

FISH ROE AND CAVIAR

Several types of fish roe are canned in the United States. While a variety of fish roe food products is prepared in Europe, particularly different types of caviar, not canned in the United States, canned roe products not found elsewhere are packed here and there are indications of a wider utilization of fish roe. All types of roe products sold in sealed containers for use as food or fish bait are included under this heading.

ALEWIFE (RIVER-HERRING) ROE

Alewife or river-herring roe is canned in Maryland, Virginia and North Carolina. The canning season extends from about April 1 to May 15, depending on weather conditions. The fish are taken by trap nets. The raw material is a byproduct of the Chesapeake herring salting industry. Only the roe is canned but experimental packs indicate that the milt would also make a good canned product.

The producers estimate that about 250 fish in a thousand are "roe" fish. In the beginning of the season, this number will yield about 1 bucket of fresh or "green" roe. As the fish mature, the amount secured increases to 1½ buckets, or in a few instances 2 buckets of roe. A bucket of roe generally weighs 20 pounds and should fill one case of 24 No. 2 short (17-oz) cans or twice that number of 8 Z-short (8-oz.) cans.

The roe is brought from the saltery to the cannery filling table, where it is freed from viscera and any roe not suitable for canning is removed since all roe must be packed while fresh. Roe stained by broken gall bladders cannot be used because of the bitter flavor. Very dark or immature roe must also be discarded. If swelling or "puffing" is observed, fermentation has set in and the roe must be discarded.

The canning of roe is intermittent, that is, sufficient roe must accumulate to justify starting the canning machinery. There may be a delay of several hours while the fish are being cleaned. Fresh water is poured on top of the cleaned roe, which is then stirred gently. After a short washing, the water is drained off.

The cans are filled by hand, the packers removing any remaining bits of entrails or other foreign material which have not been removed in the cleaning or washing processes. Packers should be closely supervised to ensure thorough cleaning and draining of the roe. The presence of viscera or bloody wash water in the con-

NOTE.—[FL-87. Canning fish roe and caviar. Reprinted from Research Report 7, Fish and Wildlife Service, U. S. Department of the Interior. The complete report (366 pp.) is a reference book on commercial canning of seafoods and is obtainable from the Superintendent of Documents, Washington 25, D. C. Price 50 cents a copy].

tainer lowers the quality of the canned product. Since the roe swells when it is canned, a headspace of about $\frac{3}{4}$ inches is left in the top of the container. The amount of "green" roe filled into the can varies from 13 to $14\frac{1}{2}$ or 15 ounces by weight, the "cut-out" or drained weight after canning varies from $15\frac{3}{4}$ to $17\frac{1}{4}$ ounces for the No. 2 short can, in which the greater part of the roe is packed, and about half this weight for the 8 Z-short can. An average drained weight of 16 ounces is required by regulations of the U. S. Food and Drug Administration.

After filling, the cans are filled with hot brine from a perforated pipe. It is not the general practice to determine accurately the strength of the brine. Some canners recommend a brine of standard strength, that is, about 30° salinometer for the immature roe, decreasing to 20° for mature roe. A few packers use hot fresh water in place of brine. After brining, the cans are given a short exhaust of about 3 minutes at 210 to 212° F. In a few canneries the cans receive no exhaust.

The cans are then sealed, placed in metal can crates and processed in vertical retorts. The process varies in each cannery. No. 2 short cans are processed from 40 minutes at 244° F. (12-lb. pressure) to 60 minutes at 210° F. (10-lb. pressure). The 8 Z-short cans are generally processed 5 minutes less at the same temperature and pressure. Some canners water cool the cans immediately after processing, but others stack cool the pack in the warehouse.

During some slack period in the canning season, the cans are labeled and packed two dozen to the fiberboard carton. Demand for herring roe is almost entirely confined to the Southern coastal States. This appetizing product deserves a much wider market.

"DEEP SEA" FISH ROE

This product is the roe of groundfish, such as the cod and haddock; and is a byproduct of the trawl and line fisheries, obtained when spawning fish are caught. When the fish are cleaned, any roe is separated from the viscera and stowed in barrels in the hold, packed in ice.

