Canned Red Hake and Pollock

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Development of Products from Underutilized Species of Fish: Booklet 9

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DEVELOPMENT OF PRODUCTS FROM UNDERUTILIZED SPECIES OF FISH

9. CANNED RED HAKE AND POLLOCK

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ABSTRACT

Red hake and pollock, like other members of the cod family, contain an enzyme, trimethylamine oxidase, which reduces their refrigerated and frozen shelf life. Since enzymes are inactivated by heat, canning these fish seemed a logical method of preservation.

By the evaluation of a number of precanning treatments, a product which was visually and organoleptically acceptable and had an acceptable level of can drip was produced. The precanning method includes precooking by steam or water, adding one percent salt and five percent vegetable oil, and exhausting to 77°C (171°F) or vacuum sealing before canning.

DEVELOPMENT OF PRODUCTS FROM UNDERUTILIZED SPECIES OF FISH

9. CANNED RED HAKE AND POLLOCK

INTRODUCTION

Red hake (Urophycis chuss) is not a high quality fresh or frozen fish because, like all gadoid fish (the cod family), it contains an enzyme called trimethylamine oxidase. When refrigerated, this enzyme breaks down trimethylamine oxide (TMAO) in the flesh to form trimethylamine, which has a characteristic "fishy" odor. In frozen storage, the enzyme breaks down TMAO to form dimethylamine and formaldehyde, which toughen the fish and produce a cottony texture. This has been documented by many researchers (Yamada and Amano, 1965; Castell et al., 1968, 1971; and Dingle and Hines, 1975). Cooking, however, destroys this enzyme, and even heating to 80°C (176°F) is effective (Lall et al., 1975). It seems logical, therefore, to can the fish instead of freezing it as a means of long-term preservation. Consumers are accustomed to buying canned tuna and salmon, and the introduction of another variety of canned fish should be no problem, especially since the price of tuna and salmon continues to rise.

Background

This publication includes the results of our experiments on the canning of red hake.

A short study follows in the canning of pollock (Pollachius virens) which is also a gadoid fish with the same problems of

instability during frozen storage, although not to so great an extent. This fish, however, does not have the problem of the mushy, soft texture in the fresh fish that is found in red hake.

In preliminary testing of the product, the following problems became apparent to us: (1) The amount of juice (cookout) in the cans after processing, (2) the texture of the fish, and (3) the number and size of the bones. In relation to the last problem, although bones and skin are accepted by the consuming public in canned salmon and sardines, in canned tuna they are not. Judging by the comments of our taste panel during the process of development of the product, canned red hake is classed with tuna, with regard to bones and skin--they are definitely not desirable. Canned pollock has the same problems except for texture; it is a much firmer fish than red hake.

COOKING AND CANNING PROCEDURES

Treatment of fish before cooking

The red hake and pollock were obtained from a dealer in the Boston area and were transported (iced) to Ithaca by truck. Upon arrival, the fish was headed, gutted, and thoroughly washed, and the skin was removed. The fish was then (1) treated by soaking in a three percent salt solution, with or without three percent phosphate (FP-88E, a blend of phosphates, salt, and sodium erythorbate intended for soaking fish [Stauffer Chemical Co., Westport, CT 06880]); (2) stored on ice; or (3) packaged in Cryovac bags and frozen at -23°C (-10°F) for later use, as described below. Fish that were held in a soak solution or on ice were always

stored in a walk-in cooler at 2-3°C (33-34°F), and were held at room temperature as short a time as possible during the cleaning operations. Yield of red hake after heading, gutting, and scaling averaged 65 percent; after heading, gutting, and skinning, 50 percent. These yields will vary with the size of the fish and the skill of the workers.

Some of the fish (as noted in the individual experiments) were soaked before cooking in either a 10 percent brine for one hour or three percent salt and three percent FP-88.

Precooking methods

We used the following procedures for precooking the filleted red hake:

1. Bake: The fish were placed on a rack in a shallow pan and baked at 177°C (350°F) for 10 minutes per inch of maximum thickness.
2. Steam: The fish were placed on a rack in a covered container and cooked over boiling water for 10 minutes per inch of maximum thickness.
3. Boil: The fish were wrapped in cheesecloth and gently boiled in water for 10 minutes per inch of maximum thickness. After cooling sufficiently to handle, the fish meat was separated from the bones and packed into "tuna fish size" cans (307 x 113).

Other lots were canned without precooking. The raw fish was cut into chunks and fitted in the cans. The following methods were used:

4. Raw: The cans were exhausted by heating in a boiling water bath to 77°C (170°F) in the center of the can, then immediately closing the cans.
5. Bake-decant: The cans were baked in an oven at 177°C (350°F) for 30 minutes, the accumulated liquid was poured off, then the cans were sealed.

