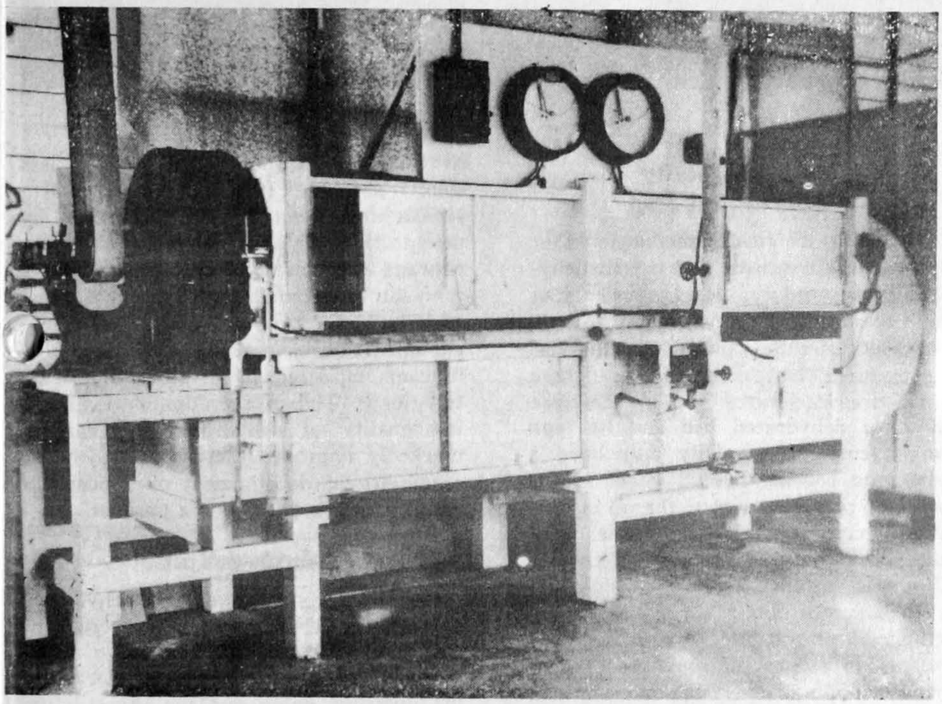
United States Department of the Interior
Fish and Wildlife Service

Fishery Leaflet 120

Chicago 54, Ill. April 1945

Dehydration of Fishery Products



Experimental fish dehydrator used by Seattle Fishery Technological Laboratory.

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TESTS conducted by the Technological Laboratories of the U. S. Fish and Wildlife Servic indicate that dehydration of fish is a relatively simple process yielding, a product of good palatability. Successful storage, however, is difficult to attain. Furthermore, cost of the dehydrated product is high, perhaps too high for commercial production for domestic markets.

In 1942 when shipping space was at a great premium, considerable interest was displayed by various governmental food purchasing agencies in dehydrated products of all kinds, including such protein foods as meat and fish. Since practically no information was then available as to the best means of dehydration and storage of dehydrated fish, the U. S. Fish and Wildlife Service started a comprehensive investigation of this subject at its Fisheries Technological Laboratories in both College Park, Md., and Seattle, Wash. The work in the Seattle Laboratory was primarily on engineering studies to determine the best processing technique and to learn the effect of various processing methods upon storage life of the product. The College Park Laboratory concentrated mainly on the utility of different species for dehydration, the determination of the nutritive value of the dehydrated product, and the application of several new and unusual processing methods to the dehydration of fish.

Processing

Engineering studies on processing were carried out in a horizontal tunnel drier (see Figure 1) in which temperature and relative humidity were automatically controlled and air velocity could be varied between zero and 900 feet per minute. The drying chamber was 18 feet long with a cross sectional area of 18 by 23 inches and held four trucks, each carrying seven drying trays of 2½ square feet area.

Removal of heads, viscera, fins and

(Reprinted from the Annual Review Number of Fishing Gazette, 1944, p. 182).

scales was considered necessary to obtain a product of acceptable consumer standard. In most cases bone free fillets were used in the experimental work.

In order to obtain a satisfactory rate of drying, precooking was found to be necessary. Raw fish[1] not only dried at a rate of about one-third that of cooked fish, but also, the resulting product did not rehydrate as well, absorbing less than half as much water as did the product obtained from cooked fish. A cooking time of 7 to 10 minutes at 5 to 10 pound steam pressure was found to give optimum drying and rehydration.

No extensive experiments were tried on dehydration of whole fish or fillets since preliminary results showed that unless the fish were ground after cooking, removal of water was slow and incomplete. In order to remove moisture at a rate sufficiently rapid for commercial operation, preliminary grinding was essential.