At the cannery the roe is emptied into large trays with bottoms of wire mesh where it is drained and sorted. Dark colored roe and lobes of roe which may appear stale are removed. The roe must also be picked free from bits of viscera or other offal, especially gall bladders.

The cleaned roe is placed in bamboo baskets holding about 25 pounds each, and is washed in fresh water. The washed roe is ground and falls into a mixing machine. To a batch of approxi-

mately 200 pounds of roe, 40 quarts of water, in which 2 pounds of salt have been dissolved, are added and the batch is thoroughly mixed for 5 minutes. As the season advances, the roe is lighter in color and does not need as much mixing.

The mixture of roe and water drops into a reservoir tank from which it flows gradually into a smaller tank. The small tank is capped onto an evaporated milk filler which fills an average of 40 No. 1 tall cans a minute, to a net weight averaging 14 ounces. The filled cans are given a steam exhaust of about 8 minutes at approximately 200° F.

The cans are sealed automatically as they come out of the exhaust box, and drop from the seamer into can baskets. The process for No. 1 tall cans is 90 minutes and for 10-ounce flat cans 75 minutes at 240° F. (10-lb. pressure). The pack is water cooled after processing.

SHAD ROE

Shad roe is canned only in the Columbia and Sacramento River districts of the Pacific Coast. On the Columbia River the roe is obtained from shad taken by salmon fishermen, incidental to the catching of salmon, with most of the shad taken in the salmon haul seines, and, to a lesser extent, in salmon gill nets. The canning season extends from about April 1 to May 15 on the Sacramento River and from about May 1 to July 1 on the Columbia River.

The haul-seine fisheries are all within a short distance of the cannery so that fish are delivered within a very short time. The shad are usually piled in wooden fish boxes, but as a rule no ice is used. As the gill-net fishing extends over a larger fishing area, more time is required in transportation and the fish are iced. Shad taken in haul seines are usually delivered directly to the cannery. Shad caught by gill nets are delivered to buying stations in the fishing area, and later transported to the cannery.

The roe is separated from the viscera when the shad are dressed at the cannery. If the amount is not sufficient for canning, the roe may be placed in cold storage until a supply has been accumulated. The quality requirements for canning are exacting and exclude some shad roe which is considered of good quality for consumption when fresh. For canning, shad roe must be fully developed but not over-ripe. If it is too ripe, with the individual eggs ready to separate from the membrane, the canned product is watery and lacks flavor. If it is too "green" (under-ripe), the texture is too hard and flavor is also poor.

The first step in canning is to wash the roe thoroughly, removing all blood clots or veins, slime and the outer membrane. The

fine membrane enclosing the individual lobes should be kept intact. Cleaning and washing requires great care in handling. The lobes should be kept whole and unbroken as much as possible. If the canned roe is badly broken, lower quality results. The loss in cleaning and washing is about 10 percent.

The drained roe is filled into $\frac{1}{4}$ -, $\frac{1}{2}$ - and 1-pound oval cans. The $\frac{1}{2}$ -pound oval can is the size most widely used. The declared net weight is $3\frac{3}{4}$, $7\frac{3}{4}$, and $15\frac{1}{2}$ ounces, respectively. The actual weight filled in is slightly heavier. The empty cans are lined with vegetable parchment paper and the roe must be laid in evenly, so that the appearance will be attractive when the can is opened. One-fourth ounce of salt is added per $\frac{1}{2}$ -pound oval can and a piece of vegetable parchment paper is placed on top of the roe. No brine, oil or sauce is used.

The cans may be sealed immediately after filling without heat exhaust or other means of obtaining a vacuum, or the lids may be clinched loosely and exhausted for about 8 minutes at 209 to 210° F. The cans are washed and scrubbed after sealing, and stacked in coolers.

