*JOURNAL OF THE SCIENTIFIC AGRICULTURAL SOCIETY OF FINLAND*
*Maataloustieteellinen Aikakauskirja*
*Vol. 50: 361–371, 1978*

# On the suitability of roach, perch, vendace and whitefish for canning in small scale canning stations

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**Abstract.** The suitability of roach *(Rutilus rutilus)*, perch *(Perca fluviatilis)*, vendace *(Coregonus albula* L.), and whitefish *(Coregonus sp.)* for canning in small scale canning stations was tested. Various pretreatment methods and processing conditions were evaluated for different fish species. Processing equipment suitable for small scale canning stations was developed in the course of this study. The keepability of the canned products was followed by physical, organoleptic and microbiological determinations during a period of 18 months.

The roach, vendace and whitefish preserves were of the types »canned fish in tomato sauce» and »canned fish in oil and its own juice» and the perch preserves of the type »canned fish in brine». Roach, vendace and whitefish were salted by immersing into 21 % brine for 4–25 minutes depending on the size of the fish and preheated by smoking at 90° C for 60–120 minutes. Products of good quality were obtained from whitefish which was dried by cooking in oil at 120 °C for 3 minutes instead of smoking. The perch were cooked in 3 % and 4 % brine for 15–20 minutes depending on the size of the fish. The best time and temperature combination for the aimed F value 10 and for a product of good quality was 60 minutes at 115° C when using rotation.

In organoleptic evaluation all the canned products were judged to be of good quality and there were no significant changes in appearance, texture, taste or aroma during 18 months' storage at room temperature. No microbial growth or swelling of the cans was detected during storage. Use of frozen raw material in canning whitefish had no detectable effect on the quality of the final product.

## Introduction

The total catch of Finnish inland fishing in 1976 was assumed to be about 22 000 tons, 4 000 tons of which were vendace, 5 100 tons perch, 1 000 tons whitefish and 3 000 tons unassorted other freshwater fish. The amount of non-utilized fish was assumed to be some 25 000 tons per year, consisting of about 5 000 tons of vendace, about 4 000 tons of *Coregonus*-species and of about 16 000 tons of perch, roach and other species of fish (ANON 1976). Notable amounts of fish and fish products for human consumption and for feed are annually imported to Finland. In 1975 imports of canned fish products totalled 4 500 tons, the selfsufficiency being only 27 %.

Because of their small size and bony flesh a great amount of the non-utilized fish species have been upgraded as human food. During the last few years the home canning of roach, perch and vendace has become popular especially in Eastern and Northern Finland. However, when such products are marketed they may cause health hazards for the consumers.

The purpose of this study was to find the optimal conditions for the canning of roach, perch, vendace and whitefish in small capacity canning stations which are considered to be the best alternative for home canning and the best means for increased utilization of the fish species mentioned above. Processing plants built for the handling of 50—100 tons of fish per year are considered small capacity canning stations. These stations should be equipped with chill and frozen storage, canning equipment and other facilities for proper handling of fish.

## Materials and methods

*Fish material*

Vendace (10—30 g), whitefish (200—300 g) and big perch (200—300 g) were bought from Kontio & Kontio, Helsinki, big roach (200—300 g) from Kalayhtymä Oy, Taivassalo, small roach (20—50 g) from a fisherman at Lake Bodom in Espoo, and small perch (20—50 g) from the fishing experiment station in Evo, all in South Finland. The fish were transported to the Department of Food Chemistry and Technology by unrefrigerated motor vehicle and processed immediately. Part of the whitefish were stored frozen in plastic bags at —20° C before processing.

*Canning*

Roach, vendace and whitefish were scaled and qutted by hand and washed under cold running water. Because the scaling of perch is difficult the scales were not removed until after precooking. Before precooking, the slime coating of the perch was washed away carefully with cold water, heads and intestines were removed and the fish were washed under cold running water.

