

HANDBOOK OF FISHERY TECHNOLOGY

VOLUME 4

EDITOR

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V.M. NOVIKOV

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This handbook comprises five chapters. The canning technology of fish, marine mollusks and algae is described along with the technology of fish preserves and production of tin-plated and glass containers. The book provides useful information on the equipment used in the canning industry and technochemical control of conserves and preserves.

Contributors to this Volume

E.S. D'yakovskaia and A.I. Tenyakov—Production of conserves (Chapter I), Production of preserves (Chapter II), Equipment for production of conserves and preserves (Chapter III), Fundamentals of technological production control (Chapter V).

T.V. Kozlova—Metal and glass containers for canning (Chapter IV), Fundamentals of technological production control (also Chapter V).

Contents

<i>Chapter I. PRODUCTION OF CONSERVES.</i>	1
Classification of Canned Products.	1
Technological Processes Involved in the Production of Conserves	3
Production of Conserves with Natural Flavor.	20
Products canned in their own liquor.	20
Natural canned products with addition of oil.	32
Canning of ukha and fish soups.	33
Canning of fish in jelly.	47
Canning of crabs and prawns.	56
Production of Conserves in Tomato Sauce.	74
Conditions of sterilization of canned products in tin-plated cans with or without back pressure.	82
Sterilization conditions for conserves in SKO-5 glass jars with back pressure.	87
Canning of blanched herring in tomato sauce.	87
Canning of fish and fish liver in tomato sauce without prior heat processing.	87
Preparation of tomato sauce.	88
Commercial characteristics of canned products.	97
Codes for canned products in tomato sauce.	98
Production of Canned Fish in Oil.	100
Canning of smoked fish in oil.	100
Canning of dried and blanched fish in oil.	111
Conditions of sterilization of canned products in oil.	133

x Contents

Code for canned products in oil prepared from dried or blanched fish.....	138
Production of Sterilized Fish Pies and Roes.....	141
Production of Canned Preparations of Fish-Vegetables and Fish-Plant Products.....	146
Canning of fish-vegetable mixtures in tomato sauce.....	148
Canning of fish-vegetable products in oil.....	156
Canning of fish-vegetable products in marinade.....	167
Canning of fish-vegetable products in broth liquid mixtures and various sauces.....	171
Canning of fish-vegetable products with garnish.....	181
Codes for canned fish-vegetable products.....	186
Canning of Non-fish Marine Products.....	188
Canning of mussels.....	188
Canning of marine scallops.....	200
Canning of whelks.....	203
Canning of sea cucumbers.....	206
Canning of squid, octopus and cuttlefish.....	207
Canning of seaweed.....	215
Code for canned products from non-fish marine products.....	219
Chapter II. PRODUCTION OF PRESERVES.....	221
Preserves from Ungutted Fish with Spicy Salting.....	222
Preserves with Special Salting.....	232
Preserves from Dressed Fish.....	234
Preserves from Salmon.....	258
Preparation of solutions from acetic acid with different concentrations.....	259
Preserves from Non-fish Marine Products.....	262
Code of Preserves.....	265
Kinds of Waste and Defects in the Manufacture of Conserves and Preserves.....	267

<i>Chapter III. EQUIPMENT FOR PRODUCTION OF CONSERVES AND PRESERVES</i>	272
<i>Chapter IV. METAL AND GLASS CONTAINERS FOR CANNING</i>	322
Basic and Subsidiary Materials for Preparing Metallic Containers	322
Tin	322
Aluminum and aluminum alloys	337
Vignetted aluminum foil	340
Lacquering of tin plate, aluminum and other metal containers	340
Lithographic Printing on Tin Plate for Tin Containers	375
Metal Cans	394
Construction and size of cans	394
Assembled cylindrical cans	396
Forged cans	418
Technical specification of metallic cans for canned fish	435
Supply of cans to the fish canning plants	437
Equipment for making metal cans	441
Material for soldering assembled cans	444
Glass Jars	447
<i>Chapter V. FUNDAMENTALS OF TECHNOCHEMICAL PRODUCTION CONTROL</i>	462
Technochemical and Microbiological Control in the Production of Conserves.	462
Scheme for sanitary-microbiological control in production of conserves	463
Technological Control of Production of Metal and Glass Containers	470
Scheme for technological control of production of assembled and forged tin cans	470
Scheme for control of lacquering tin plate	477
Scheme for control of preparation of gelatine rolls	479
Scheme for control of printing on tin plate and aluminum....	481