There is a wide variation in processing. Some packers on the Columbia River, sealing without exhaust, process $\frac{1}{2}$ -pound oval cans for 90 minutes at either 220° F. (3-lb. pressure) or 240° F. (10-lb. pressure). The former process is also used by packers who exhaust before canning. Those who use the low pressure cook claim that a high process gives the canned roe an overcooked flavor and poor texture. The pack is air cooled. The processes fixed by the Bureau of Cannery Inspection, Department of Public Health, State of California, are: $\frac{1}{2}$ -pound oval cans 60 minutes at 240° F. or 40 minutes at 250° F., 1-pound oval cans 85 minutes at 240° F. or 65 minutes at 250° F. (15-lb. pressure). If the packer wishes to process at lower temperatures, the regulations permit a time of 120 minutes at 230° F. for $\frac{1}{2}$ -pound ovals, and 145 minutes at the same temperature for 1-pound ovals.

STURGEON CAVIAR

Caviar is prepared from the roe of the following species of sturgeon. On the Atlantic Coast, the common sturgeon (*Acipenser oxyrinchus*); in the Great Lakes region, the lake sturgeon (*A. fulvescens*); on the Gulf Coast, the short nosed sturgeon (*A. brevirostrum*); on the Pacific Coast, the green (*A. medirostris*) or white (*A. transmontanus*) sturgeon; and in the Mississippi River valley, the shovel-nosed sturgeon (*A. scaphirhynchus*) are used. Roe from the last-named species is reported to make the poorest grade of caviar.

The sturgeon are caught in large-mesh drift gill nets similar to salmon gill nets in construction and operation, and, especially in the Columbia and Mississippi River areas, on set- or trot-lines. A few sturgeon are taken in haul seines and traps. Gill-net fishing is most effective at night and in localities where the water is not clear. As the sturgeon are bottom feeders many of the sturgeon gill nets are operated as "sunken" gill nets, just scraping the bottom.

To make good caviar, the roe of the sturgeon should be "green" or immature. Fully developed roe, in spawning or near spawning condition, makes a very inferior product. The amount of roe obtained from an individual fish varies with size, species, and locality and may run from 10 to 70 pounds.

The fish should be gutted immediately and the roe freed from intestines and other viscera. Washing in fresh water is reported to lower the quality because such roe will not cure well. Icing the roe is claimed to have a similar effect. The roe must be landed and the cure begun, as soon as possible.

The roe is placed on a work table with a portion of its surface consisting of a 1/4-inch wire mesh screen. A second finer mesh screen below this slants at a 45° angle into a large tub. Portions of the roe are rubbed lightly over the screen, so that the individual eggs are separated from the membrane and fall through the mesh onto the screen below, sliding gradually into the tub. Slime, blood and bits of membrane, drain through the second screen.

When the eggs have been drained they are mixed with salt. Caviar makers claim that the type of salt also affects the quality. In the United States "mild-cure" or "dairy-fine" salt is believed to be best but caviar makers with European experience claim that even this salt does not result in the best grade of caviar and that imported Luneberg salt should be specified. The amount of salt used varies with the training and experience of the curer, the condition of the roe and with the temperature. The average is about 8 pounds of salt per 100 pounds of roe (Hoffman; N. D.).

The cure should be mild since heavily cured roe will sell only in the cheapest trade. The curer distributes the salt as evenly as possible, then "rouses" or mixes salt and sturgeon eggs together carefully by hand. Paddles or other stirring tools are not recommended. The process of stirring is the most delicate operation in curing caviar. Only trained men of much experience can do it well. Cobb (1919) stated that both hands should be used to thoroughly mix the eggs and salt for 5 to 8 minutes, until a foam of slime appears on top of the egg mass. The mass is allowed to stand for 10 minutes and is then mixed again for a few minutes. By this time a copious brine should have formed so that the eggs

will pour readily. If the operation has been properly performed a slight noise is perceptible when the mass is stirred, like small pieces of glass rubbing against one another.

The salted eggs are transferred to trays with a fine wire-mesh bottom (1/32-in. mesh), holding about 10 pounds each. These trays are placed between cleats on slanting boards set against a wall where they remain until the brine is completely removed. Sufficiency of drainage is determined by pressing against the under side of a tray. If cracks appear on top of the mass, the trays may be removed and the cure is completed.

The sturgeon caviar is packed in small kegs to a net weight of 100 pounds. Some canners line the containers with vegetable parchment paper before filling. The kegs are not headed immediately, but set in a cool place to stand for a few days until the caviar has settled. The headspace in the top of the keg is then filled with caviar and the top set in place. The kegs are usually shipped to New York City for final packaging and processing. Caviar should be shipped and held in chill storage at 34 to 36° F. If it is packaged and hermetically sealed unprocessed, it should be held by the retailer in refrigerated showcases.