*Salting*

To give a tasty salt flavour to the canned products the fish were salted after gutting. The optimum salting conditions were selected on the base of organoleptic evaluation of the final canned products. Roach, vendace and whitefish were salted by immersing in wire baskets into a strong brine. The brine concentrations tested ranged from 15 % to 21 %. The brine was cooled to 15° C before use because in cold brine the salt was assumed to penetrate the various parts of the fish more evenly than in brine at room temperature. To obtain a uniform salt content in every part of the fish the brine and fish were stirred manually with a ladle at short intervals during brining. Perch were salted by precooking in a dilute brine which was used further as sauce in the canned product instead of oil or tomato sauce. The salt concentration of the brine varied from 3 % to 4 %.

*Predrying*

The moisture contents of the fish species used in this study are high and to avoid excessive release of liquid in the can during heat processing the moisture contents were reduced by preheating the fish before packing into the cans. The usual methods for reducing the moisture content of raw fish are precooking in steam, oil or dilute brine and smoking, the latter being the most common method in the Scandinavian countries. In this study smoking was used for roach, vendace and whitefish, cooking in oil for whitefish and cooking in dilute brine for perch. The optimum preheating times and temperatures were selected on the base of organoleptic evaluation of the final products. The salted fish were left to drip on screens for 5 minutes so that the skin dried a little. Roach, vendace and whitefish were smoked by the hot smoke method on screen trays in an electrically heated laboratory-size smoking equipment at 90° C. The smoke was generated with sawdust. Perch were precooked in dilute brine as described above, after which the scales and skin of the fish were removed.

*Sauces*

The standard sauces added into the cans were selected on the base of preliminary studies and prepared from commercial ingredients: table oil, peanut oil, tomato paste, onions, carrots, cabbage, spices and salt. No further studies were made to optimize the taste of the products by using, for example, different spices. For canned products in oil, table or peanut oil was added into the cans. The tomato sauce for canned roach and vendace was prepared by homogenizing water (1 500 g), tomato paste (1 000 g) and table oil (500 g) in a Waring blendor. For canned whitefish in tomato sauce the heads of the fish were cooked in water and the liquid obtained after filtering was added into the sauce containing tomato paste (500 g), cooking water of the fish heads (750 ml), vegetable pureé (400 g), sugar (100 g), oil (80 g) and vinegar (90 g). For the vegetable pureé, cabbage (150 g), carrots (70 g), onions (400 g) and water (140 ml) were cooked for one and a half hour after which they were homogenized in a Waring blendor. The cooking brine of the perch was used as the sauce of the canned perch products and the spices peppercorn, dill, thyme and bay leaves were added into the cans.

*Packing into cans*

Small fish were packed into cans whole and big fish were cut into pieces before packing. A can of standard size 60 × 99 mm was used into which 300 g of fish and 100 g of sauce were packed. After filling, the cans were seamed with Lanico »V 10 Automat» seaming machine (Lanico-Maschinenbau Otto Niemsch KG, Braunschweig, FRG).

*Autoclaving*

Heat processing experiments were made with the food processing autoclave of Santasalo-Sohlberg which is equipped with a rotating can frame. Some can lots were sterilized in a Sterilomat autoclave (MKT-Tehtaat, Helsinki, Finland)

designed in collaboration with our Department in the course of this study for small capacity canning stations. Three processing temperatures, 110° C, 115° C and 120° C, were tested and the processing time was adjusted so that the lethal value was F = 10. The temperature of the can contents was registered during heat processing by Temperature Recorder type Z 9 CT-F (Elektro-laboratoriet Ellab A/S, Copenhagen, Denmark).

*Sterility control and keepability tests*

After heat processing three cans of each lot were stored at 35° C for 14 days for control of sterility. Microbiological examinations were made after this storage period.

Using the optimal pretreatment and processing conditions for the different fish species, test lots were prepared for testing their keepability at room temperature for 18 months. Microbiological determinations, organoleptic evaluation and pH measurements were made at 6 months' intervals during storage.