xii Contents

Scheme for controlling lacquering of forged cans and lids.	484
Scheme for control of production of assembled cans on automatic machines.	486
REFERENCES	493

CHAPTER I

Production of Conserves

CLASSIFICATION OF CANNED PRODUCTS

Canned fish production depends on the large-scale destruction of most of the microorganisms under the effect of high temperature (sterilization at a temperature above 100°C) on the products, which are already packed in hermetically sealed containers. The canned products can be stored for a long time without significant changes in the quality of the product under conditions that ensure the integrity of the airtight containers and reliable protection of the inside surface of the cans from the action of the contents by means of a lacquer coating.

Fish, meat of crustaceans, mollusks and mammals as well as algae go to make up a wide range of canned products. Depending upon the preliminary processing of the raw material and canning technique the canned products are conventionally divided into several groups.

Natural canned products are prepared from dressed fish, meat of crabs and prawns and cod liver, rat-tail and scorpion fish with the addition of only a small quantity of salt. In the course of preparation of certain types of canned product (for example, from herring, scad, halibut and fish liver), hot chillies and pimento, laurel leaves and sometimes fish broth or liquid gelatin are added.

In recent years the range of this group of canned products has grown to include new products processed by the addition of small quantities of vegetable oils or spices and roots to the fish preparations. Natural canned products have high food value. They are mainly used in the preparation of the fish course, entrees, cold snacks and salads.

Canned products in tomato sauce are prepared from different kinds of fish that are first dressed, fried in vegetable oil, blanched in live steam or in oil, dried in hot air, or light smoked (sprat with tomato). The prepared pieces of fish are arranged in the cans and covered with different types of tomato sauce prepared according to various recipes. These canned products, which do not require additional culinary processing, are served as snacks.

2 *Handbook of Fishery Technology*

Particular lines of these canned products can be used for preparation of first courses and entrees.

Some of the canned preparations in tomato sauce (for example, made from cod or hake liver, Atlantic herring, perch, Baltic sprat or other fish) do not undergo preliminary heat treatment and are preserved with concentrated hot tomato sauce.

Such canned products also do not require additional culinary processing and can be used as cold snacks.

Canned products in oil are prepared from different types of fish which are first fully (whitefish, cod, sturgeon, etc.) or partially dressed (Baltic herring, sprat, sardine, vendace, small herring, etc.), presmoked and fried in vegetable oil, dried under hot air and blanched with live steam or in oil. The trunks or pieces of fish are arranged in the cans, which are then filled with vegetable oil or a mixture of vegetable oils. The canned products in oil make good snacks.

Pies and pastes are prepared from meat and liver of different fishes. The carefully ground raw material (or semi-finished product) is mixed with vegetable oil or animal fat, tomato paste, onions, condiments and sometimes groats.

The pies taste good, have uniform consistency and make very good snacks.

Canned fish products with the addition of vegetables or groats are prepared from trunks, pieces, liver and testes of fish in the form of goloubets,* cutlets, quenelles or meat balls which are first fried in vegetable oil and blanched or without heat treatment with different vegetable garnishes, legumes or groats with the addition of tomato sauce, oil and pungent marinades.

Canned products from nonfish marine products are prepared from mollusks, which include oysters, mussels of scallop, squid, echinoderms including holothurians (sea cucumbers), trepangs, sea cabbage and other kinds of raw material. The raw material is treated by frying in oil, blanching under steam or in salt solution, smokecuring, etc.

