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Effect of Processing Variables on Storage Characteristics of Frozen Minced Alaska Pollock

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INTRODUCTION

The ocean off Alaska contains one of the largest groundfish resources available to the U.S. industry. Yet these resources have been harvested almost exclusively by foreign fishermen, who have caught over 2 million metric tons of groundfish annually since 1971. Initially most of the catch was used for foreign consumption, but during the early 1970's increasing amounts of these catches entered the U.S. market to meet our growing demand for frozen fillets and fillet blocks. Much of the imported fish went to the institutional trade in which low price and uniform quality are essential. Foreign processors found production costs could be lowered through high flesh yields from mechanized methods of recovering minced flesh. This flesh was frozen into blocks and used for fish sticks and portions production.

The minced Alaska pollock, *Theragra chalcogramma*, blocks that were used in fish sticks and portions production in 1973 and 1974 were imported primarily from Japan and varied widely in quality. The primary defects were poor color and nonuniformity in appearance, ammoniacal odors, and tough or rubbery texture. The breading on the precooked fish sticks was often overly wet or "soggy" in places. As a result of these quality problems, the price of minced Alaska pollock blocks was drastically reduced and imports from Japan virtually stopped.

The raw flesh of freshly caught Alaska pollock has a bland neutral odor, but uniced fish develop a strong, over-powering surface or skin odor in less than 1 day; whereas iced fish gradually develop this odor in about a week, thus reducing acceptability as fresh fish (Okada and Noguchi, 1974). Trimethylamine oxide in the flesh of Alaska pollock, as well as other Gadoid family members, is converted enzymatically to dimethylamine and formic acid with accompanying deterioration in texture (Amano et al., 1963; Amano and Yamada, 1964a, 1964b). Thus, special handling procedures for Alaska pollock may be required to assure production of uniform high-quality blocks.

During this period when the world-wide demand for fish fillets and blocks was high and their prices were at their peak, the question was raised whether U.S. fishermen and processors might develop these fisheries off Alaska, improve product quality, lessen our growing dependence on foreign production, and thereby strengthen our own fishery economy. To provide information by which the opportunities for domestic utilization of Alaska groundfish could be evaluated, in the spring–summer of 1974 a joint industry–government venture carried out production fishing and processing trials (Anonymous, 1974[1]). The National Marine Fisheries Service's Northwest and Alaska Fisheries Center, Utilization Research Division, participated in two of the studies.

In the first study, various species of groundfish were held under different storage conditions on board the 295-foot stern trawler–processing vessel, *Royal Sea*. To determine the relative effectiveness of these different treatments, observations were made on the changes in quality of the fresh and frozen fish. The results of these tests will be reported in another paper[2].

In the second study, which is the subject of this paper, some handling and processing variables that might improve the textural and flavor characteristics and frozen storage life of minced Alaska pollock blocks were investigated. Variables included: preservation methods used to hold the fish prior to processing [in ice, slush ice, or refrigerated seawater (RSW)], effect of washing the minced flesh, particle size, and the addition of various ingredients—sodium chloride, sodium tripolyphosphate, and sugar. In earlier minced fish studies, some of the processing variables did improve the cold storage characteristics of minced black rockfish blocks (Miyauchi et al., 1975).

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[1]Anonymous. 1974. Preliminary results of an industry—government venture on Alaska groundfish. Processed rep., 72 p. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

[2]Nelson, R. W., and P. Hunter. In prep. Preservation and quality characteristics of Alaska bottomfish. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, WA 98112.

COMPARISON OF PRESERVATION METHODS

To determine the effect of the method of preservation of round fish on the quality and storage stability of the minced flesh, fish that were caught 23 May from the area south of Usof Bay, Unalaska Island, were held either in ice for 4–6 days or in either slush ice or RSW at 30°F for 5 days. Each lot of fish was headed and gutted, washed, and passed through the Bibun[3] flesh separator equipped with a drum having 5-mm holes and with the belt set at medium pressure. Approximately 1-pound quantities of minced flesh were packed into waxed frozen-food cartons, frozen aboard the *Royal Sea*, and shipped to Seattle where the initial examination for quality was conducted about 3 months after they were prepared. Additional examinations for quality differences were made after 6 and 12 months of storage at 0°F. At each examination, the frozen minced blocks were evaluated for appearance and were then cut, battered, breaded, and deep-fat fried at 360°F for 4 minutes for flavor and texture evaluation by a panel of 12 experienced judges.

