THE EFFECT OF PORK GELATIN POWDER AND WHEAT FIBER ON QUALITY CHARACTERISTICS OF LOW FAT EMULSION TYPE SAUSAGE

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Abstract – The addition of pork gelatin powder (PGP) and wheat fiber (WF) to emulsion type sausage on quality characteristics were examined. The following four treatments groups were used: Con (without PGP and WF), GW1 (with 2% PGP and WF), GW2 (with 3% PGP and WF), GW3 (with 4% PGP and WF). The chemical composition, calorie, cooking yield, emulsion stability, texture, and sensory properties were measured. As increasing in the addition of PGP and WF, the moisture and protein contents increased, but the fat contents and calorie values significantly decreased (*P*<0.05). GW2 and GW3 had more stable emulsion, higher cooking yield and higher hardness than control. In the sensory evaluation, GW2 had no significant difference with Con excluding overall acceptability, however GW3 had the lowest score in juiciness, tenderness, and overall acceptability. This study suggests the addition of PGP and WF could reduce fat and improve quality of emulsion-type sausage.

Key Words – dietary fiber, pork gelatin powder, reduced-fat sausage.

I. INTRODUCTION

Emulsion-type sausage is typical meat product that has been consumed worldwide since early times. In traditional emulsion-type sausage, fat content is around 30%. Fat improves quality characteristics, such as stable meat emulsion, less cooking yield, improving flavor and tenderness [1], [2]. But high fat consumption causes to increasing intake of saturated fatty acid, which can cause obesity, cardiovascular disease, and high blood pressure. For these reasons, many studies suggested various fat replacers which decrease fat contents in emulsion sausage without deterioration of quality characteristics [3].

Gelatin generally derived from the collagen inside animal skin, collagen was known for improving cooking yield and product color on frankfurter-type sausage [4]. Dietary fiber can improve technological properties, such as cooking yield, texture quality [5]. The aim of this study was to evaluate the effect of pork gelation powder (PGP) and wheat fiber (WF) as a fat replacer which can improve quality characteristics of low fat emulsion type sausage. The chemical composition, calorie analysis, cooking yield, emulsion stability, texture profile analysis, and sensory evaluation were measured.

II. MATERIALS AND METHODS

2.1. Preparation of Pork Gelatin Powder (PGP) and Wheat Fiber (WF) and Emulsion Type Sausage

Fresh pork hams and back fats were purchased from a pilot plant at Konkuk University, Korea, 48 h postmortem. All subcutaneous and intramuscular fat and visible connective tissues were removed from the fresh ham muscles. The formulation of the emulsion type sausages with PGP (Sias, Cheongwon, Korea) and WF (Central fiber chemical Inc., Seoul, Korea) is presented in Table 1. The pork hams and back fat were grinded through a 3 mm plate. The ground pork ham and back fat, PGP, WF, ice, salt, phosphate, and isolated soy protein (ISP) were emulsified using a silent cutter (Nr-963009, Scharfen, Witten, Germany). After emulsification, the meat batter was stuffed into collagen casings (NIPPI Inc, Tokyo, Japan; approximate 25 mm diameter) using a stuffer (IS-8, Sirman, Marsango, Italy), and the samples were heated at 80 °C for 40 min in a smoker (MAXI 3501, Kerres, Backnang, Germany). The cooked sausages were then cooled with cold water and stored at 4 °C until testing.

Table 1 Formulations (%) of low-fat emulsion type sausages with different level of PGP and WF

Traits	Treatments			
	Con	GW1	GW2	GW3
Pork meat	50	50	50	50
Pork back fat	30	20	15	10
Pork Gelatin powder	-	2	3	4
Wheat fiber	-	2	3	4
Ice	20	26	29	32
Total	100	100	100	100
Salt	1.5	1.5	1.5	1.5
ISP[1)]	0.4	0.4	0.4	0.4
Phosphate[2)]	0.2	0.2	0.2	0.2

[1)]ISP : isolated soy protein
[2)]Phosphate : sodium tri-polyphosphate

2.2. Chemical compositions

The chemical compositions of the samples were determined using standard AOAC (2000) methods [6]. The moisture content was determined based on the weight loss after 12 h of drying at 105ºC in a drying oven (SW-90D, Sang Woo Scienctific Co., Bucheon, Korea). The fat content was determined using the Sohxlet method with a solvent extraction system (Soxtec® Avanti 2050 Auto System, Foss Tecator AB, Höganas, Sweden). The protein content was determined using the Kjeldahl method with an automatic kjeldahl nitrogen analyzer (Kjeltec® 2300 Analyzer Unit, Foss Analytical AB, Höganäs, Sweden) and the ash content was determined according to the AOAC (2000) method.

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2.3. Calorie analysis

Calorie values of cooked sausage samples were determined by measuring the heat of the samples using a Bomb-calorimeter (Parr 1261, Paff Co., Frankfurt, Germany).

2.4. Cooking yield

The meat mixture was weighed (80 g) and stuffed into collagen casings and then heat processed at 80 ± 1 °C for 40 min. After cooling for 30 min, the cooked sausages were weighed and the percentage cooking yield was calculated from the weights.

