SOME OBSERVATIONS ON FISH PROCESSING IN NORWAY

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INTRODUCTION

During July and part of August 1946, various fish-processing plants were visited in the area from Stavanger to Trondheim, Norway. The principal purpose of this tour was to learn whether the Norwegian sardine industry was employing methods that might be applied in the United States for the improvement of our domestic sardine pack. Incidental observations on the manufacture of byproducts, the refining of herring oil for use in sardine canning, and the preservation of cod are also reported here.

The Sardine Industry

THE SARDINE FISHERY: Two species of fish are canned as sardines in Norway, the brisling (Clupea sprattus) and the herring (Clupea harengus). The packs prepared from the brisling are generally considered to be of finer quality than those prepared from herring.

The brisling, which are small even when full grown, are canned when mature, and the size varies from 12 to 40 fish to the one-quarter pound sardine can. They are caught in commercial quantities from Oslo on the East coast to Aalesund on the West coast, the season extending from the latter part of June into August. However, the entire year's supply for a particular area may be caught within a period of about 10 days. The brisling are generally caught with purse seines and are held alive in temporary net enclosures or pounds for periods up to a month or longer. Each morning, the day's requirement of fish is dipped out and packed with ice in boxes which hold about 35 to 40 pounds of fish each. Transport boats then carry the boxes to a central wharf, where the fish received from the various pounds are dispatched by trucks or small boats to individual canneries in the area.

The herring grow to a larger size than the brisling and are canned as sardines when immature. Small herring are taken from May to January, and the fishing methods are similar to those used for taking brisling. The geographical range of the herring is more extensive; shipments from some fishing grounds to the canneries being en route as long as 72 hours.

WASHING, BRINING, AND STRINGING: After the fish are received at the cannery, they are either placed in a refrigerated room or are well iced. As fish are needed, they are washed thoroughly in large tubs to remove scales and dirt. Some canners use mechanical rotary washers. The washed fish are then placed in a tub of brine with an excess of fine salt. Each tub holds several hundred pounds of fish; and the fish are left in the brine for 10 to 30 minutes, the length of time depending on the size and fat content of the fish.

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If brisling or small herring are being prepared, they are then taken to work tables for stringing. Each table has a hinged metal attachment connected to it which has rows of parallel grooves cut into its top, and a woman worker places the fish headfirst in the individual grooves. The grooves hold the fish firmly so that the worker can quickly pass a wire through a slot vertical to the grooves thus piercing the heads of all the fish in the grooves. The worker then opens the hinge of the metal attachment and removes the string containing 22 fish and places it in a rack which accommodates 30 wires. The loaded frames are then placed on wheeled racks, about 10 frames to the rack, and wheeled to the smoking and cooking oven.

SMOKING AND COOKING: The smoking is most commonly carried out in a horizontal oven or tunnel about 50 feet long, through which the racks are pulled by a motor-driven chain. Furnaces burning various types of hard wood are connected to the end of the tunnel at which the fish leave. The smoke and hot gases are drawn through the tunnel by a suction fan placed at the end where the fish enter.

A uniform circulation of smoke is obtained, first, by the use of solid metal plates which form the back of each rack and prevent horizontal movement of the smoke and, second, by the installation of smoke channels placed alternately along the top and bottom of the tunnel to direct the smoke up through one rack of fish and down through the next. This arrangement eliminates channeling of the smoke and makes certain that all the fish will be equally cooked and smoked.

At the end of the tunnel where the fish enter and the smoke is discharged, the temperature of the smoke is about 175° F. At the other end, where the fish leave and the smoke enters, the temperature is about 260° F. The temperature is controlled by a system of manually-operated checks and dampers which regulate the entrance of air and the rate of combustion in the furnaces. The smoking and cooking operation requires 30 to 55 minutes depending on the size of the fish.

In some plants the smoking and cooking operation is carried out in a vertical smokehouse. The individual frames are carried, first up and then down, on a continuous conveyor, the length of the complete path being about 50 feet. This type of smoker is fired with hard wood directly underneath the vertical sections of the conveyor.