*Analytical methods*

The moisture contents of raw, brined, smoked and precooked fish and of canned products were determined by drying a minced weighed sample in an oven at 105° C for 20 hours and weighing it after cooling in a desiccator. The moisture content was calculated as follows:

$$\text{moisture content } \% = \frac{\text{moist weight g} - \text{dry weight g}}{\text{moist weight g}} \times 100$$

The salt contents of brined, smoked and precooked fish and of canned products were determined by a modification of the method described by ANTONACOPOULOS (1973). The sample was homogenized in an Ultra-Turrax homogenizer (Janke & Kunkel KG TP 18/2 20 000 r/min.). About one gramme of the homogenized sample was weighed accurately into a 250 ml erlenmeyer glass, 50 ml of distilled water was added and the sample was heated to boil. After some minutes of boiling it was cooled to room temperature and titrated with 0.1 N $AgNO_3$ solution using a 10 % $K_2CrO_3$ solution as indicator. The salt content was calculated as follows:

$$NaCl\,\% = \frac{\text{ml } 0.1\ AgNO_3 \times 58.5 \times 0.1}{\text{weight of sample mg}} \times 100$$

The pH values of canned products were measured with Radiometer pHM 26 meter by immersing the electrode into the sample homogenized in the above Ultra Turrax.

The ash content of roach was determined by weighing about 5 g of dried minced sample into a weighed ashing dish and igniting it at 550° C in a muffle oven to constant weight. After cooling in a desiccator it was weighed and the ash content was calculated as follows:

$$\text{ash content } \% = \frac{\text{weight after igniting g}}{\text{moist weight g}} \times 100$$

The amount of protein in roach was determined by the Kjeldahl method (SCHORMULLER 1967) with Tecator Kjeltec I apparatus (Tecator Instruments Ab, Helsingborg, Sweden).

The crude fat was extracted from dried minced roach with petroleum ether in a Soxhlet apparatus.

*Microbiological methods*

After sterilization three cans of each lot were kept for two weeks at 35° C for sterility control. After this pre-incubation the amounts of aerobic and anaerobic, mesophilic and thermophilic sporeformers and non-sporeformers were determined by the methods of SHARF (1966) and SPECK (1976). For keepability tests two sample cans were pre-incubated and examined in the same way at 6-month intervals.

*Organoleptic evaluation*

The appearance, texture, taste and aroma of the canned products were evaluated by triangle test and ranking test by a taste panel of eight judges. In the keepability tests the appearance, texture, taste and aroma of the products were evaluated in scoring tests after storage at room temperature for 2 weeks and 6, 12 and 18 months. The scores ranged from 4 to 1, 4 being the best and 1 the poorest alternative.

## Results

*Composition of roach*

The composition of roach determined in this study and the compositions of perch, vendace and whitefish reported in the literature (SOUCI et al. 1969, TURPEINEN 1975) are presented in table 1.

Table 1. Composition of roach, perch, vendace and whitefish as percentage of moist weight.

| Fish species | Water % | Protein % | Crude fat % | Ash % |
|---|---|---|---|---|
| Roach | 80.3 | 16.7 | 1.4 | 1.2 |
| Perch | 79.5 | 18.4 | 0.8 | 1.3 |
| Vendace | 78.0 | 18.0 | 2.5 | 1.5 |
| Whitefish | 77.7 | 17.8 | 3.2 | 1.1 |

*Salting of the fish*

In the salting of roach, vendace and whitefish the salting time was the shorter the stronger the brine was. The concentration of 21 % proved to be suitable. The brining times required for obtaining a pleasant salt flavour in the final products are presented in table 2.

Table 2. Optimum brining times of roach, vendace and whitefish in 21 % brine at 15° C and the salt contents of the final products.

| Fish species | Brining time minutes | Salt content of final product % |
|---|---|---|
| Roach, 20— 50 g | 4 | 1.7—1.8 |
| Roach, 200—300 g | 25 | 1.6—1.7 |
| Vendace, 10— 30 g | 3 | 1.7—1.9 |
| Whitefish, 200—300 g | 25 | 2.1—2.3 |

Cooking in 3 % or 4 % brine for 20 minutes was found to be the best cooking method for big (200—300 g) perch, while cooking for 15 minutes in 3 % brine was suitable for small (20—50 g) perch (Table 3). In organoleptic evaluation no significant differences were found between the canned products prepared from big perch precooked in 3 % and in 4 % brine.