The frozen minced blocks prepared from the iced fish were normal in appearance, but those prepared from fish held for 5 days either in slush ice or RSW had a slight-to-moderate greyish cast. This off-color was caused in part by pigmented particles sloughing off from the skin as the flesh was removed in the flesh-separating machine. The flavor and texture of the fish sticks from the various blocks were rated fair to good (Table 1). Sticks made from fish iced 4 days were the best; they were of good flavor and fair-to-good texture during the 12 months of storage at 0°F. In comparison, the sticks from the other three lots had lower flavor and texture scores. Statistical analysis of the scores for flavor and texture of each of the lots showed no significant changes resulting from storage of the block. Nevertheless, there was a slight declining trend in scores with increasing storage time.

PROCESSING STUDIES

Alaska pollock caught on 5 August by the trawler *Anna Marie* at 54 fathoms on the Portlock Bank located south of the Kenai Peninsula were used. The fish were somewhat small, with about 80 percent of them being 12 to 14 inches long and weighing about 0.85 pounds each. The fish were iced within several hours after catching and unloaded the following day at a processing plant in Seward, Alaska.

Minced Flesh Yield

In the plant the fish were washed, headed, gutted, split to remove the backbone by hand, washed again, and passed through the Bibun flesh separator as described in the previous section.

The "first-pass" minced flesh yield was 35.7 percent based on the weight of the whole fish. By passing the waste from the first-pass through the flesh-separator machine, an additional minced flesh yield of 6.0 percent was obtained. Partial removal of the belly wall that is lined with a black membrane and of the backbone with the adhering kidney and blood vessels before mechanical flesh separation resulted in less than maximum flesh recovery. In comparison, Okada and Noguchi (1974) reported that the edible part is about 40 percent of the weight of the fish. The "second-pass" flesh was much darker in color than the first-pass flesh and was considered unsuitable for making fish sticks and breaded portions; therefore only the first-pass minced flesh was used in the processing experiments.

Effects of Washing Minced Pollock Flesh

Buyers of frozen fish blocks have indicated preference for blocks that are "white" or light-colored. Since our earlier studies showed that a single cold-water wash improved the color and frozen storage stability of minced black rockfish, this technique was tried with minced pollock.

Preparation of Unwashed Minced Muscle Blocks (Controls)

Approximately 1-pound quantities of the minced pollock muscle taken directly from the flesh separator were packed into waxed frozen-food cartons and frozen in a contact freezer at about −40°F to form our mini-block control samples.

Washed Minced Muscle Blocks

A portion of the minced muscle taken from the flesh separator was weighed in a close-knit nylon mesh bag and gently agitated for 10 minutes in chilled tap water (ratio of 5 parts by weight of water to 1 part by weight of minced muscle). The bag containing the fish–water slurry was suspended so as to permit the excess water to drain through the bag. Normally, draining for several hours will bring the weight of the washed muscle down to approximately 3 percent less than that of the muscle before washing. With 1-day iced pollock, however, it was necessary to apply weights on the bag to expedite the removal of the excess water from the minced muscle. The washed muscle was packed and frozen similar to the control sample.

Results

The frozen blocks that were made from washed minced muscle were definitely lighter in color than those made from unwashed flesh. In the initial examination 2 months after the blocks were prepared, no significant differences in texture were found between fish sticks made from washed and unwashed minced flesh (Table 2); however, the lack of flavor of the samples made from washed flesh resulted in a slightly lower flavor rating than that received by samples made from the unwashed minced flesh. In subsequent examination after 6 and 12 months of storage, 5 percent NaCl was added to the batter used on the washed flesh blocks to compensate for the flavor constituents lost by washing. This simple addition of salt to the breading material increased the flavor level to the point where there was essentially no difference between washed and unwashed blocks. Washing had no effect on the texture of the muscle fibers. Several judges, however, noted that the samples from the washed flesh were more moist and tender than those made from the unwashed flesh blocks. This reflects the higher moisture content of the washed blocks (average 85.75 percent) compared to that of the unwashed blocks (average 83.35 percent) (Table 3). The cook drip from the washed blocks was significantly higher than that of the unwashed blocks (Table 3). Based on these limited tests, the benefit of improved color gained from washing is questionable when weighed against the disadvantages of lower flesh yield and increased processing costs.

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Effect of Minced Flesh Particle Size

Two lots of samples were prepared by passing unwashed and washed minced flesh through a plate grinder having 1.9-mm diameter holes, packaging, and freezing as previously described.

In comparing the frozen minced blocks made from 5-mm particle size and from the 1.9-mm particle size, the larger particles of dark flesh mixed in with the white flesh gave the coarse minced block a mottled appearance, whereas the 1.9-mm particle blocks were more uniform in appearance. Our sensory panel found no significant differences in flavor and texture of the fish sticks prepared from the 5-mm and 1.9-mm particle blocks (Table 2) throughout the 12-month storage test. Both lots were judged "fair" to "good" in flavor and texture. The drip losses were generally lower for the 1.9-mm blocks than for the 5-mm blocks (Table 3).