PACKING AND SEALING: The sardines after coming from the smoke oven and cooling somewhat are beheaded mechanically, one frame at a time. Small pans on a conveyor pass beneath the beheading machine, catch the bodies, and continue on to the packing tables. Here women workers pack the fish in cans to which some of the canning oil has already been added. The packers take great care to fill each can neatly with fish of uniform size. The filled cans are carried on trays to inspectors who carefully examine each can, adding or removing fish as needed and replacing any damaged fish.

The cans then receive additional oil and are carried to the sealing machine. Here one worker places the lids on the cans, and another worker feeds the cans to the machine. The machines in common use are of French make and are capable of sealing about 2,600 cans per hour.

PROCESSING: The sealed cans are placed in small metal wagons which are then run into horizontal retorts where the fish are processed under steam and air pres-

sure. The process technique is practically the same as that used for glass containers which cannot stand an internal pressure in excess of the external pressure, and is necessary for the aluminum cans used in Norway for the sardine pack. The cans are kept submerged under water during the process, and air is pumped into the retort to maintain a partial pressure of about 8 pounds per square inch. The one-quarter cans are cooked for about one hour at 240° F., and are then cooled by the introduction of cold water into the retort. The air pressure is not reduced until the cooling operation is completed.

After being cooled, the cans are cleansed in a washing machine with a detergent solution. Later, they are wrapped in paper, the keys are inserted, and the wrapped cans are labeled and packed 100 to the case.

CANNING OF LARGER HERRING: Those herring that are considered too large for the best grades of sardines are treated somewhat differently from the brisling and smaller herring. The larger herring are first beheaded; and then, after being washed and brined as previously described, they are spread on wooden-framed, wire-bottomed trays, about 20 inches square. The trays are stacked in racks and the fish steamed in metal steam boxes and then dried in a tunnel drier. The subsequent packing, oiling, and processing are the same as for the smoked sardines. The steam-cooked pack is considerably lower priced than the smoked pack.

HERRING OIL FOR CANNING: The refining of herring oil for human consumption has been relatively more common in Norway than in other countries. When sufficient quantities of other oils could not be obtained, the Norwegians began to employ specially refined herring oil in the canning of sardines.

The raw herring oil, which may have an objectionable odor and color, is shipped from the reduction plants to centrally located refineries. At the refinery, the oil is destearinated, treated with alkali, filtered with various filter aids, polymerized, and deodorized by being blown with superheated steam at a low pressure and high temperature.

The refined product is somewhat more viscous than the crude oil and is also clear, light colored, and practically free from taste and odor. It is claimed to be quite satisfactory for use in the canning of sardines, at least to consumers who do not have a definite taste preference for olive oil. Although this specially refined herring oil is stated to be more resistant to the development of rancidity than ordinary refined fish oils, it is less resistant to oxidation than high quality, edible vegetable oils. The cost of the specially refined herring oil was slightly greater than the price of domestic soya oil during the summer of 1946.

The 1946 specifications for polymerized marine animal oils for use in the canning industry for the packing of sardines were reported by Ronold and Taarland in the March 1947 issue of the Norwegian Canners Export Journal as follows:

