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THE ARMY'S WARTIME FISHERY RESEARCH

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Although fish and fishery products have never occupied the place in American diets that they have in the diets of European and Asiatic peoples, the popularity of fish as a food is increasing in this country. Since eating habits show sectional, as well as national and individual, variations and are influenced by religious customs, fish is more favorably received in some parts of this country than in others.

Consumption of fish by the Army during World War II showed this sectional influence. Men's desire for fish was influenced by the peculiarities of the section of the country in which they had lived. Those from the West, parts of the Middle West, and from sections of the South did not consume much fish or fishery products, while troops from the coastal areas ate large quantities of a wide variety.

A considerable amount of a variety of fish and shellfish was available for Army use prior to and during the war. This included about twenty-five varieties of salt-water fish, nine varieties of fresh-water fish, and five species of shellfish. There were many more acceptable varieties in each of these groups, but because their supply was limited, they were not considered practical for Army feeding.

Many Army camps throughout this country were close enough to market centers and fisheries to permit the use of an abundant supply of various types of fresh and chilled fish. Since fishing is a seasonal operation, these camps filled their off-season demands for fish largely through the use of frozen fishery products. Thus the troops were assured of a constant supply of good seafood. For the camps located farther from the coasts, there was a limited supply of fresh-water fish as well as the cold-storage and frozen fishery products shipped from the Atlantic and Pacific seaboards.

The many varieties of canned fish and shellfish also supplied a large portion of the Army's requirements for fishery products. The extent of Government requirements for canned fishery products is evidenced by the large set-aside orders made by the War Food Administration. Amendment 7 to War Food Order 44, effective January 13, 1945, provided the following restriction on the 1944 pack of canned fish:

"Seventy percent by weight of each canner's 1944 pack of salmon; red, pink, silver, chum, . . . is hereby established as his respective quota of the 1944 pack of such classes for sale or delivery to government agencies."

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This order also included a set-aside of 60 percent for king salmon and 55 percent for canned pilchard, Atlantic sea herring, Atlantic mackerel, and Pacific mackerel.

As the war progressed, demands for fishery products increased tremendously. The WFA set-aside requirements for canned fishery products from the 1945 pack were increased to 80 percent of most of the packs designated.

Because of the Army's great demand for fishery products and for protein foods in general, and in anticipation of a possible meat shortage, the Subsistence Research and Development Laboratory of the Quartermaster Corps, located in Chicago, Illinois, deemed it necessary to institute a research program to insure more efficient utilization of the present supply of fishery products and to investigate possible uses for the many species of fish that were abundant but were not being used, or were used only to a small extent. As a result of the eventual execution of this program, fresh, frozen, and canned fish were used in the A and B rations and in the new Ten-in-One ration, while the less expensive grades of canned fish were used extensively in prisoner-of-war feeding and for Philippine Scout rations.

Wartime development of fishery products received impetus from the need for production of adequate food for liberated countries. Certain types of fishery products have been used very successfully for relief feeding, because of their high nutritive quality, excellent digestibility, and low cost of production.

The Quartermaster Corps outlined its research and development program to accomplish the following objectives:

- a. To increase the number and variety of fishery products utilized by the Armed Forces.
- b. To develop uses for the many types of previously unutilized species of fish.
- c. To develop new and improved fishery products; methods of handling, packing, and shipping, procurement and inspection; recipes for cooking; and standards of nutritional value and keeping quality.

In March of 1944, members of the Laboratory consulted with various research organizations to determine their attitudes toward this fishery program and to secure a man qualified to do the investigational work. Possibilities for the program were discussed at meetings held with representatives of these organizations, and served to interest various West Coast fishery groups in the undertaking.

The U. S. Fish and Wildlife Service expressed willingness to place some of its personnel at the Laboratory to work on specific fishery problems and offered the cooperation of its four laboratories at College Park, Maryland; Seattle, Washington; Ketchikan, Alaska; and Mayaguez, Puerto Rico. The agency also stationed one of its technologists at Chicago as Fishery Technological Liaison Officer to organize and coordinate various phases of the fishery research program. The eventual marked success of the program was due, in large measure, to the wholehearted cooperation of the Fish and Wildlife Service. Not only did it supply available technical information on fishery products, but it delegated several experts to participate actively in research.

