Korean J. Food Sci. An. Vol. 34, No. 1, pp. 122~126 (2014)
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DOI http://dx.doi.org/10.5851/kosfa.2014.34.1.122
ISSN 1225-8563 eISSN 2234-246X

ARTICLE

Effects of Chicken Breast Meat on Quality Properties of Mackerel (*Scomber japonicus*) Sausage

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Abstract

This study was performed to evaluate the effects of chicken breast meat on the quality of mackerel sausages. The mackerel sausages were manufactured by additions of 5%, 7%, and 10% of chicken breast meat. The lightness of mackerel sausages showed no significant differences between the control and addition groups. The redness increased in a dose-dependent manner, but the yellowness decreased significantly with the addition of 7% chicken breast meat ($p<0.05$). The whiteness value of mackerel sausage added with 7% chicken breast meat was significantly higher than those of the other groups ($p<0.05$). In texture analysis, the hardness and adhesiveness of the mackerel sausage added with 5% of chicken breast meat showed no significant differences as compared to the control. However, the mackerel sausages added with 7% and 10% of chicken breast meat showed a dose-dependent decrease. The gel strength of the mackerel sausage added with 5% chicken breast meat was not significantly different from the control, but the addition of 7% and 10% chicken breast meat reduced the gel strength of the mackerel sausage. In sensory evaluation, the mackerel sausages prepared with chicken breast meat have higher scores in smell, taste, texture, hardness, chewiness, and overall preference as compared to the no addition group. Therefore, these results suggest that the optimal condition for improving the properties within mackerel sausages was 5% addition of chicken breast meat.

Key words: mackerel sausage, texture, chicken breast meat, gel strength

Introduction

Dark-fleshed fish have been paid more attention as a potential alternative raw material for surimi production, due to its high potential for capture and low price (Chaijan *et al*., 2004). However, the problems with producing surimi from dark-fleshed fish, such as mackerel, are a large amount of lipid and sarcoplasmic proteins in dark muscle (Chaijan *et al.,* 2004). These components are associated with its poor gel forming ability (Ochiai *et al.,* 2001). In addition, lipid oxidation can decrease the quality of surimi produced from dark-fleshed fish and may be a limiting factor for shelf-life, causing discoloration and an off-odor, and resulting in protein damage induced by peroxide radicals (Chaijan *et al.,* 2005; Lingnert and Eriksson, 1980; Murakawa *et al.,* 2003). Thus, due to the difficulty of storing mackerel, its uses are limited to frozen, canned or salted product forms compared to its large catches, and it is known to be difficult to be used as a variety of processed products (Lingnert and Eriksson, 1980).

The mackerel processed products, such as mackerel soup powder (Lee *et al*., 1986), mackerel fish cakes (Park *et al.*, 1985), mackerel burger (Lee *et al*., 1993), have been reported. However, their types are limited and studies on manufacturing fish sausage with dark-fleshed fish like mackerel are insufficient. Fish meat sausage has its unique elasticity and textural properties due to the network structure formed by thermal denaturalization of salt-soluble muscle proteins that exist in surimi. Such textural properties will serve as an important quality factor which directly affects the consumers' preferences (Park, 2005). The textural properties of surimi-processed products have been known to be additionally affected by starch, auxiliary protein and hydrophilic colloid that are used as submaterials as well as surimi quality (Park, 2005). Studies on the effects when the appropriate sub-materials are added in order to increase the elasticity of these fish jelly

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products have been reported as follows: the changes in water-holding capacity of fish jelly products according to starch mixing ratios by each type (Lee, 2000), elasticity enhancer addition such as EDTA, PMSF, TGase, collagen (Bae *et al*., 2003), polysaccharides including agar (Niwa *et al*., 1988) and egg albumin (Iso *et al*., 1985).

Therefore, it is expected that the elasticity and texture properties will be able to be increased if appropriate sub-materials are added when manufacturing fish sausage using mackerel which has a low gel forming capability.