Table 3. Optimum cooking times for perch in 3 % and 4 % brine and the salt contents of the final products.

| Size of fish | Brine strength % | Cooking time minutes | Salt content of final product % |
|---|---|---|---|
| 20— 50 g ..... | 3 | 15 | 2.0—2.1 |
| 200—300 g ..... | 3 | 20 | 1.5—1.6 |
| 200—300 g ..... | 4 | 20 | 2.0—2.2 |

*Preheating of the fish*

To reduce the moisture content of small (20—50 g) roach and vendace (10—30 g) by 10—13 % the fish had to be smoked for 60 minutes at 90° C. The moisture content of smoked roach was 67—69 % and of smoked vendace 66—68 % (Table 4) and in the canned products the texture of the fish was firm. Longer smoking times were required for big (200—300 g) roach and whitefish. The moisture content of the smoked fish after 120 minutes' smoking was over 70 % (Table 4). In spite of this only slight amounts of liquid were released from the fish during heat processing in the cans and the fish were whole and firm in the canned product. If longer smoking times were used the smoke flavour became too strong and gave a bitter taste to the canned products.

Table 4. The optimum smoking times for roach, vendace and whitefish at 90° C and the moisture contents of the smoked fish.

| Fish species | Smoking time minutes | Moisture content of smoked fish % |
|---|---|---|
| Roach, 20— 50 g | 60 | 67—69 |
| Roach, 200—300 g | 120 | 71—73 |
| Vendace, 10— 30 g | 60 | 66—68 |
| Whitefish, 200—300 g | 120 | 70—72 |

After 3 minutes' cooking in table oil at 120° C the moisture content of whitefish was 73—74 %. Prolonging of the cooking time to 5 minutes reduced the moisture content by 1 percent but the fish became soft and further handling was difficult.

Precooking for 3 minutes was therefore considered to be the most suitable. In the organoleptic evaluation the texture of the final product was judged to be good when the fish were packed in tomato sauce but a little too soft when packed in oil.

Perch were precooked in connection with salting in 3 % or 4 % brine for 20 minutes (big perch) or 15 minutes (small perch), as described above. The moisture content decreased from about 80 % to 71—73 % during precooking. The perch were relatively soft and tended to break into pieces when the skins with the scales were removed. In the final product the fish were soft and broke up on being removed from the can.

*Heat processing*

Heat processing experiments were made with all the different types of canned products at 110° C, 115° C and 120° C in the food processing autoclave of Santasalo-Sohlberg. In the Sterilomat autoclave the experiments were made at 115° C. The species and size of fish and the type of sauce had no effect on the heating rate of the can contents during processing. In Santasalo-Sohlberg autoclave the effect of rotation was clear but in Sterilomat the effect was slight. In Santasalo-Sohlberg autoclave the processing time required for getting the desired F value was at 115° C twofold when processing without rotation as compared to the rotatory processing. Owing to the shorter total processing time the rotation technique was used in the further experiments. The processing time required for an F value of about 10 was 60 minutes at 115° C or 30 minutes at 120° C (Table 5). The maximal automatically controlled processing time of the Santasalo-Sohlberg autoclave was 100 minutes, which was not long enough to give F value 10 at 110° C, the value being 5.3 after 100 minutes heating at 110° C (Table 5). In Sterilomat autoclave the F value 10 was obtained after 45 minutes' heating at 115° C (Table 5).

The bones of small fish were soft and undetectable after processing at any of the three temperatures while those of big fish were still rather hard after 30 minutes heating at 120° C but softened during 60 minutes at 115° C. Therefore the cans for keepability tests were processed for 60 minutes ar 115° C.

Table 5. Processing times required for getting F value 10 at 110° C, 115° C and 120° C in Santasalo—Sohlberg autoclave and at 115° C in Sterilomat autoclave.

| Type of autoclave | Processing temperature °C | Processing time minutes |
|---|---|---|
| Santasalo—Sohlberg | 110 | 100*) |
| » | 115 | 60 |
| » | 120 | 30 |
| Sterilomat | 115 | 45 |

*) F value was 5.3.