Canning methods

After cooling the cooked fish until it could be handled, the flesh was separated from the bones in as large pieces as possible and packed into cans, about 190 grams (6-7 ounces) per can. To all cans were added one percent salt and five percent corn oil (Mazola, Best Foods, Englewood Cliffs, NJ 07632). Previous work had shown that five percent was the most acceptable oil level for most people. If necessary (all cans in methods 1, 2, and 3 above), the cans were covered with the lid (but not sealed), then exhausted by heating in a boiling water bath to 77°C (170°F) in the center of the can to create a vacuum in the can after processing. They were then closed with an electric can sealing machine (Model 23-500, Dixie Can Co., Athens, GA 30603). All batches were processed at 121°C (250°F) for 60 minutes, as advised by Jackson and Shinn (1979), with five minutes extra for safety. The cans were cooled immediately.

During the cooking and can filling operations, weights were recorded as necessary, so that yields and losses could be calculated. These are for comparison between treatments only; in a large scale operation the yields would probably be somewhat higher.

The same procedures were followed for precooking the skinned pollock except that method 5 (bake-decant) was not used. The same canning procedures were also used.

EVALUATION PROCEDURES

Can drip

Drip was determined by inverting a weighed opened can with the lid in place in a funnel inserted into a 100 milliliter graduated cylinder and allowing the contents to drip for two minutes. Amount of drip was recorded; the data in Table 1 show the total amount as a percent of the total can contents (excluding the weight of the can and lid).

Taste paneling

A taste panel composed of seven to eight interested persons (students and faculty) who previously had considerable experience in judging fish products was used to evaluate the products. Testing was done at individual booths. Water, unsalted crackers, and celery were available for use between samples. All fish samples were served at room temperature in individual coded sample cups. In the case of cooking methods in which the bones and/or skin were not removed before canning, bones and/or skin were not served to the taste panel, since it was reasoned that they probably would not be eaten by the consuming public.

Visual scores were obtained from a number of experimental batches by asking the panelists to give each treatment a rank score (with 1 being the most desirable) for overall visual desirability.

FIGURE 1. SCORE SHEET FOR CANNED FISH

Name: _____

Date: _____

Product: Canned fish

Color
9 8 7 6 5 4 3 2 1

Like extremely — On the fence — Dislike extremely

/ : $ % X V

Texture
9 8 7 6 5 4 3 2 1

Like extremely — On the fence — Dislike extremely

Tenderness
9 8 7 6 5 4 3 2 1

Too tough — Just right — Too soft

Juiciness
9 8 7 6 5 4 3 2 1

Like extremely — On the fence — Dislike extremely

Flavor
9 8 7 6 5 4 3 2 1

Like extremely — On the fence — Dislike extremely

Overall desirability
9 8 7 6 5 4 3 2 1

Like extremely — On the fence — Dislike extremely

COMMENTS:

FIGURE 2. VISUAL SCORE SHEET FOR CANNED FISH

Product: Canned fish

Please examine the products visually.

1) Rank in order of preference:

most preferred least preferred

2) Which of these products would you purchase if available on the basis of your visual inspection? Indicate on your preference scale by a line. (———/———)

3) Please give reasons for your selection of the following.

most preferred

least preferred

4) Comments

RESULTS

Red hake

Effect of precooking method and phosphate treatment

Yields: Table 1 shows that the highest yields were obtained by packing chunked fish into cans and either baking in cans and decanting, or exhausting (heating to 77°C or 170°F) before sealing cans. However, the bones were still in the cans, and from the comments of our taste panel, this was very undesirable. The high amount of cookout in the cans packed raw was also undesirable. The data in the table do not show it but this cookout was very variable from can to can, probably depending in part on the stress of the fish before death, which affects the state of rigor. This problem has led to an extensive study into the factors contributing to the water-holding capacity of fish which has been started to find the answer to why some fish have a greater ability to hold moisture than others.

Based on the data in Table 1, simmering or steaming were the most acceptable ways of precooking. These two methods also produced the lowest amount of drip in the cans, slightly less than in the cans of commercially packed tuna which we evaluated at the same time.

Phosphating appeared to reduce the precooking loss in most cases, but the drip in the can increased to considerably more than that of the commercially packed tuna. The end result is a higher yield in can (which includes drip) but a slightly lower end yield (can contents exclusive of drip). We conclude that although the phosphate has the ability to increase the precooking yield, when further and higher heat is applied this ability is lost.

