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Processing of Salmon (*Salmo salar L.*) and Conger eel (*Conger myriaster*) Snacks and Their Quality Characteristics

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Abstract Fish snacks were prepared by adding starch, gelatin and oligosaccharide. Among the snacks with fish meat contents of 50, 60 and 70%, the salmon-70 and the conger-70 snacks (70% fish meat) received the highest score in sensory evaluation. The hardness of the snacks containing 50% or higher fish meat content tended to increase as the amount of added starch increased. The protein content of the salmon-70 snack was 32.4%, and for the conger-70 snack, it was 38.6%; salmon-70 snack (16.4%) contained more lipids than conger-70 snack (10.5%). The acid value (AV) and peroxide value (PV) of the fish snacks with high lipid contents increased with storage period. PV did not exceed the standard value during the storage period when applying the Codex standard for the seasoning dried laver. During the storage, the volatile basic nitrogen of the snacks was almost unchanged. Fatty acid composition of the salmon-70 snack containing only salmon frame, which was composed of 40% oleic acid, 16.4% linoleic acid, and 4.3% and 7.3% EPA and DHA, respectively. In the conger-70 snack, oleic acid (23.6%) and DHA (22.8%) were highest among the fatty acids, followed by palmitic acid (16.4%) (which the saturated fatty acid) and EPA, by 9.2%.

Keywords: *fish, by-product, snack, salmon, conger eel*

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1. Introduction

Despite a recent decline, per capita consumption of fishery products in Korea in 2011 - 2013 was approximately 60 kg per year; thus, Korea is still the largest consumer of fishery products [1]. The most important reason for the decrease in the consumption of fishery products is the rejection of fishy fish and tastes, and the difficulty of ingestion of fish bones.

Fish snacks are a fishery product and are widely consumed in Asian countries, including Thailand, Malaysia and Indonesia [2,3]. These snacks are mainly prepared by mixing minced meat and starch.

Starch contributes to the crispness and expansion of the snack, but fish meat interferes with the expansion of the snack [3,4]. In addition, lipid in the fish interferes with the binding capacity and affects the product quality during storage. Starch contributes to the crispness and expansion of the snack, but fish meat interferes with the expansion of the snack [3,4]. In addition, lipid in the fish interferes with the binding capacity and affects the product quality during storage.

During fish processing, various by-products such as heads, viscera, skins and frames are produced and account for approximately 50% of the raw materials [5,6]. Fish processing by-products are mostly abandoned or used as animal feed due to limited development of human consumer products that are safe and acceptable due to a lack of processing techniques. By-products that are worthless as food can be made into more valuable foods by adding a variety of seasonings [7]. Salmon frame is a typical processing by-product generated during the processing of sashimi and smoked products [8]. Salmon frame contitutes 9-15% of salmon total weight and is composed of proteins, lipids and bones. Salmon lipid is rich in highly polyunsaturated fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), as well as astaxanthin, a lipid-soluble pigment. It also possesses approximately100-fold higher antioxidant activity than vitamin E for lipid oxidation [9,10]. The bones of the salmon frame may also contain good dietary minerals.

In Korea, conger eel is mainly sold as sashimi, or sold and exported as Kabayaki products processed by traditional manufacturing methods.

In our study, we did not use minced meat, which is generally in fish snack manufacturing. The salmon snack used the salmon frame, including the bone, and the conger eel snack used snack raw material that consisted of conger eel with only the intestines of the conger eel removed. Fish snacks for each ingredient were prepared and their

determination of physicochemical properties and sensory evaluation were performed.

2. Materials and Methods

2.1. Materials

Salmon (*Salmo salar L.*) frame was purchased as a byproduct after smoked salmon processing, from Wooyoung Fisheries in Busan, Korea. The salmon frame used in the experiment was 40 – 45 cm in length, approximately 1 cm in thickness and contained bone and skin. Conger eel (*Conger myriaster*) was purchased from local market in Tongyeong, Korea, and the viscera were immediately removed. The meat was frozen to manufacture snacks. The starch was a pre-gelatinized potato starch and the oligosaccharide was 100% fructooligosaccharide.