Survey on Acceptability of Fish: To determine the amount of waste occurring when fish was served in Army camps and to offer suggestions for reducing this waste,

the Subsistence Research and Development Laboratory, in early 1944, instituted an extensive survey of the acceptability of fishery products at domestic military installations in the nine Service Commands. Reports of findings of this survey in approximately 400 Army messes may be summarized as follows:



- a. Type of Fishery Product Desired: There was quite general agreement that fish served as boneless fillets, preferably from fairly large fish, were the most desirable. Many men expressed a preference for frozen fillets and none disapproved of them. Canned fish of all types were generally regarded as acceptable.
- b. Species of Fish Desired: There was no unanimity as to the most popular species of fish. Canned salmon, shrimp, and flounders were selected by four different Service Commands as the most desirable species, while haddock, halibut, mackerel, and oysters were given as first choice by three Service Commands. Mackerel, on the other hand, was mentioned unfavorably by three Service Commands and shrimp, haddock, and cod by one each.
- c. Method of Preparation Favored: Frying was generally given as first choice in cooking methods, with most camps preferring the use of a batter and nearly all recommending that the fish be served with some sort of sauce. The desirability of using different sauces from time to time to avoid monotony was frequently mentioned. For large fish, most reports showed that baking was a satisfactory second choice.
- d. Quality of Fish: Of those commenting on the quality of fish when received, none complained of lack of freshness. Several specifically mentioned that no trouble had been encountered from receiving stale, or otherwise unsatisfactory, fish. Several comments implied, however, that there was a decided preference for frozen fish. One camp reported that iced fish was not acceptable and that only frozen fish was used, but no reason was given for this choice.
- e. Recommendations for Increasing the Popularity of Fish: Most reports stressed the importance of methods of serving fish, and emphasized especially the desirability of having a variety of sauces available. Many of the reporting agencies felt that improvements in serving methods, together with increased knowledge of existing methods, by Army cooks provided the best approach to increasing the popularity of fish. It was quite generally felt that publication of new recipes represented the best way to disseminate such new information.

Most Service Commands recommended pamphlets and posters for increasing the popularity of fish. Two reporting agencies, however, were quite emphatic in their belief that such psychological approaches would lead to little or no success.

The conclusions of this survey were:

1. Filleted fish, prepared in pieces, suitable for individual servings, were preferred.
2. Thirty pounds of fish per one hundred men was the most desirable proportion for serving.
3. The most popular method of preparation was deep-fat frying, preferably with flavorful sauces.

4. Special instructions with respect to proper preparation of fish should be given to cooks and mess sergeants.

As a result of this survey, it seemed advisable to prepare a fish reference manual for Army use. With the help and suggestions of members of the Subsistence

Research and Development Laboratory, the Fish and Wildlife Service's Technological Section prepared the fish Cookery and Reference Manual¹ for Army use. This manual contains information concerning the marketing and food value of fishery products and provides instruction for the purchase and preparation of all fish and shellfish available for military feeding. The manual is now being used by the Subsistence School, Chicago Quartermaster Corps.



SCHOOL FOR BAKERS
AND COOKS

Development of Canned Lake Fish: In the latter part of 1944, samples of carp

and buffalofish,^{2/} packed in a style similar to that of canned flaked tuna, were submitted to the Laboratory by a Minnesota canning company. After several years of work on the canning of carp and buffalofish, this company had finally developed a product it considered suitable for military use. The samples submitted were carefully examined, and were found to be acceptable in flavor and color, but it was suggested that the texture of the fish could be improved. After further experimentation with the brining and cooking procedures, with the Laboratory acting in an advisory capacity, the company submitted a product which was considered satisfactory in flavor, color, and texture.

Although carp and buffalofish had been used commercially only to a limited extent, the Laboratory thought it advisable, in view of the critical shortage of protein foods, to utilize acceptable food products of this type from all potential sources. It estimated that, in excess of current fresh market demands, 50,000,000 pounds of round carp and buffalofish from Minnesota and surrounding States would be available annually for food purposes and that canning of these species would make available approximately 10,000,000 pounds of highly nutritious canned fish.

Chemical and vitamin analyses of canned lake fish made in February 1945 showed it to be a highly nutritive product, comparing favorably with canned tuna in this respect.

Early in 1945, following the canning of a successful test pack of 5,000 cans of this product by the Minnesota company, the Army contracted for the purchase of 150,000 cans (14 oz. net) for Service use and for foreign relief feeding. The contract provided also for the purchase of an additional 50,000 cans (14 oz. net) of a canned ground fish product, packed without the addition of cottonseed oil, which would be used exclusively for foreign relief feeding.

¹/Subsistence School Text No. 28, Ed. 1, July 1945.

²/Research Report No. 6-45, Fish, Lake, Canned, Tuna Style, April 27, 1945.