Chicken meat, like fish meat, has high salt-soluble protein contents. In particular, it has been reported to have appropriate characteristics for manufacturing surimi since chicken breast meat has less connective tissue (Jin *et al*., 2006). Most of the studies focus on fish meat substitute surimi by utilizing chicken breast meat such as gel formation according to salt concentration and heating conditions (Min, 2001), washing times (Hah *et al*., 2007; Jin *et al*., 2005) and pH control measures (Jin *et al*., 2007; Park *et al*., 2005) rather than adding chicken meat as sub-materials. Jin *et al*. (2008a) have reported that up to 35% of pollack surimi can be substituted by utilizing chicken breast meat surimi when manufacturing fish sausage (Jin *et al*, 2008a). However, to date, there are no studies on improvement of gel forming capability for mackerel meat with the addition of chicken meat.

Therefore, the optimum condition to improve the gel forming capability of mackerel meat was examined by conducting texture properties, gel strength, color measurement and sensory evaluations when manufacturing mackerel fish sausage with the addition of chicken breast meat (5, 7, and 10%).

Materials and Methods

Materials

Crushed mackerel meat was provided from Deungpureun Food, Inc. located in Busan City and stored at 4°C in this experiment. Chicken breast meat was purchased from a large store.

Mackerel sausage manufacturing

The crushed mackerel meat was washed twice with ice water at a ratio of 1:5 (meat : purified water : ice = 2:3:7) for 15 min each and then the water was removed using cloth. The dehydrated meat, 2% salt, 2% sugar, 0.5% phosphate complex, and chicken breast meat (0, 5, 7, and 10%, respectively) were placed in a silent cutter (ST11, ADE Co., Hamburg, Germany) and the mixture was mixed for 5 min. The sausage batter was then stuffed into a polyvinyl-chloride casing (4.3 cm diameter). After undergoing a setting process using a hot air dryer (WFO-600SD, RI-KAKIKAI CO., Tokyo, Japan) for 3 min at 40°C, it was heated at 80°C for 50 min in a boiling tank. After heating, it was cooled in cold water for 40 min and then was stored at 4°C.

Gel strength and texture measurements

Gel strength was measured with a sample (cut into 3 cm in height) using a texture meter (T1-AT2, SMS Co., Tokyo, Japan) at conditions of force 100 g, distance 15 mm, test speed 1.0 mm/s. The measurement was done with four replicates of each sausage. In addition, the samples (cut into 2×2×1.5 cm) were measured for hardness, fracturability, adhesiveness, springiness, cohesiveness, gumminess, chewiness, and resilience using a texture meter (T1-AT2, SMS Co.) at conditions of force 100 g, distance 10 mm, test speed 2.0 mm/s. The measurement was done with five replicates of each sausage.

Color measurement

The samples (cut into 3 cm in height) were measured with a colorimeter (JC 801, Color Technosystem Co., Tokyo, Japan). Lightness (L*), redness (a*), and yellowness (b*) were evaluated. Before data collection, a white calibration plate (L*=93.73, a*=–0.12, b*=0.11) supplied with the instrument was used for calibration. The color was measured five times per sample. Whiteness was calculated using the following equation.

$$\text{Whiteness} = L^* - 3b^*$$

Sensory evaluation

Sensory evaluation was performed by thirteen trained panels (majoring in Food Engineering and belonging to Food Resource Development Laboratory - 4 males and 9 females; age, 21-26 years). The samples were evaluated using a 7-point scale (1, dislike very much; 7, like very much). The samples were sliced into equally sized pieces and presented on a white plastic dish. Color, smell, taste, texture, hardness, chewiness, and overall preference were measured.

Statistical analysis

Statistical evaluation was carried out by a one-way analysis of variance with SAS software (Statistical analytical system V8.2, SAS Institute Inc., Cary, NC, USA). The

differences between means were conducted by Duncan's multiple range test ($p<0.05$).