Canned products of this group are produced in a wide range in different kinds of marinades or without them. They have high food value and can be used as entrees or semi-finished products in salads and other snacks.

Among the above groups of canned products usually canned preparations of delicatessen and dietetic types are identified.

Delicatessen canned preparations are products each having its special kind of piquant taste typical of them only. Often they are characterized not so much by the fish flavor as by a particular kind of processing. Such canned products include "sprats in oil", "sardines in oil", "eels in oil" and others.

*Stuffed cabbage rolls—General Editor.

Dietetic canned products are prepared from different kinds of raw fish. The recipes and technology of preparing these canned products are, as a rule, recommended by the Institute of Nutrition of the Academy of Medical Sciences of the USSR. They are meant for persons who have to take special care of their diet. Such canned products include preparations from mollusks, sea cabbage and different species of fish.

TECHNOLOGICAL PROCESSES INVOLVED IN THE PRODUCTION OF CONSERVES¹

Washing. To remove dirt, blood residue, viscera and mucus and reduce infection by microorganisms the gutted and ungutted fish are washed in running or frequently replaced fresh water in washing machines of various designs.

The water should meet the requirements fixed for drinking water. The hardness of the water should not exceed 15°, pH 6.5-7.5, coli-titer not less than 333, number of microorganisms—not more than 100 per 1 cc of water. For washing fish clean sea water is also used. The temperature of the water used for washing fish should not be higher than 15°C. Consumption of water for washing fish varies from 2 to 7-8 m³/ton of fish.

Small frozen fish, which are used without dressing, are not washed after defrostation in water, but are immediately supplied for subsequent operations.

To avoid losses of extractable substances, washing of fish should be done rapidly to eliminate saturation of the fish tissues (especially in gutted fish) and the loss of organoleptic and technological properties of the meat associated with this.

Defrosting. The fish are defrosted in the canneries in water or in air. The process of air defrostation proceeds slowly because of the low heat conductivity of air and the fish are defrosted nonuniformly. Defrostation of fish in water proceeds more rapidly than in air; at a temperature of 10-12°C it is over within a few hours.

Fish frozen in blocks or heaps are thawed in mechanized defrosters or in water baths with removable bottom grilles (ratio of fish to water not less than 1:2) with periodic careful shaking. Defrostation is complete when the fish body becomes elastic and its internal organs can be easily separated. Upon completion of defrostation the fish are immediately taken out of the water to avoid additional extraction of water-soluble substances from

¹In the present section the technological processes described are specific to the canning industry. Cooling, transport of raw material from the place of catching to the cannery, grading by quality and the standards relating to the quality of the raw material and storage conditions were given in Vol. 1 of this handbook.

4 *Handbook of Fishery Technology*

the tissues, increase in the infection of the fish with microorganisms and acceleration of autolytic processes.

After defrosting the fish are graded: specimens, even entire catches, that do not conform to operating standards or technical conditions are discarded.

Removal of scales during dressing. The scales are removed before gutting the fish because weakening and cutting open the abdomen make this operation very difficult after dressing. The firmly set hard scales are removed on a drum-type machine or with special equipment (scalars, scrapers, etc.); in this process the integrity of the fish skin must not suffer. Loose scales (for example, in herring) can easily be removed in the process of washing the fish.

In sturgeon, scad, certain species of flatfish, after prolonged blanching of the fish (usually in water), the bony formations (scutes) are removed by hand with a knife and the sharp scales are removed in rat-tails.

After removing the scales large and medium-sized fish are dressed—the internal organs are removed without damaging the gall bladder, the peritoneal cavity is cleaned, the head is removed along with the fins, including the caudal fin. In small fish, as a rule the head and caudal fin are removed (sometimes the caudal fin is cut short, for example, in canning of sprat) and part of the viscera is removed without opening the belly.