While some of the sturgeon caviar canned in this country is of domestic origin, most of the pack is made from caviar imported from the U. S. S. R. The caviar is filled into cans holding 1½ to 2 ounces, 4 ounces, and 8 ounces and "nappy" glass jars with about the same net weights. The containers are sealed in a vacuum closing machine, then given a heat process. Publications stating the process as 50 minutes at 250° F. are entirely in error. Experimental packs indicate that heating under pressure will coagulate and harden the eggs to such an extent as to make the caviar entirely inedible. Accurate data on processing are not available at present. It is reported that caviar is pasteurized for about 60 minutes at 170 to 180° F., but this has not been verified.

WHITEFISH CAVIAR

Caviar is prepared commercially in the Great Lakes region from the roe of the common whitefish. (*Coregonus clupeaformis*). The principal manufacturing center is Port Washington, Wis. About 53 percent of the domestic catch is taken with pound and trap nets, 44 percent with gill nets and 3 percent with other forms of gear (U. S. Tariff Commission, 1933).

The roe is a by-product of the marketing of fresh whitefish. The skeins of roe are separated from viscera and blood, rinsed, then separated from the enclosing membrane as described in the preparation of sturgeon caviar. In fact the process follows this

method, with the exception that as the eggs are much smaller, less time is required to absorb the salt, and allowance must be made for this in curing.

The whitefish caviar is colored in a caramel solution made from burnt sugar until it has acquired the almost black color characteristic of sturgeon caviar. It is packed in glass and tin containers of the same size as those used in marketing sturgeon caviar, and given approximately the same degree of pasteurization. The quality is usually excellent and the price is much lower than that of sturgeon caviar.

SALMON CAVIAR

Salmon caviar was originated about 1910 by a fisherman in the Maritime Provinces of Siberia, and the preparation is a modification of the sturgeon-caviar method (Cobb, 1919). This caviar has found a good market in the U. S. S. R. and other European countries, where it is known as "red caviar" to distinguish it from the sturgeon or "black caviar." Several attempts have been made to manufacture salmon caviar in the United States but only a few firms in the Pacific Northwest have been able to operate successfully on a commercial scale. Their product is marketed mostly in New York and other Eastern cities. One of the salmon canning firms operating in Bristol Bay also prepares salmon caviar, principally for export.

To be suitable for caviar, the eggs must be absolutely fresh, free from blood, of a clear color and good consistency. Large eggs do not make good caviar. Most salmon caviar is prepared from the roe of silver and chum salmon, the eggs of these species having been found to be best suited for this purpose.

The egg sac is slit and rubbed gently over a table stand with a top of half-inch mesh screen. This mesh is just large enough to let the eggs drop through, separating them from the membrane. The eggs fall onto an inclined screen of a fine wire mesh leading into a large shallow box. The eggs drain on the screen and finally slide into the box. The eggs are cured in brine testing 90° salinometer and usually made from fine mild-cured salt. The salmon eggs are occasionally stirred with a wooden paddle to ensure thorough mixing and equal absorption of brine. The brining time varies with the season, temperature and humidity; size, consistency and freshness of the eggs. The time required is believed to vary from 20 to 45 minutes. The packers determine the sufficiency of cure by noting the change in consistency of the eggs. The interior must coagulate to a certain jelly-like consistency, but the egg must not be shrunken. The eggs are dipped from the vat, placed on wire-meshed screens and drained overnight or for a period of about 12 hours.

After draining, the eggs are filled into small kegs holding about 100 pounds lined with vegetable parchment paper. The kegs are covered and allowed to stand until the eggs settle. The head space caused by settling is then filled up with more caviar, the keg headed and put in chill storage at 34 to 36° F. until shipped.

