Manufacturing of a Crab Analogue to Determine the Quality of U.S. Shore-based Produced Surimi

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Introduction

In 1986, Alaska Pacific Seafoods Inc.[1] (APS) in Kodiak, Alaska, produced over 1.8 million pounds of surimi, successfully completing the first commercial U.S. production of surimi funded by a National Marine Fisheries Service Saltonstall-Kennedy grant through the Alaska Fisheries Development Foundation. This has provided the impetus for U.S. companies to begin production of surimi and fabrication of seafood analogues from Alaska pollock, *Theragra chalcogramma*.

At present, laboratory tests can define certain properties of surimi, but further work is needed to relate the results of these tests to the ability of the surimi to form a seafood analogue (Reppond et al., 1987b). The purpose of this study was to monitor closely the production of surimi and to relate the chemical and functional properties of the surimi to its performance in the fabrication of a crab analogue.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

ABSTRACT—The chemical changes in Alaska pollock, Theragra chalcogramma, *flesh were monitored during the shore-based production of surimi. The ability of the surimi to produce a crab analogue was then related to the chemical and functional properties of the surimi. The results indicated that the frozen storage stability and chemical composition of surimi produced using an in-line washing system were equivalent to surimi produced using a conventional batch-type process. The results also demonstrated that shore-processed surimi can be used to produce an excellent crab analogue.*

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Materials and Methods

Raw Materials

Alaska pollock were caught between the afternoon of 12 November 1986 and the evening of the 13th by the F/V *Arcturus* and held using a flooded refrigerated seawater (RSW) system (Gwinn, 1987). The pollock were off-loaded by a pneumatic fish pump the evening of the 13th and production of surimi started at 1:00 a.m. on the 14th. The surimi process was similar to that used in Japan (Lee, 1984) except Baader 182 and 184 filleting machines and an in-line washing system described by Kelly (1986) were used to prepare and wash the minced pollock flesh.

Samples of fillets, minced, and washed minced pollock flesh for chemical analyses were taken at 1:00 p.m. on the 14th. The fillet sample was taken from the end of the Baader skinning machine, the minced sample from the Baader 695 meat separator, and the washed minced sample from the end of the rotary dewatering screens. After an elapsed time of 30 minutes to allow for the washed minced pollock flesh to pass through the screw-press dehydrator, five batches (137 kg each) of surimi (containing 4 percent sugar, 4 percent sorbitol and 0.3 percent tripolyphosphate equivalent to the weight of pollock flesh) were prepared for testing. The 72 blocks (10 kg each) of surimi were plate-frozen, shipped frozen by Sea-Land, and held at UniSea, Inc., Redmond, Wash., until evaluated.

Chemical Analyses

The analyses for moisture, protein (total N × 6.25), fat, ash, and salt were determined according to AOAC procedures (AOAC, 1980). Minced fish samples were extracted with trichloroacetic acid according to the method of Bullard and Collins (1980). Trimethylamine oxide was determined by the method of Dyer et al. (1952), except, trimethylamine was measured using the method recommended by Bullard and Collins (1980).

Surimi Quality

Frozen surimi quality standards (Suzuki, 1981; Lee, 1984) were used to evaluate the surimi, and the properties of the frozen surimi were determined according to the method of Reppond et al. (1987b).

Crab Analogue Fabrication

The evaluation of the surimi was conducted on 9 December 1986 by UniSea, Inc. in Redmond, Wash. Routine procedures for formulating and processing the crab analogue were followed.

Results and Discussion

Raw Materials

Pollock used in this study averaged

Table 1.—Temperatures of pollock flesh during surimi processing.

Category	°C	°F
Minced flesh	0-2	32-36
After rotary screens (washing)	6	43
After refining	7	45
After screw-press (dewatering)	8	46
After mixing (surimi)	10	50

48.2 cm (19 inches) in length and 1,362 g (3.0 pounds) in weight (range 1.5-5.0 pounds). The pollock were in good condition and the delay of time from catching to processing was 25-49 hours. The temperatures of the pollock flesh at various stages during processing are shown in Table 1. Comments have been made on temperature controls for trawler production of surimi (Hilderbrand, 1986), but no specific temperatures during production have been reported.