In individual species of fish, depending upon the line of canned product, scales and bony structures (scutes and fins) may be retained as well as guts and roe or testes. A cut is made in the abdominal parts (in goby, herring, mackerel and scad). The parts of the body that can be retained in the process of dressing the fish for canning are listed in Table 1.

Depending on the order from the wholesaler or by agreement with him, canned products may be prepared from small fish without gutting (sprat and smelt).

After dressing trunks or blocks of fish fillets, cartilage, testes, roe, cut pieces of sturgeon fish, liver and trimmings, which can be used for canning purposes, are washed in running or frequently replaced water (ratio of waste material to water 1 : 3). Washed fish trunks and fish trimmings that cannot be packed whole in the cans are carefully cut into pieces of a size suitable for the size of can and rinsed in clean running water.

Presalting of the fish. Several methods of salting are in vogue.

First method: wet salting. The fish is presalted in salt solution or a vinegar-salt solution with a density of 1.18-1.20 g/cm³ at as low a temperature as possible. The flesh of presalted fish should contain 1.2-2.0% salt. In the course of curing in vinegar-salt solution the concentration of acetic acid should be 1-3%. This method has the following shortcomings: need for vast, relatively complex equipment (baths and containers made of stainless steel, concrete baths, salt concentrators, pumps for transferring salt solution

Table 1

Canned products						
Body parts that can be retained in fish dressing	1	2	3	4	5	6
		natural	in tomato sauce	fish-vegetables	in oil	
					smoked fish	fried fish in oil
Scales		halibut, small scad, mackerel and salmon	cod, flatfish, goby, capelin, salmon, vendace and Black Sea mackerel	cod, flatfish, goby and capelin	small herring, Baltic herring, sprat, anchovy, vendace, smelt, capelin, flatfish, halibut, cod, haddock, saithe, burbot, goby, garfish, mackerel, eel and Pacific saury	cod, flatfish and goby
Cartilage		—	common sturgeon, medium-size bastard sturgeon, starlet and sevruga of all sizes	—	—	—
Fins, except caudal fin		in small fish with body size not exceeding 14 cm,	in small fish with body size not exceeding 14 cm	in small fish except pectoral fin, in goby with body	in small herring, Baltic herring, vendace except	—

(Contd.)

1	2	3	4	5	6
	Pacific saury as well as herring, mackerel and scad with machine dressing	(except river ruff and perch), garfish, Pacific saury, scad, polar cod, capelin as well as small burbot (size exceeding 30 cm), and mackerel, scads and herring after mechanized gutting	size not exceeding 14 cm, in Capelin and herring gutted on mechanized lines	with body size not exceeding 14 cm	
Fins including caudal fin	—	in anchovy, sprat, sardelle, and smelt with body size not exceeding 10 cm	in small-size fish having body size exceeding 10 cm	in Baltic herring, sprat, anchovy, scad with body size not exceeding 10 cm	in small-size fish—smelt, Baltic herring, vendace, small herring, scads, picarel, roach, Black Sea mackerel, Siberian dace and northern navaga
Guts	—	in anchovy, sprat, sardelle and smelt with body size not exceeding 10 cm	—	small herring, Baltic herring, sprat and smelt with body size not exceeding 14 cm	—
Roe and testes	—	in flatfish, river	in flatfish, river ruff,	in flatfish, and	in flatfish, Baltic

	ruff, Baltic herring, smelt, European vendace, Pacific saury, sardines as well as small fish with body size not exceeding 14 cm	small fish with body size not exceeding 10 cm	river ruff	herring, ruff and Pacific smelt
Heads	—	in sprat, sardelle, and smelt of size not exceeding 10 cm	—	—
Partial cutting of abdomen	in goby as well as mackerel, scad and herring after machine gutting	—	in goby and machine-gutted herring	—
Scutes	—	in small-size Black Sea scad with body size not exceeding 11 cm	—	—
Scales	cod, flatfish, goby, capelin and Pacific saury	—	scads and mackerel	sprat and Baltic herring (presence of individual scales)
Cartilage Fins, except caudal fin	—	in sardine	in mackerel, scad, herring in mechanized gutting	in sprat and Baltic herring
	in small-size fish with body size not exceeding 14 cm, goby (except pec-	in Baltic herring and sprat	—	—

(Contd.)