2.2. Preparation of Fish Snacks

Salmon frame with bone and skin was retorted at 110°C for 3 h. After cooling, the salmon frame was finely ground in a blender to prepare a salmon frame paste, which served as the raw material for the salmon snacks. The conger eel including bone, head and skin was retorted at 110°C for 2 h after thawing, and conger eel paste was prepared similarly to the above method for salmon frame paste.

Salmon frame and conger eel paste were mixed in a blender for 5 min by adding starch, gelatin, and oligosaccharide as shown in Table 1. The mixtures were shaped to 2 cm in length, 1 cm in width and 0.8 cm in height and dried at 100 °C for 1 h to obtain fish snacks.

Both snacks (salmon-70 and conger-70) were stored for 60 days at 25 °C to measure quality changes.

2.3. Proximate, Water Activity, Calcium, Phosphorus Analysis

Moisture, crude protein,, crude lipid, and ash were determined according to AOAC 1995 [11]. Water activity was measured using a digital AW-meter (AQS-31, Nagy, Germany). Calcium and phosphorus contents were analyzed by an atomic spectrophotometer (Model UNICAN 969, solar) as described by Onwuka [12].

2.4. Heavy Metal Analysis

Cadmium (Cd) and lead (Pb) were determined using the Standard Method for the Marine Environment [13]. Approximately 10 g of the homogenized sample was lyophilized and decomposed with nitric acid and perchloric acid, and the solution was evaporated. The sample was re-eluted with 0.2N nitric acid, and then diluted to 100 mL and analyzed with ICP-OES (Perkin-Elmer, Avio 200, USA). The recoveries of each metal were determined using certified reference material (CRM) for Cod muscle (BCR-CRM 422, Sigma-Aldrich, St. Louis, Mo., USA) in the same manner as the sample. Total mercury analysis was performed using an automatic mercury analyzer (MA-300, Nippon Instruments Corporation, Japan). The recovery of total mercury was analyzed in the same manner as the samples using the standard certified substance DORM-4 (Fish protein certified reference material for trace metals, National Research Council, Ottawa, Canada).

2.5. Peroxide Value (PV) and Acid Value (AV)

Lipid extraction from fish snacks was performed by extracting 50 g of fish snacks using chloroform and methanol following the method of Bligh and Dyer [14]. Peroxide value was determined using the ferric thiocyanate method [15]. The PV was calculated and expressed as milliequivalents of ferric ion/kg lipid. The acid value was measured according to the method given in AOCS [16].

2.6. Fatty Acid Composition

The fatty acid composition of fish snacks was analyzed by gas chromatography (GC, Hewlett-Packed 6890 series, Avondale, PA, USA). Ten milligrams of the sample was dissolved in 1.5 ml of 0.5 N KOH-methanol and heated at 80°C for 10 min. After cooling the mixture, 3 ml of BF_3-methanol solution was added, and the mixture was heated at 80°C for 5 min. After cooling, 3 ml of saturated NaCl solution was added to the mixture, followed by addition of 3 ml of hexane. The hexane layer containing the fatty acid methyl ester (FAME) was separated from the mixture and the water was removed with a Na_2SO_4 column for use as a GC sample. FAME solution was injected into the GC equipped with a SP-2560 fused silica capillary column (100 m x 0.25 mm I.d., 0.2μm film thickness, Bellefonte, PA, USA). The oven temperature was maintained at 150 °C for 5 min and then increased at the rate of 4 °C / min to a final temperature of 220 °C. A nitrogen flow rate of 50 mL / min was used as the carrier gas, and the injector and flame ionization detector temperature were set at 250 and 260 °C, respectively. The fatty acid profile was expressed in % of total lipids.

