# RESEARCH
## IN SERVICE LABORATORIES

## CHANGES IN COMPOSITION OF SOLE DURING REFRIGERATION

ABSTRACT

Extensive changes in mineral content of the meat of fish take place during the storage of the fish in ice and in refrigerated brine. In the present report, changes in the composition of sand sole and English sole are discussed.

### INTRODUCTION

Changes in composition taking place in the meat of fish under various conditions of storage now are being studied at the Bureau's Seattle Fishery Technological Laboratory. In particular, the effects of ice and chilled brine are being investigated. A report on analyses of Puget Sound pink salmon is being prepared, and analyses of other species will be reported upon as results become available. The present paper reports on analyses of sand sole (Psettichthys melanostictus) and English sole (Parophrys vetulus).

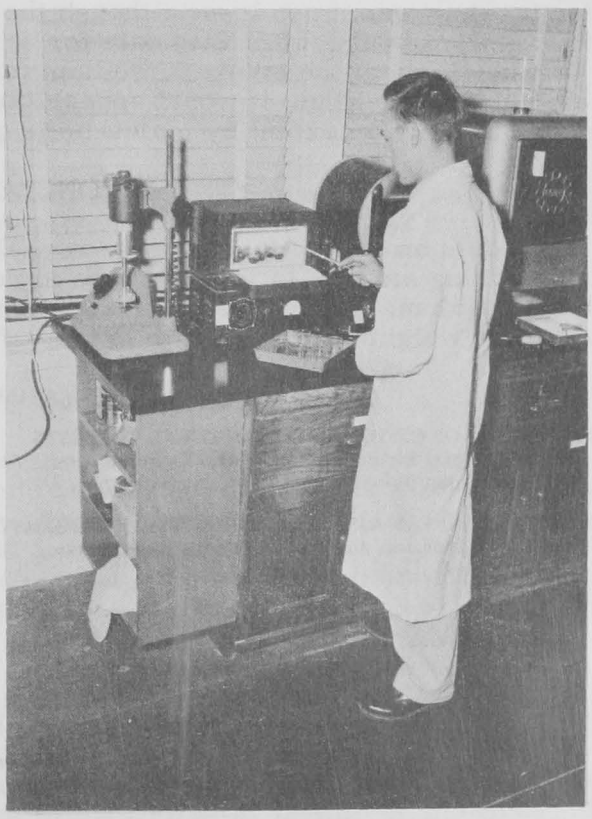

Fig. 1 - Ashing sample of fish.

### EXPERIMENTAL

In this section is discussed the method of preparing the samples and the analytical procedures employed.

PREPARATION OF SAMPLES: Sand sole and English sole, caught in Puget Sound waters by School of Fisheries personnel on the University of Washington exploratory vessel The Commando, were stored in ice on board the vessel until landed at Seattle.

The fish then were treated in two different ways. Some of the fish from each species were filleted, and the fillets were ground and sealed under vacuum in individual half-pound salmon cans. The cans were stored at 0° F. until the contents were analyzed. The remaining fish were placed in plastic bags containing a 3-percent solution of sodium chloride (common salt) in the ratio of two parts of fish to one part of brine, by weight. The bags were sealed, immersed in a 3-percent solution of chilled sodium chloride, and kept at 30° F. Samples were removed at intervals of about 3 days for a period of 2 to 3 weeks. Fillets were taken from these samples, organoleptically examined, and prepared and stored as above.

ANALYTICAL PROCEDURES: The cans containing the samples from both of these groups were placed in lukewarm water for about 30 minutes to soften the contents. The cans were opened, and 40-gram portions then were removed, reground in a high-speed grinder, and placed in plastic weighing bottles.

Analyses for moisture, oil, protein, and ash were made according to standard methods of the Association of Official Agricultural Chemists (1955). The ash samples were analyzed for sodium and potassium by the procedure developed in the research laboratory of the National Canners Association (1956).

## DISCUSSION OF RESULTS

The sole had the typical composition of a flat fish: namely, about 81 percent moisture, about 18 percent protein, less than 1 percent oil, and a little more than 1 percent ash. The content of sodium and potassium averaged about 60 and 350 milligrams, respectively, per 100 grams of sample. The content of moisture, oil, and protein showed only slight variation during storage under these two types of refrigeration. After storage in ice, the meat showed a large decrease in potassium and in ash and a slight decrease in sodium. The meat, when stored in refrigerated brine, took up relatively large quantities of sodium, and its content of ash was increased by about one-half. Potassium showed an apparent loss of about one-fourth of its original value. This decrease was due, in part at least, to the fact that the large increase in sodium gave so much more total ash that the relative percentage of potassium was much less, although there undoubtedly was some actual leaching of potassium. Compared with data for other species where the brine-to-fish ratio was much higher, the uptake of sodium for the sole stored in refrigeration brine was much less. Thus, it would appear that the gain in sodium content can be controlled to quite an extent by maintaining a high fish-to-brine ratio.

## CONCLUSIONS

Studies on composition of sole reveal that there is extensive leaching of minerals during storage in ice. Storage in refrigerated brine involves excessive uptake of sodium. The degree of absorption can be controlled to some extent by regulating the weight ratio of fish to brine.