A rather wide range of conditions were found to be suitable for satisfactory dehydration of fish. Drying temperatures as high as 205° F. can be used in the initial drying stage without harmful effect. As the product becomes drier, it is necessary to use a lower temperature in order to prevent scorching and in the later stages, temperatures above 145° F. are inadvisable. Relative humidities between 10 and 40 per cent have no appreciable effect on the quality of the product. Low humidities and high initial drying temperatures are, of course, helpful in increasing the rate of drying.

Some tests have been conducted in cooperation between the College Park Laboratory of the Fish and Wildlife Service and several industrial manufacturers of dehydration equipment to determine the adaptability of certain new dehydration processes to fish. Both the Megathem process utilizing radio frequency energy as a source of heat, and the process employing high vacuum desiccation of the frozen product were tried in a preliminary way. Both of these processes showed promise but since neither of these methods are, as yet, sufficiently perfected for commercial adaptation to dehydration of fish, no extended studies were made.

Species which have been successfully dehydrated include cod, whiting, rajafish, angler fish, sea robins, puffers, croakers, ling, mullet, groupers, sea trout, and sea mussels from the Atlantic Coast; carp and burbot from interior waters; and rock cod, grey cod, halibut, herring, pilchard, petrale sole, chum salmon, king salmon, silver salmon, Pacific mackerel, and squid from the Pacific Coast.

Tests at College Park, Maryland, Laboratory.

Keeping Quality of Dehydrated Fish

The quality of fish immediately after dehydration is excellent and it will dehydrate to a product closely resembling minced fresh fish. However, upon storage, changes occur quite rapidly, altering flavor, texture, and appearance. These changes are accelerated by high moisture content of dehydrated fish and by high storage temperature. Oily fish have a tendency to become rancid. Since in the process of removing water, the oil is concentrated considerably, even species generally considered to be relatively non-oily will give a product having considerable oil. In order to obtain a product having any sort of reasonable storage life, it is necessary to reduce the moisture content to well below 5 per cent and to store in a hermetically sealed container (such as a tin can) either in a vacuum or with an inert gas such as nitrogen. Even under these conditions the product definitely deteriorates in a six-month period of time.

Storage changes occurring with non-oily species include development of an extremely tough texture, darkening of color, and appearance of a burnt flavor and odor. These changes are identical with those encountered with dehydrated eggs where such changes are attributed to a chemical combination between the protein and certain sugars which occur in only small traces in eggs. With dehydrated eggs these changes are minimized by reducing the moisture content to less than 1 per cent. It seems possible that a similar improvement might be obtained by dehydrating fish to a similarly low level. Storage experiments are now in progress with samples containing 0.5 per cent moisture, but tests have not yet proceeded far enough to determine whether any significant improvement in storage characteristics is obtained thereby. Unless keeping quality of dehydrated fish can be markedly improved there seems to be no possibility of development of a post-war domestic market for such a product.

Nutritive Value

Feeding tests with rats on dehydrated cod, mullet, whiting and carp were conducted and it was found that the dehydration process did not adversely affect either the nutritive value nor the digestibility. Tests on the thiamine (vitamin B_1) and riboflavin (vitamin B_2) content before and after dehydration showed that the dehydration process caused a loss of about 50 per cent of the thiamine and 65 per cent of the riboflavin. The loss took place largely in the cooking process and about half of each vitamin loss could be recovered in the stickwater.

Methods of Utilizing Dehydrated Fish

The dehydrated fish products are readily rehydrated by mixing four to six parts by[2] weight cold water with one part of the dehydrated product and allowing to stand

1/ Raw fish required three times as long a drying time as cooked fish.
2/ This gives an excess of water which must be drained after rehydration is complete.

Grinding fish, preparatory to dehydration.

for 15 to 30 minutes. Some species rehydrate more rapidly, e.g., salmon in about 1 minute, and in all cases the temperature of the water used is not at all critical. The rehydrated fish can be used in any recipe where fish flakes are called for, such as fish loafs, fish balls, fish salads, etc. An all dehydrated fish chowder in which the dehydrated fish was mixed with other dehydrated ingredients has been prepared. To utilize as a chowder it is only necessary to add water and heat the mixture.

In addition to the technological difficulties already mentioned connected with storage of dehydrated fish, the economic aspect of cost of production is a large handicap to any successful venture in this field. Owing to the removal of water, which is the principal constituent of fish (water occurs up to 80 per cent in lean fish), there is such a concentration of the other ingredients as to make the cost of the final product very high. For example, if we take the cost of haddock fillets as 30 cents per pound, and if we reduce the water content from 80 per cent to 1 per cent, then the finished product will have been concentrated five times and the raw material cost exclusive of all processing and overhead charges will be $1.50 per pound. It is hard for the ultimate consumer to realize he is buying such a concentrated foodstuff, and he is usually unwilling to pay such a high price for a new product with which he is unfamiliar. These considerations limit the possibility for rehydrated fish production to such inexpensive species as pilchard or to such trash fish as are at present not utilized at all. If small fish like pilchard were to be dehydrated, the labor cost of dressing and preparation would be so high when translated to the cost of the concentrated final product as to seriously limit even the possibility of utilizing such fish in this way.

