 4th European Congress on Biotechnology, edited by O.M. Neijssel, R.R. van der Meer and K. Ch. A.M. Luyben, Vols. 1–4, Elsevier, Amsterdam, The Netherlands, 1987, ISBN 0-444-42831-3.

Journal articles

Bühler, M., and Chr. Wandrey, *Fat Sci. Technol. 89*:598 (1987), Continuous Use of Lipases in Fat Hydrolysis.

Kloosterman, J., P.D. van Wassenaar and W.J. Bel, *Fat Sci. Technol. 89*:592 (1987), Membrane Bioreactors.

Röbbelen, G., *Fat Sci. Technol. 89*:563 (1987), Development of New Industrial Oil Crops.

Schmid, R.D., *Fat Sci. Technol. 89*:582 (1987), Unusual Fatty Acids and their Scope in Biotechnology.

Wagner, F., *Fat Sci. Technol. 89*:586 (1987), Strategies for Biosurfactant Production.

Ratledge, C., *J. Am. Oil Chem. Soc. 64*:1647 (1987), Lipid Biotechnology: A Wonderland for the Microbial Physiologist.

Stumpf, P.K., *J. Am. Oil Chem. Soc. 64*:1641 (1987), Plant Lipid Biotechnology through the Looking Glass.

Yamane, T., *J. Am. Oil. Chem. Soc. 64*:1657 (1987), Enzyme Technology for the Lipids Industry.

Fukui, S., *J. Am. Oil Chem. Soc. 65*:96 (1988), Conversions of Lipophilic Substances by Encapsulated Biocatalysts.

Gillies, B., H. Yamazaki and D.W. Armstrong, *Biotechnol. Lett. 9*:709 (1987), Production of Flavour Esters by Immobilized Lipase.

Omar, I.C., N. Nishio and S. Nagai, *Agric. Biol. Chem. 51*:2145 (1987), Production of Thermostable Lipase by *Humicola lanuginosa* Grown on Sorbitol-Corn Steep Liquor Medium.

Omar, I.C., N. Nishio and S. Nagai, *Agric. Biol. Chem. 51*:2153 (1987), Fat Hydrolysis and Esterification by a Lipase from *Humicola lanuginosa*.

Wisdom, R.A., P. Dunnill and M.D. Lilly, *Biotechnol. Bioeng. 29*:1081 (1987), Enzymic Interesterification of Fats: Laboratory and Pilot-scale Studies.

Bhatnager, S., and B.N. Johari, *Curr. Sci. 56*:775 (1987), Microbial Enzymes in the Processing of Oilseeds.

Ashloowalia, B.S., *Crop Sci. 27*:813 (1987), Somatic Embryogenesis and Plant Regeneration in *Eruca sativa*.

Haferburg, D., R. Hommel, R. Claus and H.-P. Kleber, *Adv. Biochem. Engin. Biotechnol. 33*:53 (1987), Extracellular Microbial Lipids as Biosurfactants.

Patents

Brady, C.D., L.D. Metcalfe, D.R. Salboszewski and F. Dieter (Akzo America Inc.), US 4,629,742, Hydrolysis of Fats.

Jizomoto, H. (Shionogi & Co. Ltd.), Osaka, Japan, US 4,673,567,

Process for Preparing Liposome Composition.

Marshall, W., and C.J. Hofmann (Kraft Inc.), US 4,678,673, Fermented Oilseed Product for Preparing Imitation Dairy Products.

Daiichi-Pharm., J 6 2195-292: 21.02.86-JP-038062, Production of Fatty Acid Esters Using Lipase in Pressurized Evaporator.

Nitto-Electric, J 6 2195-291: 20.02.86-JP-036390, Production of Fats and Oils containing γ-Linolenic Acid Esters by Tissue Culture of *Oenothera*.

Publications

Book reviews

Health Effects of Polyunsaturated Fatty Acids in Seafoods, edited by Artemis P. Simopoulos, Robert R. Kifer and Ray E. Martin (Academic Press, 6277 Sea Harbor Dr., Orlando, FL 32821-9989, 1986, 473 pp., $45).

