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THE EXPLOITATION OF THE LIVING RESOURCES OF THE CALIFORNIA CURRENT: A FOOD TECHNOLOGIST'S POINT OF VIEW

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Food technology is the application of scientific knowledge and scientific methods to the production of foods in forms that are safe, economical, diverse, and acceptable to the consumer. Food technology involves factors relating to the production of the raw material, harvesting, transportation, preservation, packaging, storage, distribution, preparation, and consumption. It involves basic research, applied research, product development, quality control, production, and use.

Fishery technology is the name given to the application of food technology to the various stages in the utilization of fish. A generalized version of such a system of use showing many of the stages through which fish must pass in order to become food offered at the table is:

Resource
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Harvesting the resource
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Transporting at sea
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Processing
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Storing
↓
Distributing to the consumer
↓
Preparing for the table

The chain of events leading to the consumer's table starts with the resource itself, which is subject to many natural variations. The seasonal condition of the fish may be a significant factor in a process. For instance, the seasonal rise in concentration of oil in a stock of fish may be important, even critical, to a profitable reduction operation. It may also be a significant factor in the quality of the fish after they are canned. Many other areas of technical involvement exist throughout the chain of events leading to the consumers table as can be illustrated by the following simple chart:

Resource	Size and condition
Harvesting	Harvesting effects on quality
Sea Transportation	Preparation, Chilling, Freezing, Holding, Thawing, Handling
Processing	Cutting, Drying, Smoking, Cooking, Canning, Other processing, Packaging
Storage	Aging and environmental effects
Distribution	Environmental effects
Consumption	Preparation, Nutrition, Consumer reactions and preferences

At the consumer end, the food technologist is concerned with how the differing characteristics and properties of various fisheries products, modified by their treatment in the system, affects their acceptance —and hence, the value and volume of their sale.

It is an obvious fact, but one often neglected by specialists in restricted disciplines, that all parts of this system must be functioning at a profitable level for the whole to continue as a viable economic entity. Many of us think of and deal with one part of the system without relating the part to the whole, but if any part does not function correctly, if any part is too expensive, or if any part damages the product, eventually the end product will fail to satisfy the consumer; then the whole system will fail in the competition for the food dollar. This relation of the part to the whole is one that has to be learned by every fishery technologist in industry before he can contribute usefully to his field.

Having now set fish technology in its frame of reference, let us look briefly at how it relates to the technological problems involved in the use of fish in California. In general, these problems are similar to those elsewhere in the United States. Perhaps the principal block to the increased consumption of fish in California and in other parts of this country is the variable and sometimes low quality of fishery products offered for sale. This problem of quality is due, not so much to a lack of knowledge of the techno-

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logical requirements, but to a lack of application of the knowledge. Much of this lack is due to the inability of a traditional industry to keep pace with the developing requirements of the modern consumer, who demands ever higher standards and who often gets them in other products. There is no indication that this barrier of quality improvement will be shortly broken unless mandatory inspection of fishery products is instituted. Other means must be sought to increase the flow of fisheries products.

Much technological study now is being devoted to different methods of preservation that may, by extending shelf life, enable fish to be offered for sale in a fresher condition. Antioxidants and other additives, controlled atmospheres, and novel packaging and handling methods are a few of these.

Researchers also have been working along two additional lines that may help us use certain stocks of fish more extensively.

The first of these is radiation pasteurization, the low-dose treatment of fish by ionizing radiation, which markedly reduces the population of bacteria on fish and thereby prolongs its storage life at chill temperatures. Much work has been done on this technique, especially in the United States. The researchers have repeatedly demonstrated, using both small- and large-scale experiments, that exposure to a low level of radiation of about 0.1 to 0.2 megarad is sufficient to more than double the life of fresh fish stored on ice without imparting any appreciable amount of radiation, or other flavor to the fish. This technique has a great potential for increasing the availability of high-quality fresh fish in the market, particularly when it is applied at sea to fish immediately after they are captured.

At present, the Food and Drug Administration, treating radiation as an additive under the Additives Amendment to the Food, Drug, and Cosmetic Act, has not sanctioned this particular technique for use with fishery products. Their concern is that, under the anaerobic conditions occurring during some conditions of storage and with the possibility of storage temperatures rising above 40° F in commercial distribution, Botulinus organisms that are not inactivated by this level of irradiation might grow and thereby form toxin in the product. Other organisms that would act as spoilage indicators by the production of strong off odors and flavors may be inactivated by the radiation and so may not give the familiar warning of potentially dangerous deterioration. In addition, the different behavior between species of spoilage organisms is a complicating factor. Authorization by the Food and Drug Administration for the use of radiation pasteurization on fish will therefore have to await further experimental evidence now being accumulated.

A second greatly significant potential for California fisheries lies in the production of fish protein concentrate (FPC) from underused species, such as anchovy, hake, and saury—fishes not generally regarded in this country as being attractive for human consumption. Fish protein concentrate, which usually is produced by a variety of solvent-extraction techniques, is generally presented as a colorless, odorless, stable powder containing 75 to 85 percent protein with a very high protein efficiency ratio. Other forms, which appear as highly flavored hydrolyzed protein products, are of a similar nature to oriental fish sauces such as *Nuoc mam* and *Nam pla* but have so far been relatively little investigated.

FPC has been widely proposed as a supplement in the protein-deficient diets found in many under-developed countries. Without doubt, if the increases in population that are predicted for the 1970's and 80's occur, all forms of available protein will be in great demand, including FPC.

Fish protein concentrate faces three associated barriers, however, in its general application.

The first is that some of the manufacturing techniques are not yet in an advanced stage of development. The construction in the Pacific Northwest of the demonstration plant authorized by Congress will give a much-needed boost to the engineering development of the extraction method using isopropyl alcohol.

The second problem is that initial product costs, which have been estimated to run from 25 to 45 cents per pound of fish protein concentrate, raise serious problems in the use of the product by the economically depressed groups who so greatly need such protein. It is to be hoped that manufacturing expertise and continued development will bring the price down much closer to the 7 cents per pound asked for fishmeal, a price that would then make its commercial incorporation into cereal products more feasible in the developing countries.

The third barrier is that relatively little work has been done on the complex of marketing problems involved in the distribution of fish protein concentrate to the widely varying social and ethnic groups who need it. More studies are required on the food and food-distribution habits in the developing countries and of the incorporation of fish protein concentrate into different local foods. Probably no general solution to this problem exists, since foods and patterns of food distribution and consumption vary considerably from country to country and, indeed, even within a single country. So this problem is hard to solve. In fact, some people believe that the difficulties are inseparable. Having had the opportunity to participate in a limited survey of the possibilities in several of the developing countries, I myself have passed, however, from a viewpoint of considerable skepticism to one of cautious optimism.

Many of the areas of greatest need, such perhaps as Brazil, will probably be unable to supply more than a part of their own requirements, so an international trade in fish protein concentrate may develop in much the same manner that the present international trade in fishmeal has developed. It may even replace the trade in fishmeal. In either event, California fishes not presently used for food, may be used for this purpose. Such use would be subject, of course, to the

removal of any legal barriers, since the manufacture of fish protein concentrate may possibly be classified legally as a reduction operation. The international trade in FPC may in practice also depend on the development of international standards for fish protein concentrate that would make FPC less expensive to produce than do the requirements of the Food and Drug Administration.