Results and Discussion

Color

The effect of chicken breast meat (0, 5, 7, and 10%) on color of mackerel sausage is demonstrated in Table 1. In the lightness, there were no significant differences according to the additions of chicken breast meat. The redness was increased in the samples with the addition of 7 and 10%. The yellowness was decreased in the sample with the addition of 7%, but, it did not show any significant difference from the other samples. Whiteness was higher values in all samples with addition of chicken breast meat than that of control. In particular, whiteness was the highest value at the addition of 7% chicken breast meat. Similar results have been reported by several researchers. Jin *et al*. (2007) reported that as a result of manufacturing surimi with chicken breast meat using pH adjustment method, the surimi added with chicken breast meat showed increases in lightness, redness, and yellowness compared with the surimi with pollack. In addition, Hah *et al*. (2007) demonstrated that as a result of manufacturing surimi under various washing times and salt concentrations, the sample with chicken breast meat showed higher lightness, redness, and whiteness values when compared with pollack surimi, but no significant difference were observed in yellowness.

Texture profile analysis

Texture profile analysis parameters of mackerel sausage added with chicken breast meat at various concentrations are shown in Table 2. Hardness and adhesiveness of 5% addition group did not show any significant difference when compared to those of 0% group (no addition); however, in the case of addition of 7% and 10%, the hardness was decreased significantly. This is a similar result to the study reported by Jin *et al*. (2008b) that the higher chicken breast meat surimi substitute ratio for pollack surimi was, the less hardness appeared significantly. Springiness, gumminess, and chewiness did not show any differences in the results between the groups with additions (5, 7, and 10%) and without addition (0%). This is consistent with the result of the study by Jin *et al*. (2008a) that there were no statistical differences in springiness, gumminess and chewiness when measuring the physical properties of both the sausage manufactured with pollack surimi only and the one with both pollack surimi and chicken breast meat surimi (37.5%). In addition, the results of fracturability, cohesiveness and resilience showed no differences between the addition groups and no addition group. Considering the changes in the texture properties and sensory characteristics, the addition of 5% chicken breast meat was found to be the most suitable.

Gel strength

Gel strength of mackerel sausage with the addition of chicken breast meat is shown in Table 3. There was no

Table 1. Changes in color of mackerel sausages by adding with chicken breast meat

	0%	5%	7%	10%
Lightness	68.25±0.19$^{NS1)}$	68.57±0.02	68.68±0.64	68.13±0.04
Redness	1.49±0.03$^{B2)}$	1.42±0.08^{B}	2.06±0.06^{A}	2.01±0.22^{A}
Yellowness	14.73±0.19^{A}	14.40±0.03^{A}	13.84±0.10^{B}	14.40±0.21^{A}
Whiteness (L-3b)	24.06±0.18^{C}	25.37±0.08^{B}	27.15±0.58^{A}	24.92±0.51^{B}

[1)]Not significantly different.
[2)]Means in the same row (A-C) bearing different superscripts are significantly different ($p<0.05$).

Table 2. Changes in texture of mackerel sausages by adding chicken breast meat

	0%	5%	7%	10%
Hardness	6,871.21±18.56$^{A1)}$	6,831.62±20.5^{A}	6,464.40±47.26^{B}	6,383.26±23.37^{B}
Fracturability	108.25±4.66$^{NS2)}$	107.17±4.31	107.46±2.19	107.13±1.06
Adhesiveness	-92.34±3.12^{A}	-87.91±4.23^{A}	-52.40±1.84^{B}	-52.94±2.70^{B}
Springiness	0.74±0.04^{NS}	0.77±0.01	0.79±0.07	0.73±0.04
Cohesiveness	0.23±0.00^{NS}	0.22±0.02	0.24±0.03	0.23±0.01
Gumminess	1,502.35±123.27^{NS}	1,381.21±2.30	1,258.12±23.26	1,238.58±91.33
Chewiness	1,140.75±31.65^{NS}	1,024.62±63.88	1,031.86±7.55	1,075.73±55.48
Resilience	0.07±0.00^{NS}	0.07±0.00	0.07±0.01	0.07±0.00

[1)]Means in the same row (A-B) bearing different superscripts are significantly different ($p<0.05$).
[2)]Not significantly different.