ORGANOLEPTIC PROPERTIES

1. The oil shall be clear, that is, carefully filtered, free from moisture, slime, and other impurities.

2. The color shall be from pale yellow to golden yellow.

3. The odor and taste shall be clean, good, and tenable.

PHYSICAL PROPERTIES

1. Only insignificant amounts of solid fat shall separate with cooling to 6° C. for three days.

2. The viscosity at 25° C. shall be between 80 and 140 centipoise.

CHEMICAL PROPERTIES

1. The content of free fatty acids (calculated as oleic acid) shall not be over 0.3 grams per 100 grams of oil.

2. The saponification number shall be between 180 and 200.

3. The iodine number (determined by Wijs method) shall be between 95 and 110.

4. The polybromide number shall not be over 2.0 (calculated as grams of polybromides per 100 grams of oil).

5. The content of unsaponifiable matter shall not be over 1.0 gram per 100 grams of oil.

6. The rancidity number shall not be over 2 red Lovibond units by the quantitative Kreiss test.

7. Saponification with n/2 alcoholic KOH shall produce a yellow colored and not a dark brown colored mixture.

8. The ash content shall not be over 30 milligrams per liter of oil.

QUALITY CONTROL: All the canners of fishery products for export belong to cooperative marketing organizations known as "Centrals," there being a Central for each product made in sufficient quantity. The Central functions as a clearing house for the smaller packers, receiving their packs and releasing them to export shippers. The Central hires inspectors to examine the canneries and to sample and grade each lot submitted for export. If the specified standards for packing are not met, the inspectors can close the cannery or down-grade the pack.

In addition, the canners maintain a cooperative laboratory which is partly financed by the government. This laboratory engages in research of value to the canners, sets standards, and serves as referee in any disputes which may arise over decisions of the inspectors employed by the Centrals.

ECONOMIC ASPECTS: The cost of fishing for sardines is in most cases borne by the packers who form fishing associations composed of several packers. They then make agreements with the fishermen and usually provide most of the gear. The fish are apportioned to the various packers in the association on the basis of the financial investment in the association. The packers claimed that the brisling would cost about $3.00 per finished case of 100 cans and that the herring sardines would cost from $1.60 to $2.00 per case for the raw material.

The packers stated that the production of sardine fish was not subsidized by the government. However, a considerable part of the fish production is subsidized by government payments to the fishermen, because it is claimed that the processors cannot meet foreign competition and at the same time pay the fishermen enough to support a reasonable standard of living.

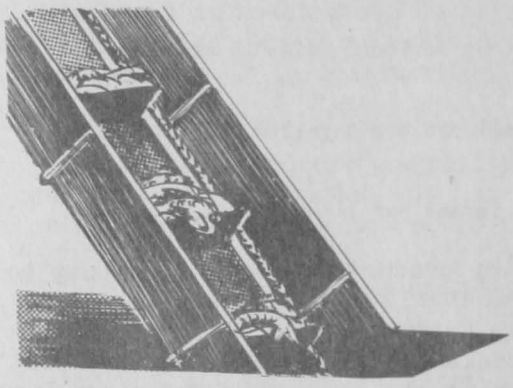
The workers in the canning plants do not appear to earn as much, in terms of dollars, as comparable workers in the United States. The labor cost, in the Nor-

wegian sardine canneries, for stringing and packing the sardines is about $0.40 per case of 100 cans. It was said that women engaged in this work earn about $15 to $18 per week and that men working in the same plants earn about $25 per week.

Most of the canneries fabricate their own cans, but some types of aluminum cans which are difficult to make are manufactured centrally. In many cases, the can-manufacturing machinery was antiquated and required considerable labor for its operation. Depending on the plant efficiency, the cost of fabricating one-quarter sardine cans varied from $18 to $30 per thousand. The canners realize that central can manufacture might be cheaper, but they state that local manufacture is necessary as a means of providing more continuous employment for their workers.

Fish Meal Production

Two fish meal plants were visited. Each has six unloading stations so that several vessels can unload simultaneously. At each station bucket conveyors carry the fish to measuring boxes. A chain-and-drag conveyor transfers the fish from the measuring boxes to large, outdoor, concrete, storage bins. Since the greater part of the catch is taken in winter, several days' requirement of fish can be held without serious effect on the quality of the meal.



FISH CONVEYOR BELT

The first plant visited was in the Bergen area. It operates somewhat similarly to California pilchard plants. The fish are first cooked and pressed. The press liquor is centrifuged to separate the oil from the stickwater, and the solids are dried in direct-fired rotary driers.