2.7. Total Volatile Basic Nitrogen (TVB-N)

One gram of fish snacks were homogenized with 8 mL of 4% trichloroacetic acid (TCA). The sample was kept at ambient temperature for 30 min and then centrifuged at 3,000 rpm for 10 min. The supernatant was made up to 10 mL with 4% TCA and determined for TVB-N according to the method of Hasegawa [17] .

2.8. Texture Analysis

Texture analysis was measured using a texture analyzer (Brookfield, CT3, USA) according to the procedure performed by Berwig et al. [18]. Samples were measured using two different probes, both knife (TA-JTPB) and cylinder (Ta-DSJ), with pre-test and post-test speeds of 5 $mm.s^{-1}$ at a 10 kg maximum weight. Hardness (g. $distance^{-1}$) was assessed using TexturePro CT software (1.8.31). For all probes, a pre-test and post-test were performed on 50 samples and the results of 20 samples excluding the lower 5 samples, and the upper 5 samples were averaged.

2.9. Sensory Evaluation

The sensory evaluation of fish snacks was performed by 32 panelists from the staff of the Department of Food

Science & Engineering, Pukyong National University of Korea. The evaluation procedure was explained to panelists before evaluation, and each panelist was given five samples. The panelists were asked to score the intensity of each characteristic describing overall impression, color, aroma, taste, crispiness, feeling of irritation and overall preference using an unstructured scale ranging from 1 to 9: 9, like extremely; 8, like very much; 7, like moderately; 6, like slightly; 5, acceptable; 4, dislike slightly; 3, dislike moderately; 2, dislike very much; 1, dislike extremely. The acceptability index (AI) of the products was obtained as follows [6]:

$$AI\ \% = (\text{Average score obtained for product} / 9) \times 100.$$

2.10. Statistical Analysis

The results from three replications of two trials were subjected to analysis of variance (ANOVA) and Duncan's multiple range test for significant differences at $p < 0.05$ [19]. Principal component analysis (PCA) was also performed among sensory evaluation factors.

Table 1. Recipe used for the preparation of fish snacks

Samples	Fish paste	Starch	Gelatin	Oligo-saccharide
Salmon-70	265	50	20	40
Salmon-60	246	100	20	40
Salmon-50	215	150	20	40
Conger-70	265	50	20	40
Conger-60	246	100	20	40
Conger-50	215	150	20	40

3. Results and Discussion

3.1. Sensory Evaluation

Fish snacks were prepared by adding as much fish paste as possible. Salmon snacks could contain 70% fish paste; when more was added, the snack dough did not agglomerate. Therefore, we prepared fish snack by adding salmon paste and conger eel paste to fish snacks below 70%. The characteristics of the sensory evaluation for salmon and conger eel snacks are shown in Table 2. The overall impression was not significantly different ($p>0.05$) depending on the fish meat content in the salmon snack. The conger eel snack was slightly darker, as it contained much skin, especially as the fish meat content increased, but the color score for the conger eel snack evaluated by the panelists showed no significant difference ($p>0.05$) as fish meat content varied. In the sensory evaluation of snacks made with tilapia in Brazil, the color of snacks darkened as the fish meat content increased, and the overall color score was lower in snacks with higher fish meat content [20]. Our results and the results for the tilapia snack may have differed due to differences in the human evaluators' diet culture. The sensory scores for the aroma and taste of snacks were highest in salmon-70 and conger-70, and higher the fish meat content in both samples was corrected with better scores. In the salmon-70 and conger-70 snacks with the same fish meat content, the aroma and taste of the conger eel snack was better than that of the salmon snack. The crispness of the snacks showed no significant differences according to the fish meat content. Generally, the degree of crispiness was high in snacks with high starch content [3,4]. However, the snacks showed no significant difference in crispness according to the fish meat content because the added gelatin increased the binding power of the snacks.