Preservation of Salt Fish: A Subsistence Research and Development Laboratory research project initiated in March 1944 was directed towards retarding rancidity in salt-cured fish products. Although these products have long been one of the basic sources of protein food for lower income populations of the world, their use has been restricted largely to fish of non-oily species such as cod. Fish of high fat content: herring, mackerel, mullet, pilchard, etc.; could not be salt-cured profitably because, to prevent rapid deterioration, salt-cured products of this type require storage at temperatures about 35° F. If they are held at 70° F., or higher, rancidity occurs within a few days, and the products become inedible within a few weeks.

In undertaking this project, the Laboratory hoped to aid in civilian relief feeding by making possible the use of protein foods which heretofore could not be shipped to tropical and semi-tropical areas without refrigerated shipping and storage space. In correspondence with the Laboratory the WFA had emphasized the importance of such research to government agencies purchasing food for relief and other purposes.

The problem was primarily that of preventing or retarding the development of rancidity in the oil of the fish. Therefore, stabilization of the oils by means of antioxidants was considered the most practicable solution. Data accumulated by the Laboratory on the use of antioxidants in fats and oils, particularly lard and shortening, were particularly helpful in this work. The following technique was adopted:

An antioxidant is dissolved in a carrier of edible fat of a type solid at room temperature and relatively resistant to oxidation because of its chemical nature. The fish, after completion of the salting process, are dipped in the liquified fat which, upon cooling, forms a thin, solid fat coating. During storage, the fish oil, upon liberation from the fish, is absorbed into the coating and thus obtains the benefit of the protective action of the antioxidant in the coating.

Subsequently it was found that, in addition to oxidative rancidity, bacterial and enzymatic activity caused both rancidity and protein decomposition, particularly at temperatures from 80° to 100° F. Therefore the use of approved, non-toxic substances which would retard bacterial and enzymatic activity, in combination with the antioxidant-coating in the salt employed to salt-cure the fish was also investigated.

A preliminary laboratory-scale experiment on salt-cured herring provided definite indication of the value of the modified stabilization process. A subsequent laboratory-scale experiment on salt mackerel demonstrated that the process definitely stabilized the salt fish for a period of months. A detailed report of this experiment was presented in Research Report No. 15-45, June 8, 1945. As a result of this test, it was predicted that six months additional storage life, at room temperatures, could be obtained before products would become rancid to the point of inedibility. It was, therefore, concluded that a commercial-scale test was warranted.



The War Food Administration offered to finance such a test on salt brine-cured herring. Accordingly, a test pack of 50,000 pounds of herring was prepared in Gloucester, Massachusetts, in March 1945. Along with the stabilized product,

untreated fish were included in the pack as controls. Portions of the pack were being stored under various controlled temperature conditions, and preliminary examinations indicate definitely superior keeping qualities in the stabilized portion of the pack. These samples were in storage under observation in September 1945, and the test was expected at that time to be completed in eight or ten months.

The stabilization technique required little change from normal methods of production of salt fish products. Integral features are:

- a. The incorporation of 4.5 pounds "Brino" (50 percent magnesium benzoate and 50 percent benzoic acid) or other approved, non-toxic, equally effective preservative, per 1,000 pounds of salt. This is equivalent to a 0.1 percent concentration based on weight of the salt plus the fish, using 30 pounds of salt per 100 pounds of fish. The salt-preservative blend is employed in the same manner as ordinary salt in normal salting operations.
- b. Coating the salted fish with an approved vegetable fat, into which has been blended 0.3 percent (by weight of fat) of nordihydroguaiaretic acid or other equally effective antioxidant.

The cost of stabilization should not exceed two cents per pound of the final product, one cent per pound for materials used, and a similar cost for the additional handling entailed. The preservative is available in relatively unlimited quantities, and the antioxidant (nordihydroguaiaretic acid) is available at present in a quantity sufficient to process 400,000 pounds of fish per day. Since only three pounds of vegetable fat are required per 100 pounds of fish, the availability of vegetable fat should not prove a problem.

The War Food Administration and the Subsistence Division of the Office of the Quartermaster General indicated both current and postwar needs for huge quantities of salt fish for civilian feeding purposes, particularly in the Philippines. Both agencies have asked for fish capable of being shipped and stored without refrigeration.