TABLE 1. EFFECT OF PRECOOKING METHOD AND PHOSPHATING ON COOKING LOSSES AND YIELDS OF RED HAKE

Cooking method	Cooking loss (%)*	Bones (%)	Drip in can (%)	End yield**	Yield in can**
Control					
Soak in 10% brine 1 hr, simmer	22.4	8.3	18.9	58.7	69.3
Simmer	18.0	8.6	13.7	59.7	73.4
Bake-decant	12.6	-	21.1	66.3	87.3
Steam	23.0	7.6	15.0	54.6	69.4
Raw-exhaust	-	-	28.6	71.4	100.0
Tuna-light chunk (commercial pack)	-	-	16.7	-	-
Phosphated***					
Soak in 10% brine 1 hr-simmer	19.6	7.7	22.7	50.1	72.7
Simmer	7.4	8.3	23.0	61.3	84.3
Bake-decant	17.2	-	27.9	54.9	82.8
Steam	23.3	8.0	19.1	49.6	68.7
Raw-exhaust	-	-	37.1	62.9	100.0

* "Cooking loss" is based on "ready to cook" weight (after heading, gutting, and skinning).

** "End yield" takes into account all losses including drip in can; "yield in can" is end yield based on entire can contents.

***Phosphated-soaked in 3% salt and 3% phosphate for 16 hrs under refrigeration.

TABLE 2. EFFECT OF PRECOOKING METHOD AND PHOSPHATING ON PANEL SCORES FOR CANNED RED HAKE

Cooking method	Color	Taste panel scores*					Visual rank
		Texture	Tenderness	Juiciness	Flavor	Overall acceptab.	
Control							
Soak in brine 1 hr-simmer	6.0	4.1	2.4	5.3	5.9	5.3	2.1
Simmer	5.8	5.0	5.7	5.2	6.8	6.2	2.9
Bake-decant	6.0	5.6	4.0	6.2	6.5	6.1	6.0
Steam	6.3	6.1	4.0	5.7	6.0	5.9	2.3
Raw	7.4	6.1	3.8	6.1	7.0	6.4	4.9
Tuna **	7.1	5.5	5.9	4.7	5.6	5.3	2.7
Phosphated***							
10% brine 1 hr -simmer	6.1	4.7	3.4	6.0	5.9	5.3	2.6
Simmer	6.5	5.3	3.5	6.3	6.8	6.2	2.5
Bake-decant	5.9	6.2	4.1	6.5	6.3	5.8	5.6
Steam	6.7	6.6	4.4	6.7	6.2	6.5	1.9
Raw	5.7	6.0	4.4	6.1	6.0	6.0	5.4

* Tenderness scores: 9 = too tender; 5 = optimum; 1 = too tough. Texture, juiciness, flavor, and overall acceptability: 9 = most desirable.

** Commercially packed chunk light tuna in water.

***Phosphated: As described under Table 1.

Taste panel scores: Visual scores show by the high rank numbers (less desirable) that fish packed raw (bake-decant and raw-exhaust) are the least desirable of any of the samples in each set. Taste panel scores in Table 2 show that highest scores for all attributes tested, except for flavor, were given to the samples precooked by steam. This was the case in both phosphate-treated and control (nonphosphated) groups of samples. These groups also had the best color and were given the highest visual scores. Samples precooked by simmering received the highest flavor scores in both the phosphate-treated and control groups. It is also interesting that all the canned red hake samples received higher overall acceptability scores than the commercially canned chunk light tuna samples, although the tuna received the highest score for color of any of the treatments. This may be due to the familiarity of the panelists with the tuna fish color.

The phosphate treatments appeared to produce variable results.

Effect of freezing before cooking

Taste panel scores: It may be more advantageous in some cases for the processor to purchase the fish from his supplier in the frozen state. In order to find out whether freezing for short periods before processing would be detrimental to the end product, red hake was headed and gutted, skinned, and frozen for two weeks, with and without phosphating before freezing. After precooking by simmering and steaming, these batches were compared to similarly treated batches that were not frozen. The results can be seen in Table 3.