1	2	3	4	5	6
	total fin), garfish, herring, mackerel, scad (with gutting on mechanized line) Pacific saury and Eb's sardinella in small-size fish with body size not exceeding 10 cm in individual specimens of Pacific saury, Eb's sardinella	—	—	—	in sprat of I grade, Baltic herring and sprat in Baltic herring and sprat
Fins including caudal fin					
Guts		in individual specimens of sardine (residual part of intestines)	in Baltic herring and sprat	—	
Roe and testes	in flatfish, river ruff, small-size fish with body size not exceeding 10 cm, in individual specimens of Pacific saury and Eb's sardinella	in sardine	in Baltic herring	—	in Baltic herring and sprat
Heads		—	—	—	—
Partial cutting of abdomen	in herring, mackerel, scad in mechanized gutting and Eb's sardinella	—	—	in herring, mackerel and scad in mechanized gutting	in smoked sprat and Baltic herring

Note: In scad and mackerel of a size not exceeding 26 cm the dorsal fins are removed in the preparation of any kind of canned product.

and filters to clean it, mechanism for cooling of salt solution); complexity of controlling concentration and temperature of the salt solution, size of fish pieces or trunks, fat content of the fish raw material; higher consumption of salt than in other methods of salting; higher infection by microorganisms because of difficulties of maintaining sanitary conditions under increased humidity in the processing plant and of maintaining cleanliness of water used for washing; additional space requirement to store fish for drainage of salt solution following presaltation.

Second method: dry salting. Clean salt is deposited right in the cans, which makes it possible to mechanize the operation and avoid all the shortcomings of wet salting. Ground salt of grade No. 2 is used with a moisture content not exceeding 0.5%. The rate of salt addition is calculated on the basis of the capacity of the containers.

Third method: is salting by the salt in the sauce. The proportion of salt depends upon the ratio between the weight of the solid fraction of canned material and the weight of the preserving liquid. The salt content of the finished product should correspond to the requirements of the standards or technical conditions. This method of salting is most commonly used in the production of canned preparations in tomato sauce. When salted tomatoes are used the quantity of dry salt is correspondingly reduced to obtain the standard salt content for the canned preparations.

Heat treatment of raw material. The purpose of heat treatment is to change (thicken) the consistency of the fish meat, enhance the food value of the finished product and impart a certain definite taste, quality and marketable outer appearance.

The method selected for preliminary processing of the fish depends upon the type of fish and line of product being prepared. The following methods of preliminary heat treatment are used: blanching in boiling water, in salt or acetic acid-salt solution, in vegetable oil at a temperature of 100-120°C, blanching with live steam at a temperature of 95-98°C; drying under heated air at a temperature not exceeding 100°C or cooking at a temperature of 80-140°C; smoking at a temperature of 80-120°C; frying in vegetable oil at a temperature of 140-160°C.

Packing fish and sealing cans. The prepared fish or other items of raw material are arranged in clean tins or glass jars. The tin containers are washed with water at a temperature of 60°C and treated with live steam, and glass jars are washed with alkali solution after preliminary heating in water at a temperature of 40-45°C. The temperature of the alkali solution should be 80-85°C. They are then washed in water at 90-95°C, after which they are sterilized with live steam at 102-110°C. Dirty or recycled containers are first treated with caustic soda solution at 30-35°C for 10 minutes and a solution of bleaching powder containing nascent chlorine (not less than 100 mg to 1 liter of solution). Recycled glass jars are also washed in a solution