At the present time, one east coast plant is preparing dehydrated fish for the British government and, so far as is known, this is the only plant operating in this country. American governmental agencies are showing no interest at present in either meat or fish. Accordingly, at the present time the outlook for development of a dehydrated fish industry, either for foreign or domestic markets, is not very promising.

REFERENCES

Anonymous.

1943. Dehydrated B.C. fish found to make attractive food products. Commercial Fishermen's Weekly, vol. 9, no. 32, pp. 375-376, October 15.

1943. Dehydration of fish. Fishing Gazette, vol. 60, no. 9, pp. 34-35, September.

1943. Dehydration through electronics. Quick Frozen Foods and the Locker Plant, vol. 6, no. 2, September.

1944. Commercial herring dehydration. Food Manufacture, vol. 19, no. 9, p. 307, September.

1944. Automatic controls for proper food dehydration. Fishing Gazette, vol. 61, no. 3, March.

1945. New products from mullet. Southern Fisherman, vol. V, no. 3, p. 152, January.

Birdseye, Clarence.

1944. Dehydrated foods must be good. Quick Frozen Foods and the Locker Plant, March.

Carl, Betty C., Betty M. Watts, and Agnes F. Morgan.

1944. Dehydration of meat scrapples. Food Research, vol. 9, no. 4, pp. 319-327, July-August.

Coen, Camillo.

1931. Preserving fish. French Patent No. 719,525, June 15.

Cooper, D. LeB.

1937. Fish drying. Biological Board of Canada-Progress Reports of the Atlantic Stations no. 20, pp. 8-10, August.

Cutting, C. L., and G. A. Reay (Torrey Research Station - England).

1944. The dehydration of fish. Chemistry and Industry, no. 6, pp. 47-50.

Grelck, W. P. M.
1935. Preparing fish or vegetable material for use as food. U. S. Patent No. 2,009,134, July 23.

Hamm, W. S., C. Butler and M. Heerdt, Jr.
1944. Food fish dehydrate well. Food Industries, June, pp. 445-447 and 489-490.

Harper, L. K.
1943. Postwar possibilities of dehydration. Quick Frozen Foods and the Locker Plant, May.

Loesecke, H. W. von
1943. Drying and dehydration of foods, chapter 5, pp. 160-177. Reinhold Publishing Corp., New York.

Martinek, William A., and Barbara Jacobs.
1943. The nutritive value of the protein of some dehydrated fishery products. Fish and Wildlife Service, Fishery Market News, vol. 5, no. 8, Separate 34.

Minde, Hjalmar.
Process for manufacture of keepable fish products. Alien Property Custodian Patent No. 2,271,272.

Ornierei, F.Y.
1932. Apparatus for preparing powdered fish. U.S. Patent No. 1,867,523, July 12.

Patterson, James C.
1943. Food dehydration. Refrigerating Engineering, vol. 45, no. 6, June.

Reay, G.A., and C.L. Cutting.
1943. Dehydration--fish and fish products. Department of Scientific and Industrial Research, British Ministry of Food, unpublished report, pp. 1-16, June.

Scott, Geo. G., and Harold G. Wolffe.
1918? Dehydration of fish. Bureau of Fisheries Mem. S-181.

Sidaway, E. P., and O. C. Young.
1943. An air-conditioned tunnel for processing fish. Fishery Research Board of Canada-Progress Reports of the Pacific Coast Stations, no. 56, pp. 4-5, September.

Silver, J. A.
1943. Dehydration through freezing. Quick Frozen Foods and the Locker Plant, June.

Steinherz, Dezsoe.
1943. Some experiments in low temperature dehydration. Quick Frozen Foods and the Locker Plant, July.

Tarr, H. L. A.
1943. Changes in moisture, micro-organisms, and volatile bases in dehydrated fish during processing and storage. Fishery Research Board of Canada-Progress Reports of the Pacific Coast Stations, no. 57, pp. 16-20, December.

Yamomato, S., and S. Masuda.
1926. The chemical change in the heat drying of fish. Journal Imperial Institute (Tokyo), vol. 22, pp. 188-197 (English resume).

Young, Leo, and C. F. Lee.
1943. Dehydration of fishery products. Fishing Gazette, vol. 60, no. 13, p. 64, December.

Young, O. C., and E. P. Sidaway.
1943. The dehydration of fish. Fishery Research Board of Canada-Progress Reports of the Pacific Coast Stations, no. 56, pp. 7-9, September.
1943. Dehydration of fish. Western Fisheries, vol. 27, pp. 8-9, December.