The fish snacks used in the experiment include fish bone and skin. Therefore, we examined the possibility of a feeling of irritation in the mouth due to these ingredients, but no significant difference was found in all samples. The acceptability index (AI) was highest in salmon-70 and conger-70 snacks containing 70% fish meat. The overall preference of each snack by the panelists was highest in salmon-70 among salmon snacks and conger-70 among conger eel snacks, and overall preference for conger eel snacks was higher than salmon snacks.

Principal component analysis (PCA) was performed using the sensory evaluation results, and the results are shown in Fig. 1. For the seven variables except the acceptance index, two principal components (factor-1 and -2) with an eigenvalue of 1 or more accounted for 50.7% for factor-1 and 16.3% for factor-2, respectively. Snack preference was most closely related to taste and aroma.

3.2. Texture Analysis

The breaking strength of salmon and conger eel snacks according to fish meat content is shown in Table 2. The breaking strengths of salmon-70, -60, and -50 with a cylindrical probe were 10,118, 12,901, and 12,122 g mm^{-1}, respectively. The salmon-60 snack with approximately 26% starch was higher than the salmon-70 snack with approximately 14% starch, but the breaking strength of salmon-50 snack with 35% starch was lower than that of salmon-60 snack. In the conger eel snack, the breaking strength of 36% starch-added conger-50 snack and 26% starch-added conger-60 snack were almost similar. The breaking strength using the knife probe was also similar to the result of using the cylindrical probe.

Table 2. Sensory and breaking strength characteristics of salmon and conger eel snacks according to fish paste contents

Items	Samlon-70	Salmon-60	Salmon-50	Conger-70	Conger-60	Conger-50
Overall impression	5.1±0.6	5.2±0.6	5.2±0.6	5.2±0.4	5.1±0.3	5.5±0.5
Color	5.8±0.4	6.0±0.7	6.0±0.5	4.8±0.6	5.4±0.8	5.3±08
Aroma	7.5±0.7	6.9±0.6	5.9±0.7	8.4±0.5	7.9±0.7	6.4±0.5
Taste	7.7±0.5	5.9±0.6	5.0±0.8	8.7±0.5	7.9±0.6	6.8±0.6
Crispiness	6.1±0.6	6.5±0.5	6.4±0.5	4.6±0.7	5.3±0.8	6.2±0.4
Feeling of irritation	4.9±0.3	4.5±0.7	5.2±0.6	5.6±0.5	5.2±0.6	5.9±0.5
Overall preference	7.5±0.5	6.3±0.7	5.2±0.6	8.5±0.5	7.9±0.6	7.1±0.9
Acceptance index (%)	70.8	65.5	61.7	72.7	71.0	68.6
Breaking strength($g \cdot mm^{-1}$)						
Cylinder	10,118±236	12,901±121	12,122±97	9,267±102	12,511±318	13,010±197
Knife	2,966±52	3,411±82	3,353±109	2,484±38	3,310±132	3,493±88