This volume is the proceedings of a conference on health effects of polyunsaturated fatty acids in seafoods, held in Washington, D.C., in 1985. Although it has been available for over a year, there still is much reference material here that is useful to those interested in dietary omega-3 fatty acids.

The volume is divided into seven parts, with a total of 21 chapters. Part One contains a single chapter by Artemis Simopoulos that covers the historical perspective, conference conclusions and recommendations, and actions by federal agencies. Part Two deals with the impact of omega-3 fatty acids on eicosanoid formation. It contains chapters by William Lands on the fate of polyunsaturated fatty acids (PUFA), by Peter Weber et al. on dietary omega-3 PUFA and eicosanoid formation in man, and by G.A. Fitzgerald et al. on biochemical and functional effects of dietary substrate modification in man.

Part Three is on thrombosis and atherosclerosis. Alexander Leaf provides an introduction on approaches to prevention. Other chapters deal with cellular dynamics in atherosclerosis (by A. Faggiotto), thrombosis and omega-3 fatty acids: epidemiological and clinical aspects (by B.A. Bradlow), and the antithrombotic effects of fish oil (by S.H. Goodnight Jr.).

Part Four deals with lipoproteins and atherosclerosis. It contains a chapter by Scott Grundy on effects of fatty acids on lipoprotein metabolism in man, a chapter by William Connor on the hypolipidemic effects of dietary omega-3 fatty acids in normal and hyperlipidemic humans, and a chapter by Paul Nestle et al. on suppression of triglyceride formation by PUFA in rat liver and attenuation in man of the effects of dietary cholesterol on lipoprotein cholesterol.

Part Five, on immunology and inflammation, contains chapters by Robert Lewis et al. on the effects of omega-3 PUFA on the 5-lipoxygenase pathway, by Edward Goetzl on effects of eicosapentaenoic acid on immune responses and inflammation in humans, and by D.R. Robinson et al. on the modification of autoimmune diseases by dietary marine lipids.

Docosahexaenoic acid: membrane function and metabolism is the subject of Part Six. N. Salem et al. discuss docosahexaenoic acid (22:6ω3) in membrane function and metabolism. Edward Dratz and Alan Deese discuss the role of 22:6ω3 in photoreceptors and model membrane bilayers, and Howard Sprecher compares omega-3 and omega-6 fatty acid metabolism.

The seventh and final part provides information on the availability, composition and preparation of seafood. It includes a choice of recipes for seafood and a chapter on the effects of cooking on the fatty acid profiles of selected seafoods. An appendix gives a provisional table on the content of omega-3 fatty acids and other fat components in selected foods.

This is a useful volume not only for those working in the omega-3 area but also for those desiring an overview of the findings, which have led to a proliferation of research in this area.

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Experiments in Industry: Design, Analysis and Interpretation of Results, edited by R.D. Snee, L.B. Hare and J.R. Trout, (American Society for Quality Control, 230 West Wells St., Milwaukee, WI 53203, 1985, 142 pp., ASQC member price, $14.95; list price, $16.95).

The editors use industry-derived examples, presented as a series of individual papers by different authors, to illustrate the application of several statistical methodologies. The authors use real problems that arose in a laboratory or production environment. Each paper includes a description of the problem, the statistical design used and the results of the statistical analysis. Many of the authors use more than one example to illustrate a particular statistical methodology. In addition, several industries are represented, including the food, chemical, electrical, bioanalytical, environmental and cosmetic industries. The book is a tribute to Horace P. Andrews, a statistics professor from Rutgers University who appears to have had quite an impact on many of his students.

A variety of statistical methodologies are used. Some of the authors apply fractional factorial designs to their particular problem. Others discuss the application of surface response methodologies. One author demonstrated that even when statistics have been overlooked in the experimental design, statistical analysis that is done carefully still can be applied to the results. Another important aspect of statistical analysis covered in detail was the graphical presentation of the results. Several of the papers address this important aspect of statistical analysis. A graphical display of the results is a major component of the more advanced statistical software available for use on the personal computer. The widespread availability of personal