Inspection and Procurement of Canned Salmon: To assure procurement of sufficient quantities of canned salmon from the 1945 pack, the Office of the Quartermaster General requested that an investigation be undertaken to determine whether any changes were needed in the Federal specification for this product. The Subsistence Division indicated that Army requirements for canned salmon were such that all wholesome products of adequate keeping quality should be accepted. Accordingly, representatives of the Laboratory conferred with representatives of the National Cannery Association, the War Food Administration, the Seattle Army Service Forces Depot Veterinary Division, and the California Quartermaster Depot, concerning the matter.^{1/}

The importance of the canned salmon investigation was magnified when, because of anticipations of a limited run of Alaska red salmon, the 1945 pack of Alaska salmon was estimated at only 5,000,000 cases, which was somewhat below average, although higher than the 1944 pack of 4,856,000 cases. Total military requirements were estimated at approximately 3,000,000 cases (140,000,000 pounds) or approximately 60 percent of the anticipated pack. Since only 52 percent of this pack could be obtained without some change in the present procurement program, it was necessary to find some means of obtaining the additional 8 percent.

^{1/}Research Report 13-45, "Investigation of Anticipated Supply of Canned Salmon from 1945 Pack Acceptable for Army Purposes," May 16, 1945.

At a joint cutting demonstration held in the Salmon Inspection Laboratory of the National Cannery Association, in Seattle, Washington, cans of the various species, at quality ranges, were opened, the contents examined, and quality grading demonstrated. Products of the minimum quality acceptable to the Army, and products of lower quality acceptable to the WFA, were demonstrated.

As a result of this demonstration, it was found that the present Army minimum standard, based upon Federal Specification PP-5-31a, July 29, 1941, as amended May 1942, was being interpreted by the Army Veterinary Inspection group to include all grades of canned salmon considered suitable for food for the United States military personnel. Reduction of quality standards governing inspection and procurement of canned salmon for Army use was, therefore, considered undesirable.

Failure to obtain sufficient canned salmon from the previous packs had not been due to unnecessarily high quality standards. There had been more than sufficient canned salmon of the desired quality to meet Army needs. Rather, the failure to obtain a sufficient amount of acceptable canned salmon was due largely to the canners' reluctance to segregate rejected codes (specific divisions marked with a "code" number) from a lot even when the greater portion of the lot was acceptable to the Army. Since the canner receives the same price regardless of whether a lot meets Army requirements, provided it meets WFA minimum requirements, there is no financial inducement to the packer to segregate codes rejected by the Army.

Under the set-aside order, there was a possibility that the packer might retain the best 20 percent of his pack for the civilian market. This Laboratory recommended that if it were found later in the season that packers were not offering the best 20 percent of their pack for Army procurement, the present set-aside procedure be modified to permit the Army to select its requirements from the entire pack.

However, the Laboratory suggested that the Office of the Quartermaster General ask the Commodity Credit Corporation to make a formal request that the canned salmon industry adopt a program of segregating codes rejected by the Army from lots containing codes of quality acceptable to the Army.

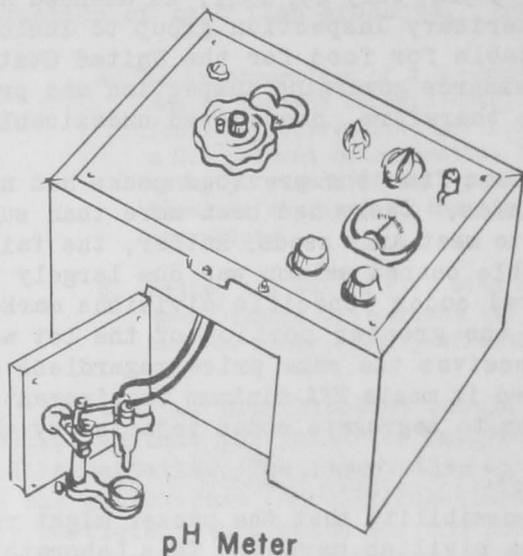
The Laboratory suggested that an additional 19,000,000 pounds of good quality canned salmon would be available to the Army if packs prepared in the standard commercial half-pound cans were used. Also, it was suggested that, if salmon were required for civilian relief feeding, a lower grade than that specified for Army use be used.

Search for a Freshness Index for Fish Fillets: The Army Quartermaster Corps purchased fish for the Armed Services through the Veterinary Corps fish inspectors. All inspection tests were organoleptic, consequently, the quality of the fish purchased depended entirely upon the judgment of the individual inspector. Organoleptic observations have been the only generally accepted criteria for judging the freshness of fish, and such tests have not been considered too accurate. It was believed desirable, therefore, to aid Veterinary Corps Inspection to insure the purchase of fresh, good quality fish for the Armed Services by devising an objective test to replace or supplement the organoleptic examinations.