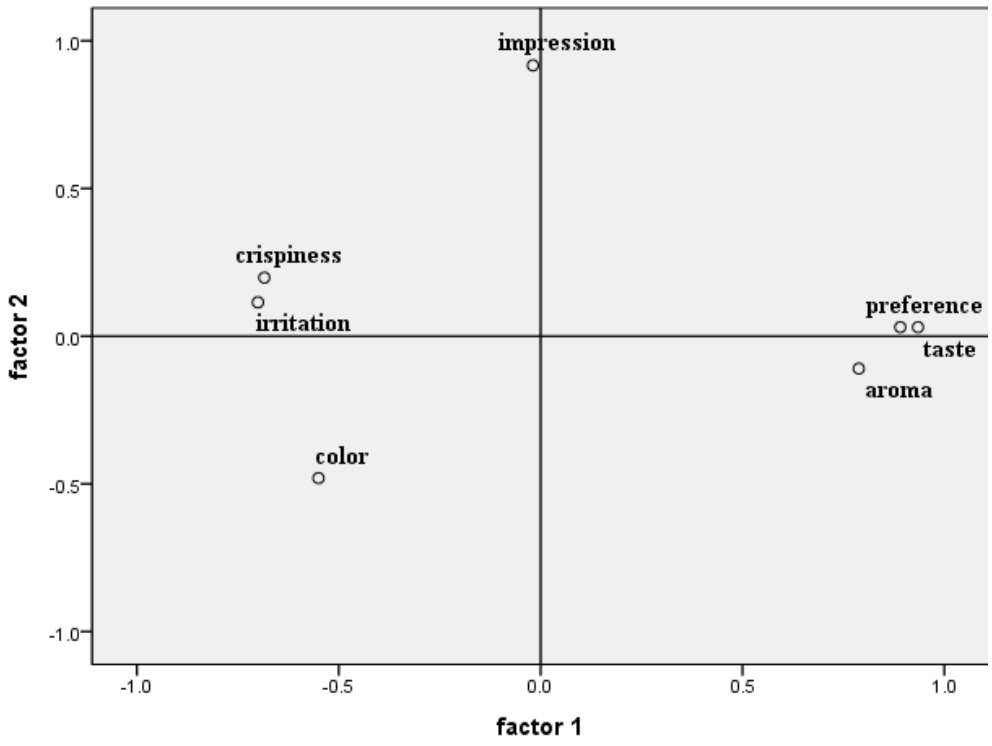

Figure 1. Principal component analysis of sensory evaluation factors of fish snack

Cortez Netto et al. [20] reported that the breaking strength of snacks containing 30% fish meat or less decreased with increasing fish meat content, but the breaking strength of snacks with fish meat content between 30% and 40% increased with increasing fish meat content. However, our results showed that breaking strength increased with the increase in starch content in the fish snack, although there were some differences depending on the fish species. These results suggest that starch may increase breaking strength in snacks with high meat content, i.e., 50% or more of fish meat.

3.3. Physicochemical Properties of Salmon-70 and Conger-70 Snacks

We investigated the physico-chemical properties of salmon-70 and conger-70 snacks, which are the preferred sensory evaluation methods for salmon and conger eel snacks (Table 3). The moisture content of fish snacks was 4.6% in salmon-70 and 5.4% in conger-70. The protein contents of salmon-70 and conger-70 were 32.4% and 38.6%, respectively, and their contents were not significantly different between the two products. The lipid content of the salmon-70 snack was 16.4%, approximately 60% that of the conger-70 snack. Ash content was significantly higher in salmon-70 snack (9.3%) than in conger-70 snack (5.7%), and calcium and phosphorus were also approximately 70% higher in the salmon snack compared to the conger eel snack. These results may be because fish paste, a raw material for snacks, contains much more bone in the salmon frame than in that of conger eel. The calcium content of the salmon frame muscle was very low (0.02 g/100 g), but the salmon-70 snack (2.3 g/100 g) contained approximately 100-fold more calcium than the muscle [21]. Commercial conger eel snacks using only conger eel frame had a calcium content of 66 g/kg, approximately three times higher than the calcium content of 13.4 g/kg in our conger-70 snack [22]. The absorption of calcium in the body is influenced by various factors, and the ratio of calcium and phosphorus is one factor. The ratio of calcium to phosphorus in human milk is 2.2:1, and its ratio in cow milk is 0.77:1 [23]. The salmon-70 snack had a ratio of calcium to phosphorus of 1.7:1 and the conger-70 snack had a ratio of 1.8:1. These results showed that the ratio of calcium and phosphorus in the fish snacks was closer to that of human milk.