The kegs are repacked in jars and tins by large wholesale dealers in the eastern part of the United States. "Nappy" glass jars holding 2 to 4 ounces are probably the most widely used containers though salmon caviar is also packed in glass tumblers holding 4 ounces and tin cans with a net weight of 2 to 7 ounces. Tin containers are usually of the "key-open" type, inside-enamelled and are lithographed. Previous discussion on pasteurization or preservation of caviar by heat applies also to salmon caviar. Experimental packs of salmon caviar processed at temperatures between 212 and 240° F. were made absolutely inedible by processing losing color and acquiring a hard, rubbery texture.

Both glass and tin containers are carefully cleaned before use, filled to the specified net weight by hand and sealed in vacuum closing machines. To secure the maximum preservation the containers should be held at temperatures not greater than 40° F. or less than 29° F., when they may remain in good condition for a year.

SALMON EGGS FOR BAIT

The first commercial use made of salmon roe was the preparation of "bait eggs" for catching trout and other game fish. This industry began about 35 years ago. A number of firms in the Columbia River and Puget Sound districts are now engaged in packing bait eggs and find a ready market for their product.

The roe must be fresh and not too "green;" that is, the egg must have a firm consistency and separate readily from the enclosing membrane. They must also be of good size and clear in color. Each packer of bait eggs uses a process developed by himself. The method described is not used by all packers of bait eggs. However, it is known to have been used commercially and will at least serve as a basis for experimentation. The first steps in preparing bait eggs are almost identical with the first stages in the preparation of salmon caviar. The egg sacs are split open and hot water is poured over the roes which separates most of the eggs from the membrane, and the remainder are freed by rubbing over a wire mesh screen. This method is quicker than screening the entire mass but should not be used except by skilled bait egg packers, as over exposure to hot water will damage the texture of the eggs and make them unfit for use.

After draining for a few minutes, the eggs are placed in a solution of salt, sugar and coloring material. The proportions of sal

to sugar vary with different packers and may range from 1 part sugar and 3 of salt to 1 part sugar and 9 of salt. The coloring material used is one of the analine dyes in several shades of red, such as Sherwin-Williams 3-R. or Erythrosin. The curing solution will test 80 to 90° salinometer and the eggs are left until "cured." The cured eggs must have a firm consistency so that they cannot be easily stripped from the hook but must not be shrunken, hard or rubbery.

The color of the eggs depends on the strength of the dye and length of time the eggs are left in the dye-pickling brine. Some markets desire a very brilliantly colored egg, while others require a pale shade, resembling the natural color of the fresh egg. It has been the tendency among fishermen to insist that the first shade of color used for bait eggs in their particular locality is the only one that will attract fish. For a medium shade, the eggs are left in the brine about 30 minutes.

After the eggs are sufficiently colored and cured, they are drained on wire-mesh screen-bottom trays and packed in small glass or tin containers. The most popular container is a glass jar with a two-piece screw top holding 3½ ounces. The tin can most widely used is a lithographed container of the same net weight. Sometimes a solution of glycerine and preservative is added before sealing the containers, but packers of bait eggs claim that if the eggs have been properly prepared this should not be necessary. Bait eggs will remain in good condition up to a year, if kept in a cool dry place. However, if the jar is opened mold will start growing.

Preservatives are added to the curing solution, usually sodium benzoate, about 1 percent, if the eggs are to be sold in warm climates. The glycerine preservative solution may contain 5- to 10-percent formalin. The eggs will harden and turn white if the formalin solution is too strong. Formaldehyde is legally prohibited for use as a bait egg preservative in some localities on the grounds that it is poisonous to fish life. There are no scientific data to support this contention.

In addition to single eggs, "cluster eggs" are marketed. These are portions of roe with membrane and eggs adhering. They are used principally in fishing for steelhead trout. Cluster eggs are manufactured from small "green" roes, still partially undeveloped. The clusters are washed, then placed in a brine as described in the preparation of single bait eggs. Preservatives are frequently added in this brine, either formalin, hexymethylamintetramin (urotropin), or sodium benzoate.

The time required for curing is variable and is determined by testing the consistency of the eggs. As a rule it is somewhat

longer than that required for the preparation of single bait eggs. When the pieces of roe are cured, they are drained and packed dry in ½- or 1-pint glass jars. Under ordinary conditions of temperature and storage, "cluster" eggs will remain in good condition from 6 to 12 months.