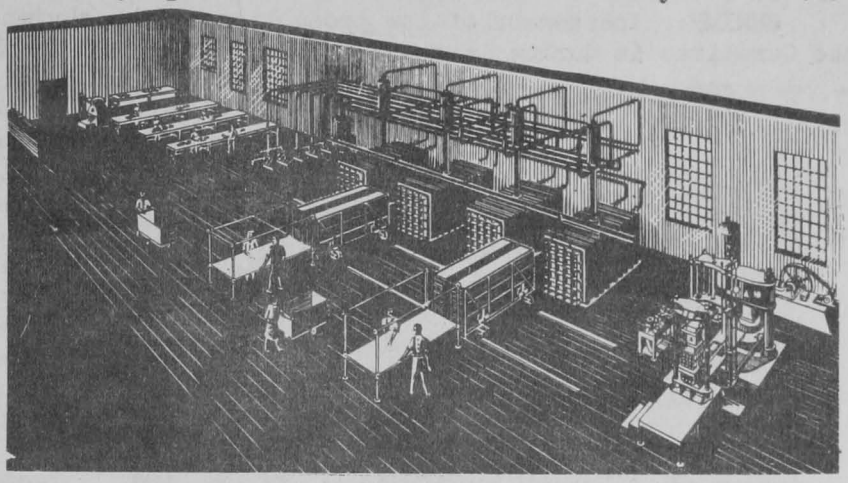
The second plant was at Stord. It is newly designed to save the soluble materials usually lost in the stickwater. When lean fish are being reduced, they are first disintegrated and then mixed with enough dried, or partially dried, fish meal to change the character of the wet raw material sufficiently so that it does not stick to the surface of the first rotary drier. This drier is an oil-fired, rotary type and is operated at a very high temperature. The material leaving this drier contains about 35 percent moisture; and about half of it is then mixed with new raw material, the proportions depending on the material being handled; and the mixture is fed back to the same drier. The other half of the discharge is fed to a second oil-fired, rotary, flame drier in which the drying is completed.

When fatty fish are being reduced, the discharge from the first drier is heated indirectly to about 200° F. and pressed. The oil is separated from the stickwater with centrifuges, and about half the stickwater and half the presscake is returned to be mixed with the incoming raw material. The remainder of the stickwater and presscake is dried in the second rotary drier.

This process, although it has the advantage of making possible the recovery of solids normally lost in the stickwater, has the disadvantage of reducing the plant capacity by about two-thirds.

Dehydration of Cod

A large part of the cod caught in Norway have in the past been dried either with or without salting. The drying is somewhat difficult to carry out in the weather prevalent on the Norwegian coast; and, although considerable labor is required, these products do not bring high prices. In an attempt to overcome some of these difficulties, one company in Aalesund had developed a dehydrated product called "pressfisk" which is now almost ready for commercial production. Similar products will also be prepared by the same method from pollock and other fish.



STANDARD DEHYDRATION AND PRESSING PLANT FOR THE PRODUCTION OF PRESSFISH FROM COD, SAITHE, HADDOCK, ETC. (NORWEGIAN COAST)

The fish are first cleaned and split, the bones and skin are removed, and the flesh is laid flat on an aluminum sheet about 8 feet long by 4 feet wide. A second aluminum sheet is placed over the fish on the first sheet. Several of the "sandwiches" so obtained are placed in the vacuum dehydrator. The dehydrator has a series of hollow plates, similar to a "Birdseye" freezer and one "sandwich" is placed between each pair of opposing surfaces of the hollow plates. The plates are then pressed together by a hydraulic jack, the dehydrator is shut and evacuated to an internal pressure of about 25 millimeters of mercury, and hot water at 194° F. is circulated through the hollow plates. The heat passes readily from the hollow plates through the aluminum sheets to the fish.

After about 6 hours, the flattened fillets are sufficiently dehydrated. They are then removed from the aluminum sheets and stacked in a dry room for a few days to allow equalization of the moisture content. Then 15-inch squares are cut from the fillets and fitted in layers into a deep, closely fitting receptacle of a hydraulic press. The fish are pressed twice: first rapidly at a pressure of about 5,000 pounds per square inch, next in a second press for about one-half hour at a somewhat higher pressure. The final block produced is approximately 15 inches square by 10 inches high. This is cut by a band saw into package-sized pieces approximately 5 x 2½ x 1 inches. The final product contains about 10 percent moisture and is said to absorb about one and one-half times its weight of water on being soaked several hours.