EFFECTS OF DUCK FEET GELATIN ON QUALITY PROPERTIES OF LOW-FAT SAUSAGES

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Abstract - The objective of this study was conducted to evaluate the effects of duck feet gelatin, as a fat replacer, on quality characteristics of low-fat sausages.
Addition of duck feet gelatin improved cooking yield of low-fat sausages. However, there were no significant differences among the low-fat sausages with duck feet gelatin levels. The increase in replacement ratio of back fat with duck feet gelatin resulted in the increased moisture and protein contents, and decreased fat content. For color parameter, yellowness of low-fat sausages significantly decreased with increasing the replacement ratio. In addition, the replacement of back fat with duck feet gelatin improved textural properties of low-fat sausages. Consequently, the duck feet gelatin would be a novel source of a fat replacer for improving cooking yield and textural properties of low-fat sausages.

Key Words – Duck feet, Gelatin, Low-fat sausage

I. INTRODUCTION

Major constituent of skin, tendon, and connective tissue is composed of collagen, and it account for approximately one third of total proteins in the body [1]. Gelatin is one of the proteins derived from collagen and produced from collagen with irreversible hydrolysis of collagen. This protein occupies a unique position in the theoretical and practical world of chemistry [2]. Especially, in meat industry, gelatin which has several technological properties, such as gel formation, texturizing, and water holding capacity, is a useful additive for improving quality characteristics of several types of meat products [3].

Generally, gelatin was extracted from pig skin or hide of cow with acidic or alkali treatments. Recently, it makes issue of alternative source of gelatin for many years due to the emergence of bovine spongiform encephalopathy and foot-and-mouth disease [4]. For these reasons, many researchers have been trying to develop and fish by-product has been considered as safe source of gelatin [5].

Poultry by-products including skin and feet contains large amounts of collagen. For chicken skin, a major component of collagen is type I collagen (75%) and type III collagen (15%) [6]. However, there is little information about characteristics of duck feet gelatin and its application to meat products.

Therefore, the objective of this study was determined to investigate the effect of duck feet gelatin, as a fat replacer, on the quality properties of low-fat sausage.

II. MATERIALS AND METHODS

1. Preparation of duck feet gelatin

Fresh duck feet were obtained from a local market, and washed to remove dirt and blood. Visible fat was removed and vacuum-packaged with using a vacuum packaging system and stored at -20 °C until use. Frozen duck feet were thawed in flowing tap water and soaking in 0.1 N HCl solution in 5 times (v/w) for 24 h. After soaking, flowing tap water is used for neutralizing duck feet for 48 hr (pH 5.5). For extraction, the ratio of duck feet and water was 1 : 1 and heated at 75 °C in a water for 6 h. The gelatin extracts from duck feet was filtered with sanitary cotton bag to remove residues and cooled at 4 °C. The gelatin extract was cut into 1 × 1 × 1 cm^3 pieces and frozen at -70 ± 1 °C. Freeze-drying of the sample was conducted under 80 × 10^{-3} torr pressure at -130 °C using a freeze-dryer (PVTFD20R, Ilshinlab, Republic of Korea). The dry matter was referred to as 'gelatin powder' and vacuum-packaged.

2. Manufacture of low-fat sausage

The gelatin powder was dissolved at 60 °C with water to prepare 20% gelatin gel solution (w/w) and cooled down at 4 °C. After cooling, the duck feet gelatin gel (DG) was cut with knife in 1 × 1 × 1 cm^3. The pork and pork back fat were ground through an 8 mm plate. The pork and DG were homogenized and ground for 1 min in a silent cutter (Cutter Nr-963009, Scharfen, Germany). Then other additives were added to the meat emulsion. The formulation of low-fat sausages is shown in Table 1. A temperature probe (Kane-May, KM330, Germany) was used to monitor the temperature of the emulsion, which was maintained below 10 ˚C during batter preparation. After emulsification, meat batter was stuffed into collagen casings (approximate diameter of 25 mm) using a stuffer (Stuffer IS-8, Sirman, Italy) and the sample were heated at 75 ˚C 40 min in a smoker (MAXI 3501, Kerres, Backnang, Germany). The cooked sausages were cooled and then used to analysis.