Islam et al. [24] reported that the amount of lead and mercury accumulated in the edible parts of Atlantic salmon was 0.16 and 0.08 mg/kg, and cadmium was not detected. Eels are reported to contain 0.001-0.024 mg / kg cadmium, 0.010-0.018 mg / kg lead and 0.147-0.273 mg / kg mercury, depending on the habitat [25]. The salmon-70 snack exhibited very low levels, even considering the moisture and additive content of the snack, suggesting that heavy metal accumulation may be lower in salmon frames than in other muscle parts. The conger-70 snack contained very low heavy metals, despite the use of whole-conger eel except for viscera. The water activity of the salmon-70 and conger-70 snacks was 0.24 and 0.25, respectively, significantly distant from the water activity limit level above which microorganisms and fungi can grow.

3.4. Peroxide Value (PV) and Acid Value (AV)

Salmon and conger eel snacks do not contain much lipid, as much of it is removed during the retort processing of fish paste. There is still a significant amount of lipid in fish paste, which is the main ingredient of the snack. These lipids are very likely to cause rancidity during storage and may lead to major deterioration in the quality of snacks during distribution. Therefore, the PV and AV of salmon-70 and congerl-70 snacks during storage were

analyzed and the results are shown in Figure 2 and Figure3. PV is a useful method to measure the initial rancidity of unsaturated fats or oils [26]. The initial PV of salmon-70 and conger-70 snacks were 3.3 and 7.1 meq/kg, respectively, but the values gradually increased during storage at 7.4 and 14.6 meq/kg at three months, respectively. The AV increased due to the release of free fatty acids from snack lipids; the values were 2.0 in salmon-70 and 3.6 in conger-70 at the beginning of storage, but increased to 4.4 and 6.9 meq/kg after three months, respectively. There are no PV and AV standards for dried fish in Codex and Korea. However, Codex and Korea set the maximum standards for PV and AV in seasoned dried laver, at 60 meq/kg and 3 mg KOH/g in Codex, 60 meq/kg and 5 mg KOH in Korea [27, 28].

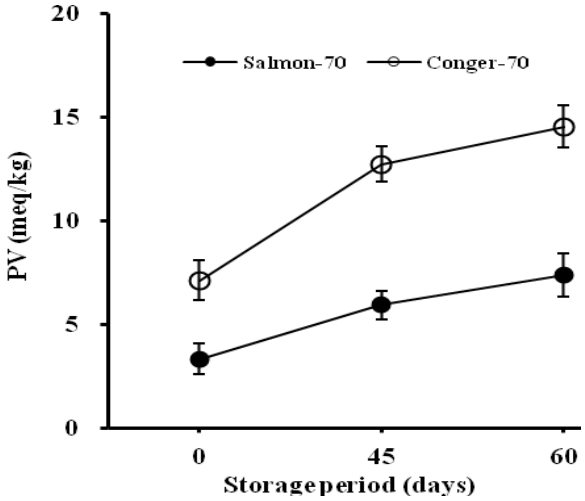

Figure 2. Changes in peroxide value (PV) during storage at 25 °C of salmon-70 and conger-70 snacks (Relationship analysis for PV and storage period in samples were significantly different according to Duncan's test ($P < 0.05$).)

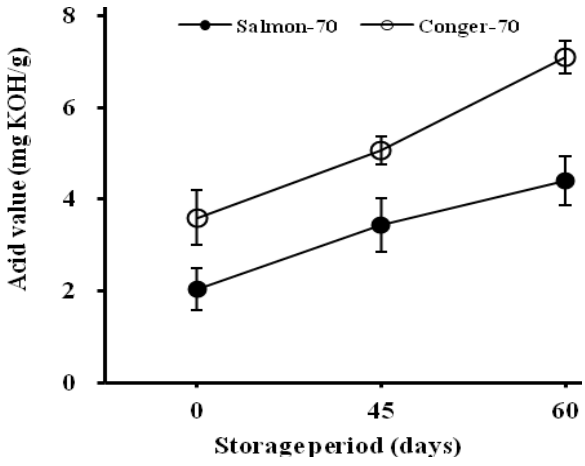

Figure 3. Changes in acid value (AV) during storage at 25°C for salmon-70 and conger-70 snacks (Relationship analysis for AV and storage period in samples were significantly different according to Duncan's test ($p < 0.05$).)