Effect of Adding Ingredients

In our earlier studies, the addition of ingredients such as salt, sugar, and sodium tripolyphosphate improved the frozen storage stability, particularly texture, of frozen blocks of minced black rockfish. We tested this procedure on unwashed and washed minced pollock flesh by adding 1 percent NaCl, 1 percent sugar, and 0.15 percent sodium tripolyphosphate. The results of the sensory examination of fish sticks prepared from the various minced pollock blocks are presented in Table 4. In general, there was no statistically significant difference in flavor between blocks with or without added ingredients. With respect to texture, the blocks with the added ingredients had lower texture scores, especially after frozen storage of 6 months or more. Blocks with no added ingredients were described as stringy, fibrous, dry, and/or chewy. Those with added ingredients were described as rubbery and tough.

DISCUSSION

Minced pollock flesh appears to have relatively good stability against the development of rancid flavors during frozen storage; on the other hand, it does not have a good positive flavor even when fresh. Minced pollock becomes dry, fibrous, and chewy during frozen storage. Work is needed to develop means of improving the flavor and texture of blocks to be used for further processing into sticks and portions.

The belly flaps of pollock are lined with a black membrane that will appear as black specks in the minced flesh if the flaps are not cut off before deboning. The kidney should be removed entirely, together with the spinal column, before deboning to avoid the discoloration of the minced flesh. In addition, the bits of kidney accelerate the flavor deterioration of the flesh during storage.

Table 1.—Mean flavor and texture scores of fish sticks prepared from minced Alaska pollock blocks prepared from fish held in either ice, slush ice, or refrigerated seawater (RSW), and then stored up to 12 months at 0°F.

Method of holding fish	Flavor score after storage of			Texture score after storage of		
	3 mo	6 mo	12 mo	3 mo	6 mo	12 mo
4-day iced	[1]4.4	4.0	3.9	4.0	3.8	3.7
6-day iced	3.8	3.6	3.8	3.5	3.3	3.4
5-day slush ice	4.0	3.5	3.8	3.6	3.4	3.4
5-day RSW	3.5	3.6	3.6	3.6	3.9	3.6

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Table 2.—Mean flavor and texture scores of fish sticks prepared from minced Alaska pollock blocks prepared from washed or unwashed flesh, 5-mm or 1.9-mm particle size flesh and then stored up to 12 months at 0°F.

Sample treatment	Flavor score after storage of			Texture score after storage at		
	2 mo	6 mo	12 mo	2 mo	6 mo	12 mo
Unwashed	[1]3.3	3.4	3.3	3.4	3.4	3.2
Washed	2.9	3.6	3.4	3.2	3.3	3.4
5-mm	3.1	3.5	3.5	3.3	3.4	3.4
1.9-mm	3.1	3.5	3.2	3.3	3.3	3.3

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Table 3.—Effect of particle size and washing of minced flesh and of added ingredients on thaw drip (68 F)[1] and cook drip of minced Alaska pollock during storage at 0°F.

Sample treatment	Moisture content %	Thaw drip		Cook drip	
		2 mo %	12 mo %	2 mo %	12 mo %
Unwashed, 5-mm	83.5	5.9	3.7	24.7	25.7
Unwashed, 1.9-mm	83.2	5.4	1.2	21.6	19.2
Washed, 5-mm	85.6	4.1	5.6	32.9	33.1
Washed, 1.9-mm	85.9	5.9	5.4	30.9	28.9
Unwashed, 5-mm (control)	—	4.6	2.3	24.4	24.6
1% NaCl	—	3.4	0.8	17.3	23.2
0.15% NaTPP	—	6.6	2.4	23.4	21.4
1% NaCl, 0.15% NaTPP	—	4.1	1.2	18.6	23.3
1% NaCl, 0.15% NaTPP, 1% sugar	—	3.6	1.8	17.9	21.2

[1]The amount of thaw drip at 34°F for all samples was negligible.

Table 4.—Effect of adding food ingredients[1] to unwashed and washed minced Alaska pollock flesh on flavor and texture of fish sticks prepared from blocks after 3, 6, and 12 months of storage at 0°F.