Table 1. Formulations of low-fat sausages

Ingredients (%)	Treatments[1)]				
	Con	Con-L	T1	T2	T3
Pork	60	60	60	60	60
Ice(total)[2)]	20(20)	30(30)	20(28)	20(30)	20(32)
Back fat	20	10	10	7.5	5
DG[3)]	0	0	10	12.5	15
Total	100	100	100	100	100
NPS[4)]	1.2	1.2	1.2	1.2	1.2
Ascorbic acid	0.02	0.02	0.02	0.02	0.02
Phosphate	0.3	0.3	0.3	0.3	0.3
Sugar	0.5	0.5	0.5	0.5	0.5
ISP	1	1	1	1	1
Bockwurst	0.4	0.4	0.4	0.4	0.4
Wheat fiber[5)]	1	1	1	1	1

[1)]Con, 20% back fat; Con-L, replacement of 10% back fat with only water; T1, replacement of 10% back fat with DG; T2, replacement of 12.5% back fat with DG; T3, replacement of 15% back fat with DG.
[2)] Figure in parenthesis means total amount of water containing water in DG.
[3)] DG: duck feet gelatin gel (20%, w/w).
[4)] NPS: nitrite pickled salt (99.4:0.6).
[5)] Wheat fiber was dissolved in water with a half level of ice except for Con-L (one third level of ice).

3. Analytical methods

To determine the quality characteristics of low-fat sausages, cooking yield, proximate compositions [7], color evaluations, and texture profile analysis (TPA) were conducted.

4. Statistical analysis

Analysis of variance was performed on all the variables measured using the General Linear Model (GLM) procedure of the SAS statistical package [8]. Duncan's multiple range test (p<0.05) was used to determine the differences between treatment means.

III. RESULTS AND DICSUSSION

Cooking yields of low-fat sausage are shown in Figure 1. Con had the highest cooking yield among all treatments, whereas the cooking yield of Con-L treatment was the significantly lowest (p<0.05). Although Con-L and T1 were prepared with the identical back fat content, T1 treatment was significantly higher cooking yield than that of Con-L (p<0.05). Con-L and T2 were formulated with same amount of water, however, T2 had a significantly higher cooking yield than Con-L (p<0.05).

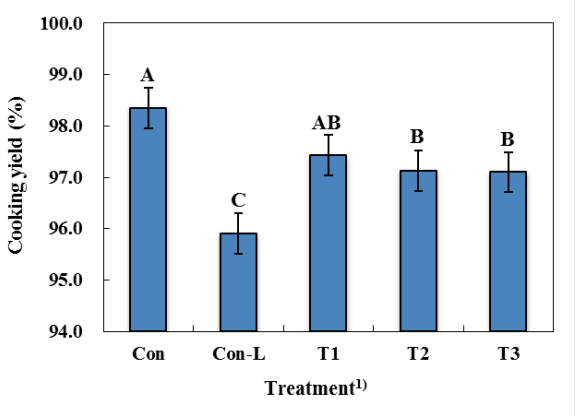

Figure 1. Effect of replacing back fat with duck feet gelatin gel (DG) on cooking yield of low-fat sausages.
[1)]Con, 20% back fat; Con-L, replacement of 10% back fat with only water; T1, replacement of 10% back fat with DG; T2, replacement of 12.5% back fat with DG; T3, replacement of 15% back fat with DG.

[A-C]Means with different superscript letters are significantly different ($p<0.05$).

There is no significances among the low-fat sausages formulated with DG ($p>0.05$) but it has differences between Con and sample which include gelatin. According to Osburn [9], gel of connective tissue protein can be potential water binder for low-fat meat product.

Table 2 shows the proximate composition of low-fat sausage prepared with DG. Moisture content and protein content of the low-fat sausages increased ($p<0.05$) with increasing replacement ratio of back fat with DG. Con showed the highest fat content among all treatments ($p<0.05$). In addition, the increase in the replacement ratio back fat with DG resulted in significantly decreased fat content of low-fat sausages ($p<0.05$).