Compared to the seasoned dried laver, PV of salmon-70 and conger-70 did not exceed the Codex standard and Korea standards. The AV of the salmon-70 snack exceeded the Codex standard after 2 months of storage but maintained the standard for three months (Korean standard). The AV of the conger-70 snack exceeded the Codex standard from the early stage of storage and exceeded the Korea standard after 2 months of storage. The high PV and AV in the conger-70 snack may be because the fish paste contains lipid-rich fish heads.

The occurrence of drip after thawing of frozen food is probably due to damage of cell structure and tissue by ice crystal growth during freezing storage. Generally, the expressible drip of frozen food differs depending on its freezing and thawing method and the freshness of the food before freezing. The initial expressible drips of raw oyster before freezing storage increased as the freshness of raw oysters decreased, with values of 9.8 % (S-1), 9.2 % (S-3), 15.9 % (S-5), and 21.6 % w/w (S-7), respectively (Table 2).

3.5. Total Volatile Basic Nitrogen (TVB-N)

Total volatile basic nitrogen (TVB-N), which is caused by degradation of protein and non-protein nitrogen compounds, is used as a quality index for fish meat products [29].

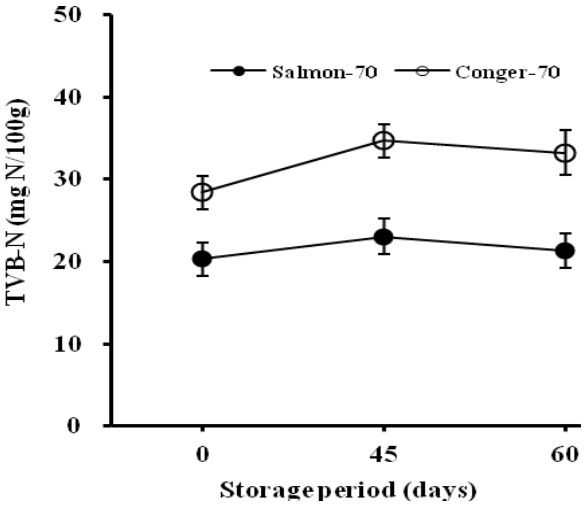

Figure 4. Changes in total volatile basic nitrogen (TVB-N) during storage at 25 °C for salmon-70 and conger-70 snacks. Relationship analysis for TVB-N and storage period in samples showed no significant differences according to Duncan's test ($p < 0.05$)

The initial TVB-N values before storage were 28.4 mg N/100 g for conger-70 and 20.3 mg N/100 g for salmon-70 snacks, which was somewhat higher for conger eel snacks containing fish head. There was no significant difference ($p>0.05$) in TVB-N between storage periods for three months in both samples, likely due to the limited activity of microorganisms and enzymes involved in degradation of the protein because of the extremely low water activity of the snacks (Figure 4).

3.6. Fatty Acid Analysis

The fatty acid composition of salmon consists of major fatty acids such as palmitic acid (17.2%), oleic acid (19.3%), and omega-3 fatty acids such as eicosapentaenoic acid (11.0%) and docosahexaenoic acid (17.6%), although wild salmon varies slightly depending on the habitat environment [30]. The fatty acid composition of salmon-70 snacks using salmon frame only was 11.3% palmitic acid, 40%

oleic acid, 16.4% linoleic acid, and 4.3% and 7.3% eicosapentaenoic acid and docosahexaenoic acid, respectively. For conger eel muscles, palmitic acid (19.9%), oleic acid (36.1%), eicosapentaenoic acid (3.5%) and docosahexaenoic acid (8.3%) constitute the major fatty acids [31]. In our conger-70 snack, oleic acid (23.6%) and docosahexaenoic acid (22.8%) were the highest among the fatty acids, followed by palmitic acid (16.4%) (the saturated fatty acid), and eicosapentaenoic acid, by 9.2% (Table 3).