Treatment			Flavor score after storage of			Texture score after storage of		
			3 mo	6 mo	12 mo	3 mo	6 mo	12 mo
4-day iced	Unwashed	No ingredients	[2]4.4	4.0	3.9	4.0	3.8	3.7
		Ingredients added	3.7	3.6	3.7	3.7	3.0	2.1
	Washed	No ingredients	3.7	3.9	3.9	3.9	3.6	3.3
		Ingredients added	4.2	3.8	3.9	4.0	3.5	2.9
6-day iced	Unwashed	No ingredients	3.8	3.6	3.8	3.5	3.3	3.4
		Ingredients added	3.7	3.5	3.6	3.5	2.8	2.3
	Washed	No ingredients	3.4	3.2	3.6	3.3	3.3	3.6
		Ingredients added	3.7	4.0	3.6	3.6	3.4	3.2

[1]The following food ingredients added to minced flesh: 1% NaCl, 1% sugar, and 0.15% sodium tripolyphosphate.
[2]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Washing of the minced flesh improves color but not flavor or texture. Washing therefore is not recommended because it is costly and unrewarding in terms of quality improvement.

ALTERNATE USES

An alternate use for minced pollock blocks is as an extender in processed meat products. The bland flavor and stringy-tough texture of frozen minced pollock, which are negative characteristics in fish sticks, offer certain advantages when used as an extender in hamburger patties and sausage products (frankfurters, luncheon meats, etc.). Since light color of fish flesh is not important for this type of end use, undoubtedly a higher yield of minced pollock could be realized.

Several tests have been carried out to determine how well minced Alaska pollock muscle performs as partial replacers of the lean beef used as emulsifiers and nutritional protein sources in sausage products. This work has been done in cooperation with commercial sausage manufacturers, and fish muscle has been found by these food processors to be eminently satisfactory in terms of function. Products made include frankfurters, bologna, and luncheon meats. Texture, flavor, yield, and resistance to spoilage have all been found to be satisfactory when 10 to 15 percent of the lean-meat portion of the product was replaced by an equal weight of fish flesh. Frankfurters were prepared in which the lean beef was replaced at various levels with pollock flesh that had been stored for 1 year at 0°F plus an additional 10 months at −20°F. The results of the taste tests (Table 5) show that the flavor scores of frankfurters extended with up to 15 percent pollock muscle were comparable to the flavor scores of the regular frankfurters.

Table 5.—Comparison of mean flavor scores of frankfurters in which lean beef is replaced by Alaska pollock muscle at various levels with those of regular frankfurters.

Replacement level with pollock %	Flavor score
0	[1]4.2
5	4.3
0	4.4
10	4.2
0	4.3
15	4.2

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Table 6.—Mean flavor and texture scores of patties in which the ground beef is replaced by 10 percent Alaska pollock and 10 percent soy protein.

Composition of patties	Flavor score	Texture score
100% beef	[1]3.8	3.8
10% pollock	3.6	3.8
100% beef	4.0	3.8
10% pollock, 10% soy protein	3.4	3.9

[1]Five-point rating scale: 5—very good; 4—good; 3—fair; 2—borderline; 1—poor.

Several tests were run in which minced fish muscle was added to meat patties to determine the acceptability of such a product. In a typical test, 10 percent of ground beef was replaced with an equal weight of minced Alaska pollock or 20 percent of ground beef was replaced with 10 percent minced pollock and 10 percent soy isolate. Most panelists found either no difference in flavor or only a slight reduction in beef flavor when pollock alone or pollock and soy protein replaced some of the beef (Table 6). Differences in texture were not significant, but some panelists indicated a preference for the samples containing fish because they were considered to be more tender. The results of these tests indicate that Alaska pollock of initial good quality may be frozen and held at 0°F for at least 1 year for use as a meat replacer at the 10 percent level in beef patties.

LITERATURE CITED

Amano, K., and K. Yamada. 1964a. A biological formation of formaldehyde in the muscle tissue of gadoid fish. Bull. Jap. Soc. Sci. Fish. 30:430–435.

_____, and _____. 1964b. Formaldehyde formation from trimethylamine oxide by the action of pyloric caeca of cod. Bull. Jap. Soc. Sci. Fish. 30:639–645.

_____, _____, and M. Bito. 1963. Contents of formaldehyde and volatile amines in different tissues of gadoid fish. Bull. Jap. Soc. Sci. Fish. 29:860–864.

Miyauchi, D., M. Patashnik, and G. Kudo. 1975. Frozen storage keeping quality of minced black rockfish (*Sebastes* spp.) improved by cold-water washing and use of fish binder. J. Food Sci. 40:592–594.

Okada, M., and E. Noguchi. 1974. Trends in the utilization of Alaska pollock in Japan: *In* R. Kreuzer (editor), Fishery products, p. 189–193. Fishing News (Books) Ltd., West Byfleet, Engl.

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