### LITERATURE CITED

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## BACTERIAL CONTENT OF PROCESSED SHRIMP UNDER STUDY

A survey of the bacterial content of raw headless and raw breaded shrimp will be conducted by private research firms located in Baltimore, Md., and Washington, D. C., under contracts awarded by the U. S. Bureau of Commercial Fisheries. The survey will attempt to pinpoint stages in the production-distribution chain where quality deterioration occurs. Sampling will begin at the retail level and may be

carried back to the processing level as the survey progresses. All sampling will be done by technologists of the Bureau, while the bacterial studies will be made by the private research firms.

## FISH STICK QUALITY IMPROVED BY BETTER PACKAGING

The loss of quality in fish sticks during frozen storage at 0° to -5° F. can be related to the quality of the packaging materials used. The use of overwrapping materials with a low rate of moisture-vapor transmission results in an extension of the shelf life of the frozen product.

These results were obtained from tests to determine the effect of improved packaging materials on the quality of the frozen fried fish sticks, conducted at the U. S. Bureau of Commercial Fisheries, Technological Laboratory in East Boston, Mass. In this study packages of fried fish sticks were overwrapped with commercial packaging materials consisting of (1) waxed glassine paper, (2) waxed bleached sulfite paper, (3) aluminum foil-paper-polyethylene laminate, and (4) MSAT cellophane. The samples were stored in a commercial-type cold-storage room at temperatures of 0° to -5° F. for 12 months.

Results of taste-panel tests showed that after 12 months of frozen storage the fish sticks overwrapped with waxed bleached sulfite paper, aluminum foil laminate, or MSAT cellophane had lost little weight and were still of good quality. However, the samples overwrapped with waxed glassine paper were dehydrated due to excessive moisture loss and were of only fair quality.

Average weight losses for the various samples after 12 months of frozen storage were (1) aluminum foil laminate, 0.28 percent; (2) cellophane, 0.93 percent; (3) waxed sulfite paper, 1.20 percent; and (4) waxed glassine paper, 4.9 percent.

## OXIDATIVE ENZYMES IN FISH TISSUE

A study is being made of the oxidative enzymes of fish as part of a collaborative research project between the Department of Food Technology of the University of California and the Seattle Fishery Technological Laboratory. Knowledge of such enzymes is of value in two areas of interest to fishery technologists: (1) the nature and properties of enzymes that are active after the death of the fish and (2) the enzymes and pathways of intermediary metabolism in fish.

Enzymes, the chemical catalyts which aid in the metabolism of foods, for instance, must be studied at a basic biochemical level in order to establish a foundation for sound subsequent research at the applied level.

The action of the enzymes in fish tissue is important both to the life processes of the fish and to the changes that take place in the fish after death. A knowledge of the intermediary metabolism of fish would help research workers to understand the details of the enzymatic reactions involved both in the synthesis and in the breakdown of proteins, fats, and carbohydrates. The potential applications of this knowledge are in the fields of fish nutrition and in improved commercial handling of fish and fishery products.

The nature and properties of the enzymes that are active after death are important because of their potential effect on fish held in refrigerated storage. The

potential changes may be either detrimental or beneficial to the final product. In either case, an understanding of these changes is necessary if they are to be controlled.

Early in the collaborative investigations, it became apparent that knowledge of the fundamental pathways of metabolism in live fish was essential to understanding the actions of the surviving enzymes. The work therefore has been concentrated on the enzymes of intermediary metabolism of fish, with emphasis on oxidative enzymes.

Carp were used as the test fish in the investigations because they are available and relatively easy to maintain in aquaria.

The initial approach to the problem was to compare directly the reactions caused by the enzymes in fish with those caused by the enzymes in mammals. The research to date has been concentrated in the areas of carbohydrate metabolism and of fatty acid metabolism. Results now available indicate that the tricarboxylic acid cycles of carhohydrate metabolism in fish is similar to that in other animals.

The multienzyme system that causes the oxidation of fatty acids in fish tissue was studied in detail. In general, the behavior of this system has been found to resemble that observed in mammals, but with some differences in detail.

The work now in progress essentially is an extension of the work already reported. Because of the importance of the unsaturated fatty acids in fish, both in terms of nutritional value and as a possible source of rancidity, the investigation of the oxidation of the highly unsaturated fatty acids will be intensified in the near future.

## SMOKING FISH BY ELECTRICITY

A method of smoking fish by electricity is being successfully used in the Kiev Fish Combine of the U. S. S. R. The advantage is that the process is shortened by 8 to 10 times, and allows operations to be easily controlled. The electrical apparatus consists of a chamber over a smoke generator. Smoke formed by burning sawdust reaches a temperature of 60° C. (140° F.). In the smoking chambers, the smoke is heated by another electrical heater to a temperature of 80° to 100° C. (176° to 212° F.). The whole process is regulated by varying the density of the smoke and its temperature and by the strength of the current. This method, claimed to be the only possible one for mechanized, moving production lines, is reported to improve the taste of the fish (The Fishing News, July 26, 1957).