Any test devised would necessarily have to be simple, rapid, and economical; also, it would have to be of such a nature that it would not mutilate the sample, rendering it unfit for sale. It is believed that if the pH value (relative acidity

or alkalinity) of fish flesh could be correlated with fish freshness, such a test would approach very closely the requirements of an ideal test. The pH determinations employing a pH meter are simple, rapid, and accurate, yet the samples are not destroyed.

In September 1944, the Laboratory requested the cooperation of the U. S. Fish and Wildlife Service in making surface pH tests to determine whether they would be of value to Army Veterinary Corps Inspectors as a basis for fish purchases, and to attempt to further simplify the tests.



Accordingly, the United States Fish and Wildlife Service detailed one of its technologists to conduct experiments and apply the test to the types of fish purchased by the Army at Gloucester, Mass. These experiments were conducted through September, October, and November 1944.

Of the various fish tested, the surface pH test was found to have some possibility of value as a freshness index for fillets of haddock, whiting, and dabs, but to be of questionable value for pollock, and to have no value for cod, grayfish, and rosefish. It was found, also,

that the limitations of the test were quite serious:

- a. It applied only to fish that had never been frozen. This is the case because erratic pH changes, not in any way connected with freshness, occur during freezing.
- b. It indicated only the spoilage that occurred after the filleting process. Spoilage taking place prior to filleting could not be determined, since the pH values of new fillets would give no more indication of freshness than those on composite samples or internal flesh. Because the filleting operation makes a fresh cut, a surface pH taken immediately after filleting would thus be an interior rather than a surface test.
- c. It may sometimes be affected by fillet dips. On the Atlantic Coast and, to a small extent, on the Pacific Coast, fillets are dipped in brine after the filleting process. Occasionally, alkaline dips are used to enhance the color of the product. If surface pH were used as a measure of freshness, any of these dips would affect the test markedly.

The data indicated further that there was no definite pH at which the limits of edibility could be set. Dyer, Sigurdsson, and Wood (1944) and VanDeurs and Hoff-Jorgensen (1936) suggested 7.5 as the upper limit for cod. In this present study, pH 7.5 in no case was considered a sufficiently low limit for edibility.

As a result of these experiments, and after thorough consideration of the limitations discussed above, it was shown that the surface pH test was not of practical value for Army use in the inspection of fish. From the standpoint of theoretical knowledge, however, these experiments proved of great value. They furnished additional information concerning the nature of fish spoilage and should prove useful for further laboratory research.

Evaluating Fishery Products for Foreign Relief: Assistance was requested by the War Food Administration, charged with the purchase of fish and fishery products for relief feeding, in evaluating the acceptability and suitability of many fish products offered for purchase for foreign relief feeding. Such products as canned squid, canned ground pilchard and menhaden, canned ground cod waste, brine-cured fish, and similar items, practically unutilized domestically because of their low acceptability to the American taste, were accordingly evaluated by the Laboratory.



When it was determined that certain of these products would be acceptable, several hundred million pounds of low cost protein food, and otherwise unutilized fish, were made available for relief feeding. Equally important was the elimination of products which would not be acceptable or which would not have the keeping quality necessary for shipment and storage before use.

Examination of Captured Enemy Fish Rations: A considerable number of captured Japanese and German fish rations were examined and evaluated with comparable types of American fish rations. In general, regular Japanese commercial products, such as canned salmon and tuna, were found to be acceptable in appearance and taste. Most of the military rations, however, were seasoned with a sweet, spicy sauce, which imparted a reddish-brown coloration to the products, rendering them unacceptable generally to American tastes.

With a few exceptions, the Japanese items seemed wholesome and nutritious. A few products such as whale, canned or dried squid, and dried sardines, however, though nutritious, did not possess an appetizing appearance. Because they were packed with such vegetables as hog rhubarb, bamboo, and seaweed, which are not commonly found in the American diet, some of the fish items were not considered generally acceptable. On the whole, the can vacuum was low, probably because of excessive filling.

The number and variety of fish items were greater in the Japanese rations than in the German rations. The German fish rations were considered as good as the comparable type of commercial American pack.

It is impossible to evaluate accurately the results of the research and development undertaken on fishery products. The whole program had such a late beginning that its results have not been practiced long enough to afford an exact index to its value. A considerable portion of the results was offered in the form of recommendations to other government agencies responsible for particular phases of the Army and civilian feeding programs. Thus, the value of the program depends largely upon the extent to which these agencies have applied these recommendations and findings.

It is believed, however, that the main contributions of the fishery research program may be summarized as follows:

1. Prevention of waste
2. Reduction of spoilage
3. Making possible the utilization of previously unused types of fish
4. Development of canned lake fish
5. Making available more canned fishery products for foreign relief feeding