TABLE 3. EFFECT OF FREEZING, COOKING METHOD, AND PHOSPHATING ON COOKING LOSSES, CAN DRIP, AND TASTE PANEL SCORES FOR CANNED RED HAKE

Cooking method	Cooking loss (%)	Can drip (%)	Color	Taste panel scores				
				Texture	Tenderness	Juiciness	Flavor	Overall acceptability
Fresh								
Control*								
Simmer	22.7	20.0	6.4	5.8	3.9	6.2	5.9	5.9
Steam	31.9	18.3	6.6	6.2	3.9	5.9	6.4	6.2
Phosphated**								
Simmer	24.4	24.6	6.5	5.0	3.3	5.7	6.4	5.5
Steam	28.6	17.4	7.4	6.3	4.3	6.4	7.1	6.5
Frozen								
Control								
Simmer	16.9	20.9	5.9	6.3	4.7	6.1	6.4	5.8
Steam	17.0	20.6	6.2	6.2	5.3	6.4	6.6	6.0
Phosphated								
Simmer	11.3	20.4	6.5	6.5	4.3	6.3	6.6	6.3
Steam	15.0	18.6	6.5	6.9	4.8	6.9	7.3	7.0

* Ice packed, no soak.

**Soaked in 3% phosphate and 3% salt 16 hours at 2°C (35°F).

Overall acceptability scores showed no detrimental effect from freezing for two weeks before cooking; in fact, scores for phosphated lots were somewhat higher for frozen fish than for the nonfrozen. The flavor was about the same, but the frozen lots had slightly better texture, were less tender (more firm) and slightly juicier than the nonfrozen fish. It should be noted, however, that this fish was frozen for only two weeks; long storage would lead to texture and flavor problems.

Cooking losses: Losses were considerably lower for the frozen fish but this may be because some of the moisture in the frozen fish was already lost in the thaw drip. The amount of drip in the cans showed very little difference.

A comparison of cooking methods showed that precooking by steam was again slightly the preferred method when compared to precooking by simmering. This method received the highest scores for texture and for tenderness (least mushy) in most cases. Although this method produced the best overall results in our trials, the differences were not great. In actual practice, probably either method would produce acceptable results and the choice of method would depend on equipment available in the plant.

Phosphate treatment appeared to reduce cooking losses slightly, in most cases, and improved the flavor.

Exploratory experiments

Several exploratory trials in canning red hake produced useful information and should be commented on. Since skinning the fish before cooking is labor intensive, several batches of fish were

cooked, by both simmering and steaming, with the skin left on. After cooking and cooling it was found that the skin had become very soft and gelatinous, and was very difficult to remove neatly from the flesh. Apparently this fish must be skinned before cooking for efficient production.

One trial was run on canning red hake in a retortable pouch vs a conventional can. Sufficient fish was cooked by simmering to fill several 8 ounce retortable pouches and 7-1/2 ounce tuna sized cans. Salt and oil were added to each. According to calculations for canning by both methods, the pouches were processed at 121°C (250°F) for 14 minutes, the cans at the same temperature for 45 minutes. Table 4 shows the results. As can be seen, the fish canned in the pouch was a superior product overall since the processing time was considerably shorter. Texture showed the most improvement.

TABLE 4. TASTE PANEL SCORES FOR RED HAKE CANNED IN RETORTABLE POUCHES AND CONVENTIONAL CANS

Parameter*	Canning method	
	Pouch	Can
Texture	6.5	4.6
Tenderness	6.3	7.4
Juiciness	5.5	6.4
Flavor	6.3	6.1
Overall acceptability	5.8	4.6

*See footnote in Table 2.

Recommendations

In summary, on the basis of our results we recommend the following procedure for canning red hake:

1. Head, gut, and skin the fish and fillet if desired.
2. Precook by either simmering in water or by steaming, until just cooked. Overcooking will cause the fish to fall apart.
3. Remove fish from the bones if not filleted.
4. Pack in cans.
5. Add one percent salt and five percent oil.
6. Exhaust to at least 77°C (170°F) before sealing, or vacuum seal the cans.
7. Process according to the can manufacturer's recommendations for this product and your can size.
8. Processing in flexible retortable pouches improves the texture and flavor of the fish, because of the shorter processing time.

On the basis of our large scale canning experience we also recommend putting the oil in the cans first, then packing the cans half full of fish, adding the salt, then filling the cans, in order to keep the salt from contact with the can as much as possible.

Pollock

Effect of precooking method and freezing

In general, our precooking trials showed that simmering and steaming produced the most acceptable products, with better flavor and juiciness scores (see Table 5). Fish packed raw was not as desirable on all factors as fish precooked by the other three methods. Freezing the fish for a short period (two weeks) had little or no effect on the canned product.