*Effect of frozen raw material on the quality of canned whitefish*

The moisture content of frozen whitefish after thawing and preheating was 1—2 % lower than the moisture content of fresh whitefish. In the final product the fish were a little drier and firmer than in those prepared from fresh fish. Frozen storage of the raw fish did not affect the taste and the aroma of the canned product.

*Canned products*

The moisture and salt contents and the pH values of the canned products are presented in table 6. In organoleptic evaluation the appearance, texture, taste and aroma of the products were judged to be good or excellent with the exception of the oilcooked whitefish packed in oil and of the perch packed in its cooking brine, in both of which the texture of the fish was quite soft. The cans did not swell during two weeks' pre-incubation at 35° C and no growth was found in microbiological examinations.

Table 6. Water and salt contents and the pH values of the canned fish products.

| Canned product | Water content % | Salt content % | pH |
|---|---|---|---|
| Small roach in oil and its own juice | 50.8 | 1.69 | 6.20 |
| Small roach in tomato sauce | 73.8 | 1.87 | 5.85 |
| Big roach in oil and its own juice | 58.9 | 1.70 | 6.31 |
| Big roach in tomato sauce | 69.9 | 1.75 | 5.80 |
| Small perch in its cooking brine | 80.2 | 2.08 | 6.70 |
| Big perch in its cooking brine (3 %) | 78.8 | 1.70 | 6.55 |
| Big perch in its cooking brine (4 %) | 79.7 | 2.25 | 6.40 |
| Vendace in oil and its own juice | 52.7 | 1.83 | 6.39 |
| Vendace in tomato sauce | 71.6 | 1.87 | 5.93 |
| Whitefish in oil and its own juice, precooked in oil | 56.5 | 2.12 | 6.46 |
| Whitefish in tomato sauce, precooked in oil | 75.5 | 2.21 | 5.83 |
| Whitefish in oil and its own juice, smoked | 59.3 | 2.07 | 6.03 |
| Whitefish in tomato sauce, smoked | 71.2 | 2.18 | 5.72 |

*The keepability tests*

In organoleptic evaluation only slight or no changes in taste, aroma, apperance or texture of the canned products were observed during storage at room temperature and all the products were judged to be of good quality after 18 months' storage.

The cans did not swell during storage or during pre-incubation at 35° C. No aerobic or anaerobic mesophilic or thermophilic sporeformers or non-sporeformers were found in the cans. The pH values did not change during storage.

## Discussion

According to the results of the present study, canned products of acceptable quality and good storage keepability can be prepared from roach, perch, vendace and whitefish. The higher moisture content of these fish species as compared to the species generally used in the fish canning industry, such as sardines, salmon and herring, may cause texture problems in the final products. Reduction of the moisture content by precooking in brine or oil or by smoking proved to have a beneficial effect upon the texture of the fish in the final products. LANTZ (1966) has reported that the canning of several Canadian species of freshwater fish raw presented a texture problem related to the release of liquid from the flesh during the sterilization process and that the texture problem was less pronounced with whitefish than with other species. In this study precooking of small perch in brine for 15 minutes and precooking of whitefish in oil for 3 minutes did not eliminate the texture problem completely. After precooking the fishes were so soft that they were difficult to handle and to pack into the cans and they broke into pieces easily, which affected the appearance of the canned produet. According to LANTZ (1966), blanching has no effect on the amount of free liquid in the sterilized product and cooking in oil affects the appearance of the final product by causing ruptures in the skin of the fish.

Use of whitefish kept in frozen storage at −20° C for 3 months as raw material did not affect the quality of the canned product and no significant differences were detected by triangle test when the products prepared from frozen fish were compared with those prepared from fresh fish. In products made from frozen whitefish the texture of the fish was a little former and drier than in products made from fresh fish. GRAVEN and DASSOW (1952) have obtained the same result with Pacific salmon. Norwegian tests have shown that fat and lean brisling *(Clupea sprattus)* may be kept frozen at −35 °C for 11−13 weeks before canning and that canned products are of comparable quality to those made from fresh fish (ANON. 1952, MATHIESEN 1954).

