COMMERCIAL FISHERIES REVIEW

August 1956 Washington 25, D.C. Vol. 18, No. 8

NEW PRODUCTS FROM FISH OILS

Part I - Introduction

By Maurice E. Stansby*

BACKGROUND

Fish oils are made up of components having an unusual chemical structure. The fatty acids occurring as glycerides are, in a large part, of unusually long-chain length, with C_{20} and C_{22} chains being found in substantial quantities. The presence of these long chains makes possible the occurrence, again in substantial quantity, of fatty acids containing an unusually high number of double bonds, with as many as six being not uncommon. Such long-chain polyunsaturated fatty acids are also found in animal and vegetable oils, but the quantity present is of very small magnitude. In fish oils, sufficient quantities occur as to make commercial utilization feasible, should there be sufficient demand for compounds of such structure.

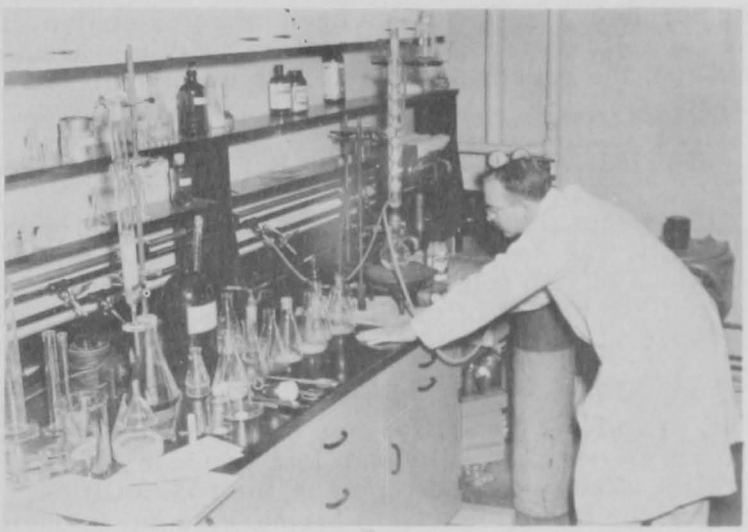

Fig. 1 - Preparation of derivative of fish oil for use as collector in iron-ore flotation.

In the past, very little consideration has been paid to the presence of these unique chemical characteristics of fish oils. Rather, the bulk of the fish oil has been sold on the basis of its general properties, usually as a substitute--all too often as a cheaper substitute--for animal or vegetable oils. Many times, the high degree of unsaturation, rather than being an asset, is a liability which causes a decrease in market value. Because fish oils are subject to odor reversion, when used as a substitute for other oils, such properties cause the fish oils to be sold at lower prices. Only a very limited portion of the fish oils sold has been used so as to take advantage of these unusual and highly specific chemical properties.

Byproducts of the meat industry include oils and fat which for many years were in the same category as fish oils so far as making use of special chemical characteristics is concerned. Within the past decade, a considerable amount of research on the part of the meat industry has greatly increased the profits realized from the byproducts. As a result of this research, a large number of chemical products are now made from meat-packing waste. The importance of this development to the meat-packing industry was pointed out in an article in Chemical Week (Anonymous 1954). One large meat-packing concern realizes 78 percent of its total profits from

* Chief, Pacific Coast and Alaska Technological Research, Fishery Technological Laboratory, Branch of Commercial Fisheries, U. S. Fish and Wildlife Service, Seattle, Wash.

these byproducts, although the byproducts represent only 15 percent of total sales.

RESEARCH ON FISH OILS

Before fish oils can be utilized extensively as a source of chemicals, making use of their content of unique chemical groupings, a considerable amount of basic research must be carried out. This research must first show exactly what the chemical structures of fish oils are and then must show which reactions of the unsaturated long-chain fatty acids will produce useful chemical compounds. The type and amount of basic research required is so extensive that there is little likelihood that it can be carried out either in laboratories of the fishing industry or of the Government. Considerable fundamental research, especially in university laboratories, is needed before any extensive practical applications can be feasible.

It is sometimes hard to understand why more basic research has not been carried out in the past on fish-oil fatty acids. One reason is undoubtedly the fact that these fatty acids are very unstable and exceedingly difficult to work with. Another barrier to much research has been the fact that the pure unsaturated fatty acids of the long-chain lengths have not been available commercially and would have to be isolated from the fish oils by the laboratory carrying out the research. The importance of the ready availability of the fatty acids is shown by the fact that with such fatty acids as oleic, linoleic, linolenic, and arachidonic, which are available for purchase, research has been more extensive. When it is also considered that the fish oils themselves are not so readily available as oils such as linseed or cottenseed, the reasons why research on fish-oil fatty acids has been limited are apparent.