TABLE 5. CAN DRIP AND TASTE PANEL SCORES FOR POLLOCK PRECOOKED SEVERAL WAYS BEFORE CANNING, USING FRESH AND FROZEN FISH

Cooking method	Can drip (%)	Taste panel scores				
		Texture	Tenderness*	Juiciness*	Flavor	Overall acceptability
Fresh control						
Simmer	16.1	6.9	6.0	6.2	6.6	6.6
Steam	19.6	7.0	4.8	6.7	7.0	6.9
Frozen control						
Simmer	14.2	6.5	5.7	5.4	6.8	6.6
Steam	20.9	6.5	4.9	5.5	7.4	6.7
Bake	22.8	6.9	5.4	5.3	6.5	6.8
Raw	24.0	6.5	5.9	5.4	5.6	5.8

*See footnote in Table 2.

Visual desirability scores (Table 6) were more dependent on the part of the fish in the can than on the cooking process before canning, since this fish has a darker streak of color in the flesh. However, from the comments

of the panelists it appears that a desirable can of fish has a light color, and has a chunky and solid-looking appearance, with a small amount of cookout liquid.

TABLE 6. VISUAL SCORES FOR POLLOCK PRECOOKED BY SEVERAL METHODS BEFORE CANNING

		Visual scores			
		Control		Phosphated	
		Trial 1	Trial 2	Trial 1	Trial 2
Fresh:	Simmer	5.8		5.0	
	Steam		3.2		5.3
	Bake	2.3		5.9	
	Raw		5.2		5.7
Frozen:	Simmer	6.8		3.7	
	Steam		1.5		1.7
	Bake	1.0		2.0	
	Raw		6.2		6.3

Factors liked:	Light color	Factors disliked:	Dark color
	Size of flake		Large cookout
	Small cookout		Soft
	Moist		Soupy
	Chunky and solid		Skin
			Coagulated protein

An undesirable can of fish, on the other hand, has either a dark color or both light and dark color, looks soft, has visible skin and bones, and has a large amount of cookout. The color of the fish in the can would be hard to control because of the thin darker muscle running most of the length of

the fish. The presence or absence of skin and bones, however, can be controlled, as well as to a large extent the amount of cookout liquid in the cans.

Effect of phosphate treatment

Treating the fish with two phosphate combinations showed that precanning cooking losses were less for phosphate treated fish (Table 7) but the amount of drip in the cans was greater, averaging 34-48 grams (3-4 tablespoons) for phosphated batches vs 30 grams (slightly over 2 tablespoons) for the control batch. As we had observed in previous batches of pollock, as well as with red hake, improvement in precanning of cook yields by phosphate treatment is usually accompanied by higher drip amounts in the can.

TABLE 7. YIELDS FOR FRESH POLLOCK TREATED BY SEVERAL PHOSPHATES* AND METHODS BEFORE PRECOOKING AND CANNING

		Soak pickup (%)	Cook loss** (%)	Amount of can drip (%)
Control		-	19.7	29.5
FP88E*:	Soak	10.5	4.9	34.5
	Slurry	6.1	8.1	40.0
Kena*:	Soak	9.7	10.9	34.0
	Slurry	6.5	7.7	48.0

*FP88E--salt, sodium hexametaphosphate, and sodium erythorbate; Kena--sodium tripolyphosphate and sodium hexametaphosphate.

**Cook loss is based on before-soak weights.

Table 8 shows very little difference in taste panel scores due to phosphate treatment.

TABLE 8. TASTE PANEL SCORES FOR FRESH POLLOCK TREATED BY SEVERAL PHOSPHATES* BEFORE PRECOOKING AND CANNING

		Texture	Juiciness	Flavor	Overall acceptability
Control		7.4	7.0	7.0	6.6
FP88E:	Soak	6.8	7.0	7.0	7.0
	Slurry	7.0	6.8	6.6	6.6
Kena:	Soak	6.8	6.4	7.0	6.8
	Slurry	5.6	6.6	5.8	5.8

*See footnote in Table 7.

Canning pollock in cans vs retortable pouches showed much the same results as the red hake: an improvement in general. Tenderness and juiciness were not affected; however, there was considerable improvement in flavor.

TABLE 9. TASTE PANEL SCORES FOR POLLOCK CANNED IN CANS AND RETORTABLE POUCHES

Parameter	Canning method	
	Pouch	Can
Texture	7.1	6.6
Tenderness*	4.6	4.7
Juiciness*	5.0	4.8
Flavor	7.2	6.2
Overall acceptability	7.1	6.2

*See footnote in Table 2.

Recommendations

In summary, on the basis of our results we recommend canning pollock by the same procedure as for red hake, with the following modifications.

If it is more convenient, the pollock does not need to be skinned before cooking, but it should be scaled. Cook time will need to be adjusted according to the size of the fish, but all fish should be cooked to the bone. If it is slightly underdone, the drip in the cans will be higher.

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