Table 2.—Effect of washing on the composition of minced pollock flesh.

	Pollock - 11/14/86 In-line system			02/06/85[1] Batch system	
Item	Fillet	Mince	Washed mince	Mince	Washed mince
Percent					
Moisture	82.01	82.14	91.58	82.88	92.78
Protein (N × 6.25)	15.80	15.90	8.10	16.20	7.30
Lipid	0.50	0.49	0.28	0.60	0.30
Ash	1.16	1.10	0.17	1.06	0.13
Percent (dry wt.)					
Protein	90.49	90.91	94.74	90.70	94.43
Lipid	2.87	2.80	3.27	3.36	3.88
Ash	6.64	6.29	1.99	5.94	1.69
TMAO (mgN/100g)	76.0	71.3	8.7	65.1	4.2
TMA (mgN/100g)	0.40	0.56	0.10		
NaCl (%)	0.24	0.24			
pH	7.08	7.10	7.21		

[1]Babbitt et al. (1986).

Table 3.—Functional properties of surimi.

Item and time	Setting at 90°C for 40 min.	Setting at 40°C for 20 min., then 90°C for 20 min.
Frozen storage (−18°C)		
One Week		
Force (g)	548 ± 34	702
Depression (mm)	14.5 ± 0.5	16.2
Gel strength (g/cm)	795 ± 53	1,144
Moisture (%)	75.2	
Three Months		
Force (g)	571 ± 62	733
Depression (mm)	14.0 ± 0.9	15.5
Gel strength (g/cm)	805 ± 130	1,136
Moisture (%)	75.4	
Six Months		
Force (g)	514 ± 61	
Depression (mm)	13.7 ± 0.6	
Gel strength (g/cm)	706 ± 107	
Moisture (%)	75.6	

Chemical Analyses

The results of the chemical analyses are shown in Table 2. Under laboratory conditions, Reppond et al. (1987a) reported the salt content of fillets from pollock held in RSW (2 parts fish to 1 part seawater maintained at from 0 to −0.5°C) for 2 days was 0.27 percent which is in good agreement to that found in pollock held under the conditions in this study. The high trimethylamine oxide (TMAO) content of 76 mgN/100g indicated the pollock were very fresh. However, the trimethylamine (TMA) content of the fillets (0.40 mgN/100g) was slightly higher than similarly held pollock (0.23 mgN/100g) reported by Reppond et al. (1987a).

The results of a study by Babbitt et al. (1986) have been included in Table 2 to compare the "completeness" of the washing method used in this study with the traditional batch system using 3 washings of 1 part fish with 2 parts water. The results indicated the in-line washing produced a washed mince equivalent to that of the 3-cycle batch system. Nearly all the nitrogenous compounds (represented by TMAO) were removed in both systems and on a dry weight basis the protein content of the washed minced flesh was over 94 percent.

Surimi Quality

Presetting the samples for 20 minutes at 40°C increased gel strength values (Table 3). The high depression values of 16.2 and 15.5 mm indicated that the surimi possessed excellent flexibility and was comparable to surimi produced at sea by a factory ship (Reppond et al. 1987b). Also, the significant increase in the gel strength values by presetting the gels at 40°C for 20 minutes may be an indication that the pollock were very fresh.

The force, depression, and gel strength values for the 40-minute setting at 90°C indicated no significant changes ($P < 0.05$) occurred in the functional properties of the surimi during 6 months of frozen storage at −18°C. Thus, the stability of the surimi during frozen storage indicated that the surimi produced from the in-line washing system was similar to surimi produced using a conventional batch-type process.

The surimi performed very well during the production run of chunk-style crab, as the formula used by UniSea to fabricate the crab analogue resulted in an excellent product. The results from informal sensory evaluations indicated that the color, texture and desirability of the chunk-style crab was very good and comparable to other commercial products.

Conclusions

The results indicated that the chemical composition of the in-line washed surimi produced at APS was equivalent to surimi produced using a conventional batch-type process. Also, pollock held in RSW can be used to produce a high quality surimi. Most importantly, the results demonstrated that shore-based produced surimi can be used to produce an excellent crab analogue. Various parameters were measured during the production of surimi and this information can serve as a basis for predicting the functional properties and frozen shelf-life stability of surimi.

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