Finnish freshwater fish, especially roach and perch, are often discarded because of the numerous small bones in the flesh. However, the bones became soft and undetectable in both small and big fish during processing for 60 minutes at 115° C, which treatment was necessary for attaining the desired F value 10 when using Santasalo-Sohlberg autoclave equipped with rotating can frame. In Sterilomat the heating time required for F value 10 was shorter, only 45 minutes, but the total processing time was longer than in Santasalo-Sohlberg autoclave because of the longer warming time of the retort water to the processing temperature in Sterilomat. There were no significant differences in appearance, texture, taste or aroma between the products processed in the two autoclaves mentioned. The size of the fish, the type of the sauce and the fish species did not affect the warming of the can contents.

According to the taste panel the taste and the aroma of the canned products were good or excellent and did not change during 18 monts' storage at room temperature. The texture of the fish in canned perch precooked in brine and in canned whitefish precooked in oil was a little too soft, but in the other

products the fish were firm. No microbial growth was found in the cans during storage, which proves that the heat processing used had been strong enough to destroy the microbes and their spores in the can contents.

The canning of fish in small scale canning stations seems to be the only alternative for areas with limited fish resources or poor transportation possibilities for fish. It can be assumed that in addition to the fish species examined in this study several other species could be used as well.

*Acknowledgement.* This research has been sponsored by the Foundation for Research of Natural Resources in Finland.

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Ms received September 14, 1978.

SELOSTUS

# Särjen, ahvenen, muikun ja siian soveltuvuudesta täyssäilykkeiden valmistukseen piensäilöntäasemilla

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Tutkimuksessa selvitettiin särjelle, ahvenelle, muikulle ja siialle soveltuvat esikäsittelymenetelmät sekä riittävän sterilointitehon aikaansaamiseksi tarvittavat kuumennusolosuhteet. Sterilointikokeet tehtiin elintarvikekemian ja -teknologian laitoksella olevalla Oy Santasalo—Sohlberg Ab:n elintarvike-autoklaavilla ja piensäilöntäasemien käyttöön kehitetyllä Sterilomat-autoklaavilla. Säilyvyyskokeissa valmisteiden laatua seurattiin aistinvaraisin ja mikrobiologisin menetelmin sekä pH-mittauksin.

Särki-, muikku- ja siikatäyssäilykkeet olivat tyyppejä »kalaa tomaattikastikkeessa» ja »kalaa öljyssä ja omassa liemessään» ja ahventäyssäilykkeet tyyppiä »kalaa suolaliemessä». Sopiviksi esikäsittelymenetelmiksi särjelle, muikulle ja siialle osoittautuivat suolaus 21 %:sessa suolaliuoksessa 3—25 minuutin ajan kalan koosta riippuen ja sitä seuraava savustus 90° C:n lämpötilassa 60—120 minuutin ajan. Savustuksen asemesta siiat voidaan keittää öljyssä 120° C:ssa 3 minuutin ajan. Ahvenen esikäsittelymenetelmänä käytettiin keittoa 3 %:sessa tai 4 %:sessa suolaliemessä 15—20 minuutin ajan kalan koosta riippuen. Kalojen keitinlientä käytettiin ahvensäilykkeiden liemenä.

Kalalaji, kalan koko ja käytetty kastike eivät vaikuttaneet säilykkeen lämpenemisnopeuteen sterilointikokeissa käytetyissä autoklaaveissa. Laadultaan parhaat säilykkeet saatiin steriloimalla tölkkejä 60 minuutin ajan 115° C:ssa Oy Santasalo—Sohlberg Ab:n autoklaavissa ja 45 minuutin ajan 115° C:ssa Sterilomat-laitteessa rotaatiota käyttäen. Tällä sterilointikäsittelyllä myös saavutettiin haluttu F-arvo 10.

Kaikki erityyppiset säilykkeet arvioitiin maultaan, hajultaan, rakenteeltaan ja ulkonäöltään hyviksi tai erinomaisiksi eikä niiden laadussa tapahtunut muutoksia 18 kuukauden varastoinnin aikana huoneenlämmössä. Säilyvyyskokeiden aikana ei havaittu tölkkien pullistumista eikä säilykkeistä löydetty mikrobeja.