Table 3. Physio-chemical characteristics and fatty acid content in salmon-70 and conger-70 snacks

Items	Salmon-70	Conger-70
Moisture (g/100 g)	4.6 ± 0.9	5.4 ± 0.8
Lipid (g/100 g)	16.4 ± 1.1	10.5 ± 0.8
Protein (g/100 g)	32.4 ± 2.6	38.6 ± 2.8
Ash (g/100 g)	9.3 ± 0.7	5.7 ± 0.6
Ca (g/kg)	22.9 ± 1.4	13.4 ± 1.2
P (g/kg)	13.1 ± 1.6	7.6 ± 0.8
Cd (mg/kg)	-*	0.34
Pb (mg/kg)	-	0.02
Hg (mg/kg)	0.01	0.09
Hg (mg/kg)	0.24 ± 0.02	0.25 ± 0.02
Fatty acids (mg/100 g)		
Butyric acid	-	-
Capric acid	-	-
Laurid acid	10 ± 0.1	-
Myristic acid	200 ± 2.1	70 ± 2.1
Pentadecanoic acid	200 ± 3.6	10 ± 0.6
Palmitic acid	1,320 ± 15.6	410 ± 11.4
Palmitoeic acid	280 ± 10.6	170 ± 4.8
Margaric acid	30 ± 2.2	10 ± 0.6
Stearic acid	340 ± 13.4	80 ± 5.2
Elaidic acid	30 ± 1.8	20 ± 0.2
Oleic acid	4,510 ± 22.4	590 ± 18.6
Linoleladic acid	20 ± 0.1	30 ± 1.8
Linoleic acid	1,850 ± 12.2	40 ± 1.6
Arachidic acid	20 ± 0.1	10 ± 0.6
γ-Linoleic acid	20 ± 0.2	-
cis-11-Eicosadienoic acid	230 ± 2.8	100 ± 5.0
α-Linolenic acid	790 ± 8.0	40 ± 2.6
cis-11,14-Linolenic acid	150 ± 5.3	20 ± 0.8
dihomo γ-Linolenic acid	50 ± 3.4	10 ± 1.4
Erucic acid	20 ± 0.2	30 ± 2.2
cis-11,14,17-Eicosatrienoic acid	30 ± 1.1	10 ± 0.4
Arachidonic acid	20 ± 0.2	30 ± 1.5
Eicosapentaenoic acid	480 ± 10.3	230 ± 19.2
Nervonic acid	30 ± 0.1	20 ± 2.8
Docosahexaenoic acid	820 ± 17.4	570 ± 28.6
Total	11,270	2,500

*Not detected.

4. Conclusions

The present study examined the physicochemical properties of fish snacks prepared using bone-salmon frames and conger eel containing head and skin. Among the snacks with fish meat contents of 50, 60 and 70%, the salmon-70 and conger-70 snacks with 70% fish meat had the highest score in sensory evaluation. The hardness of the snacks containing 50% or more fish meat content tended to increase as the amount of added starch increased. The acid value and peroxide value of the fish snacks with high lipid contents increased during the storage period of three months. The peroxide value did not exceed the standard value during the storage period when applying the Codex standard for seasoning the dried laver. However, the acid value results exceeded the Codex standard. During the storage period, the volatile basic nitrogen of the snacks was almost unchanged. If proper antioxidants are added to prevent lipid oxidation of fish snacks, fish snacks containing high protein and calcium contents can be produced. In addition, fish snacks are expected to be used as pet food products derived from omega-3 fatty acids and calcium-rich aquatic products in the pet food market, where cattle, pigs, and poultry products are mostly used.

Acknowledgments

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