Table 2. Proximate composition of low-fat sausage prepared with duck feet gelatin gel (DG)

Traits (%)	Treatments[1)]				
	Con	Con-L	T1	T2	T3
Moisture	63.09 ±0.68^{D}	71.42 ±0.31^{B}	69.82 ±0.66^{C}	71.35 ±0.71^{B}	72.88 ±0.68^{A}
Protein	13.60 ±0.47^{C}	14.91 ±0.47^{B}	17.06 ±0.64^{A}	17.20 ±0.55^{A}	17.96 ±0.88^{A}
Fat	19.24 ±0.92^{A}	11.28 ±0.89^{B}	10.49 ±0.74^{B}	8.46 ±0.79^{C}	6.34 ±0.94^{D}
Ash	1.83 ±0.08^{AB}	1.76 ±0.05^{B}	1.80 ±0.04^{AB}	1.81 ±0.02^{AB}	1.86 ±0.07^{A}

All values are mean ± SD.
[1)]Con, 20% back fat; Con-L, replacement of 10% back fat with only water; T1, replacement of 10% back fat with DG; T2, replacement of 12.5% back fat with DG; T3, replacement of 15% back fat with DG.
[A-D]Means in a row with different superscript letters are significantly different ($p<0.05$).

The effects of replacement of back fat with DG on color parameter of low-fat sausages are shown in Table 3. As duck feet gelatin was added, lightness of sausages were significantly decreased and yellowness of them were significantly increased ($p<0.05$) but redness has no difference ($p>0.05$). The yellowness of low-fat sausages would be affected by color characteristics of duck feet gelatin.

Table 3. Effect of replacing back fat with duck feet gelatin gel (DG) on color parameters of low-fat sausages

Traits	Treatments[1)]				
	Con	Con-L	T1	T2	T3
CIE L*	69.63 ±0.33^{A}	70.61 ±1.14^{A}	67.71 ±1.53^{B}	66.36 ±1.32^{C}	65.87 ±1.13^{C}
CIE a*	9.36 ±0.43	9.00 ±0.40	9.05 ±0.91	8.96 ±0.87	8.97 ±0.45
CIE b*	10.75 ±0.44^{B}	11.18 ±0.71^{B}	11.21 ±0.45^{B}	11.99 ±0.67^{A}	12.00 ±0.85^{A}

All values are mean ± SD.
[1)]Con, 20% back fat; Con-L, replacement of 10% back fat with only water; T1, replacement of 10% back fat with DG; T2, replacement of 12.5% back fat with DG; T3, replacement of 15% back fat with DG.
[A-C]Means in a row with different superscript letters are significantly different ($p<0.05$).

Replacement of back fat with only water caused the decreased hardness, cohesiveness, gumminess, and chewiness, but DG improved these textural parameters of low-fat sausages (Table 4).

Table 4. Texture profile analysis (TPA) of low-fat sausage formulated with duck feet gelatin gel (DG)

Traits	Treatments[1)]				
	Con	Con-L	T1	T2	T3
Hardness (kg)	5.48 ±0.43^{C}	4.08 ±0.25^{D}	7.43 ±0.35^{B}	7.57 ±0.59^{B}	8.67 ±0.68^{A}
Cohesiveness	0.42 ±0.02^{B}	0.32 ±0.05^{C}	0.48 ±0.07^{A}	0.47 ±0.05^{A}	0.51 ±0.07^{A}
Gumminess (kg)	2.44 ±0.30^{C}	1.29 ±0.16^{D}	3.77 ±0.40^{B}	3.52 ±0.28^{B}	4.35 ±0.66^{A}
Springiness	0.78 ±0.01^{D}	0.85 ±0.02^{C}	0.86 ±0.03^{BC}	0.88 ±0.03^{B}	0.90 ±0.02^{A}
Chewiness (kg)	1.89 ±0.22^{C}	1.04 ±0.14^{D}	3.19 ±0.33^{B}	3.28 ±0.28^{B}	4.24 ±0.74^{A}

All values are mean ± SD.
[1)]Con, 20% back fat; Con-L, replacement of 10% back fat with only water; T1, replacement of 10% back fat with DG; T2, replacement of 12.5% back fat with DG; T3, replacement of 15% back fat with DG.
[A-D]Means in a row with different superscript letters are significantly different ($p<0.05$).

IV. CONCLUSION

Duck feet gelatin gel improved the cooking yield and textural properties of low-fat sausages, and duck feet can be a useful ingredient of gelatin.

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