Table 3. Gel strength of mackerel sausages by adding chicken breast meat

	0%	5%	7%	10%
Gel strength (g·cm)	669.27±25.48$^{A1)}$	691.3±10.63^{A}	568.1±28.45^{B}	474.57±29.32^{B}

[1)]Means in the same row (A-B) bearing different superscripts are significantly different (p<0.05).

Table 4. Changes in sensory evaluation of mackerel sausages by adding chicken breast meat

	0%	5%	7%	10%
Color	3.42±0.51$^{NS1)}$	3.42±0.51	3.42±0.51	3.42±0.51
Smell	3.33±0.50^{NS}	3.50±0.69	3.75±0.67	3.67±0.69
Taste	3.25±0.79^{NS}	3.67±0.67	3.75±0.65	3.92±0.70
Texture	3.50±0.52^{NS}	3.75±0.47	3.75±0.92	3.75±0.81
Hardness	3.50±0.93^{NS}	3.92±0.87	4.00±1.14	4.00±1.30
Chewiness	3.33±0.90^{NS}	3.83±1.01	3.83±1.01	4.08±1.26
Overall preference	3.17±0.60$^{B2)}$	3.75±0.65^{AB}	3.92±0.87^{AB}	4.17±0.75^{A}

[1)]Not significantly different.
[2)]Means in the same row (A-B) bearing different superscripts are significantly different (p<0.05).

significant difference between 5% addition group and no (0%) addition group. However, the groups added with 7 and 10% chicken breast meat showed a tendency to decrease. This result was in agreement with Jin *et al*. (2008b) who reported that the higher chicken breast meat surimi substitute ratio for pollack surimi was, the less the gel strength showed (significantly at p<0.05). In addition, Jin *et al*. (2007) reported that when measuring the texture of both the sausage manufactured with Alaska cod meat and the one with chicken breast meat (after washing two times), the sausage manufactured with Alaska cod meat showed higher gel strength. Thus, it is considered that the addition of 5% chicken breast meat should be suitable for manufacturing mackerel sausage because the additions of 7 and 10% chicken breast meat decreased the gel strength of mackerel sausage.

Sensory evaluation

The results of sensory evaluation for mackerel sausages added with chicken breast meat for are shown in Table 4. In the case of color, there were no differences among the treatment groups. The groups with added chicken breast meat scored higher in smell and taste than no addition group, suggesting that applying chicken breast meat can reduce fish odor and off-flavor. There were no significant differences in texture between the addition groups and no addition group. In the cases of hardness and chewiness, the high scores were obtained by the addition of chicken breast meat. However, there were no significant differences according to the chicken breast meat concentration at 5, 7, and 10%. As to overall preference, scores were increased as the concentrations of the chicken breast meat increased. It is suggested that the high overall preference was due to the fact that mackerel sausage softened as chicken breast meat was added. In a similar study, as a result of comparing the quality characteristics of the sausages manufactured with different mixing ratios of pollack surimi, chicken breast meat surimi, and starch (Jin *et al*., 2008a), the sausage mixed with pollack surimi and chicken breast meat showed higher overall preference than the one with only pollack surimi. In conclusion, the gel forming capability did not reduce with the addition of 5% chicken breast meat when manufacturing mackerel sausage. As the groups added with chicken breast meat at concentrations of 5, 7, and 10% obtained good scores in the sensory evaluation, the addition of 5% chicken breast meat is considered to be the most suitable when manufacturing mackerel sausage.

Acknowledgements

This work (Grants No. C0024463) was supported by Business for Cooperative R&D between Industry, Academy, and Research Institute funded Korea Small and Medium Business Administration in 2012.

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(Received 2013.7.12/Revised 2014.1.24/Accepted 2014.2.2)