INITIAL WORK AT SEATTLE FISHERY TECHNOLOGICAL LABORATORY

In discussions over a period of years with technical members of the fishing industry, it was unanimously agreed that research as to the chemical properties and reactions of fish oils was a potentially fruitful field. Because of the exceedingly specialized nature of this field and the need for highly-qualified organic chemists and special expensive equipment, little more than discussions developed.

Early in 1953, the Seattle Laboratory of U. S. Fish and Wildlife Service decided that, in spite of the difficulties of this field of research, some attempt to obtain and publish research results was long overdue. A very small-scale program was therefore initiated to explore some of the possibilities. It was realized that considerable work along these lines had been carried out in chemical laboratories of some oil processors. Since, however, these results had, for the most part, never been published, they were not available either as a starting point for the present research or as a guide to fish-oil producers to indicate the value and potential use of their products. It was therefore necessary to repeat much relatively elementary work which undoubtedly had already been carried out but which had never been published.

In this early work, the Seattle Laboratory made extensive use of part-time graduate organic chemistry students from the University of Washington. This made possible considerable research work in the field of organic chemistry without exceeding the limited budget available. Much of this work was exploratory rather than specific. Reactions of unsaturated fatty acids described in the literature were tried, first with pure fatty acids, then with mixed fish-oil fatty acids. At least partial fractionation of the fatty acids was needed since otherwise it was impossible to identify the reaction products in the complex mixture of fatty acids obtained from the saponified fish oils.

It was realized from the start that the extent of research needed was so great that the small amount which could be carried out in Fish and Wildlife Service

laboratories under the limited regular budget would make almost imperceptible progress toward solving the problems. It was hoped rather that if a few publications on fish-oil chemistry could be made available, other laboratories, especially in universities, might be interested to enter this field of research.

The chance to get such expanded work under way came much sooner than anticipated. As a result of the funds provided by the Saltonstall-Kennedy Act of 1954, research contracts were let in 1955 for work on fish oils at a considerable number of universities. This Fish and Wildlife Service program then was transferred from a limited local project of the Seattle Laboratory to one of nationwide scope. In the resulting expansion, it was necessary to reorient the research program on fish oils at the Seattle Laboratory.

PRESENT PROGRAM AT SEATTLE LABORATORY

One of the primary responsibilities of the Seattle Laboratory, under the expanded oil-research program, has been the coordination of research on oils at those laboratories west of the Mississippi River which participate in Fish and Wildlife Service programs. These programs include several basic ones at Hormel Institute of the University of Minnesota on the chemistry, composition, and reactions of fish oils; and one at the University of California, Food Technology Department, on oxidative deterioration in fishery products. Several other contract research programs on applied research on fish oils are also included. Work at the Seattle Laboratory has thus taken on a new aspect in addition to the research begun earlier. It has been necessary to carry out considerable work in connection with providing authentic fish-oil samples for use by the various contract research laboratories. In some cases, it is necessary to extract and prepare the oils in the laboratory. Other activities involve reviewing the programs and seeing that information found by one laboratory which might be helpful to another is promptly made available.

To adequately coordinate these highly-specialized programs, considerable first-hand knowledge of the research is needed if optimum results are to be obtained. For this reason, some of the research started under the initial program when it was a purely local project has been continued at Seattle. Projects already under way have been pushed toward conclusion. Work will be continued in important fields not covered by existing contracts with other laboratories. One such field is concerned with fractionation of fatty acids from fish oils into fractions containing compounds of similar properties. Such fractionation will be needed in order to utilize fish oils as a source of new chemical compounds. Several methods are available, but not enough is known about their relative advantages and disadvantages. One paper (Domart, Miyauchi, and Sumerwell 1955) covering work done at this laboratory on urea fractionation of fish-oil fatty acids has already appeared. Another one describing a new urea-countercurrent-distribution method for fish-oil fatty-acid fractionation is in preparation.

Subsequent papers in this series will be concerned with either (1) reporting the early survey studies carried out at the Seattle Laboratory on reactions of fish oils or (2) continuing research especially on separations of the component constituents of fish oils.