Cooking yield (%) = [weight of sausage after cooking (g) / weight of sausage before cooking (g)] × 100

2.5. Emulsion stability

The meat batters were analyzed for emulsion stability using the method of Ensor *et al* with the following modifications [7]. At the middle of a 15 mesh sieve (50 mm diameter), pre-weighed graduated glass tubes (Pyrex Chojalab Co., Korea, Volume: 15 ml, Graduated units: 0.2 ml were filled with batter. The glass tubes were closed and heated for 30 min in a boiling water bath to a core temperature of 75±1 ºC. They were then cooled to approximately 4 ºC to facilitate the separation of the fat and water layers. The fluid water and fat, which separated well in the bottom of the graduated glass tube, were measured in milliliters and calculated as percentages of the original weight of the batter.

Fat loss (%) = [the fat layer (mL) / weight of raw meat batter (g)] × 100
Water loss (%) = [the water layer (mL) / weight of raw meat batter (g)] × 100

2.6. Texture profile analysis (TPA)

The TPA was performed in duplicate on each sample. Samples were cooked as previously described. The cooked sausage was cooled at room temperature for 30 min and the textural properties were measured. The textural properties of each sausage were measured using a spherical probe (5 diameter), attached to a texture analyzer (TA-XSK1*i*, Stable Micro System Ltd., Surrey, UK). The test conditions were as follows: stroke, 20 g; test speed, 2.0 mm/s; and distance, 20.0 mm. Data were collected and analyzed in terms of hardness (N), cohesiveness, springiness, gumminess (N), and chewiness (N) values.

2.7. Sensory evaluation

The cooked sausage samples were evaluated color of appearance, flavor, warmed-over flavor, and overall acceptability. The samples as previously described were cooled to room temperature at 25±1 ºC and cut and served to the panelists in random order. The sensory evaluation was performed by the panelists under fluorescence lighting. Panelists were instructed to cleanse their palates between samples using water. The appearance, color, flavor, warmed-over flavor, and overall acceptability (1 = extremely undesirable, 10 = extremely desirable) of the samples were evaluated using a 10-point descriptive scale. The trained sensory panel consisted of 12 members from the Konkuk university.

2.8. Statistical analysis

An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SAS statistical package (SAS, Cary, NC, USA) (2010) [8]. Duncan's multiple range tests (P<0.05) was used to determine differences between treatment means.

III. RESULTS AND DISCUSSION

The chemical compositions and calorie of the emulsion type sausages with different level of PGP and WF are presented in Table 2. As increase in PGP and WF, the moisture and protein contents increased and fat contents and calorie decreased (P<0.05) because the pork back fat replaced with PGP, WF and water. Especially, GF3 reduced fat content by 66.4% than Con.

Table 2 Chemical compositions (%) and calorie (Kcal/100 g) in low fat emulsion type sausages with different level of PGP and WF

Traits	Treatments[1)]			
	Con	GW1	GW2	GW3
Moisture	55.84± 0.55^{D}	60.31± 0.61^{C}	63.87± 0.59^{B}	67.01± 0.71^{A}
Fat	26.46± 0.24^{A}	22.35± 0.31^{B}	16.75± 0.15^{C}	14.06± 0.17^{D}
Protein	13.63± 0.10^{C}	14.64± 0.36^{B}	16.09± 0.15^{A}	16.51± 0.35^{A}
Ash	2.05± 0.11	2.10± 0.12	2.17± 0.14	2.21± 0.17
Calorie	297.93± 0.90^{A}	262.65± 0.73^{B}	220.56± 0.87^{C}	197.85± 0.65^{D}

All values are mean ± SD of the three replicates.

$^{A–D}$Means sharing different letters in the same row are significantly different (P<0.05).

[1]Control: sausage without pork gelatin powder and wheat fiber, GW1: sausage with 2% pork gelatin powder and 2% wheat fiber, GW2: sausages with 3% pork gelatin powder and 3% wheat fiber, GW3: sausages with 4% pork gelatin powder and 4%wheat fiber.

Table 3 Cooking yield (%) and emulsion stability (%) in low fat emulsion type sausages with different level of pork gelation powder and wheat fiber

Traits	Treatments[1)]			
	Con	GW1	GW2	GW3
Cooking yield	95.15± 0.28^{B}	95.21± 0.13^{B}	95.65± 0.30^{A}	95.34± 0.48^{A}
Fat loss	1.64± 0.02^{A}	1.24± 0.22^{A}	1.31± 0.29^{A}	0.54± 0.15^{B}
Water loss	3.25± 0.04^{AB}	3.99± 0.38^{A}	3.05± 0.25^{AB}	2.58± 0.30^{B}

All values are mean ± SD of the three replicates.

$^{A,\ B}$Means sharing different letters in the same row are significantly different (P<0.05).

[1)]Treatments are the same as in Table.1

Cooking yield and emulsion stability in low fat emulsion type sausages were displayed in Table 3. GW2 and GW3 showed the higher cooking yield than Con, especially GW3 had most stable meat emulsion than the others (P<0.05). These increase of cooking yield and emulsion stability because PGP and WF may act as emulsifier, by improving water and fat binding capacity.

Table 4 and Table 5 displayed respectively TPA and sensory evaluation in low fat sausage with different level of PGP and WF. The addition of PGP and WF caused to sharply increase in hardness value. Excessive hardness value means decrease of tenderness. And this increase of hardness indicates that PGP and WF had strong water-holding capacity in emulsion type sausage. Too high water-holding capacity leads to decrease juiciness of emulsion type sausage because of preventing to exude meat juice from sausages to mouth. Thus, GW 3 presented the lowest score in tenderness and juiciness.

IV. CONCLUSION

The addition of PGP and WF can improve nutritional and functional properties. PGP and WF increase protein content and decrease fat content and calorie without quality deterioration. That means these materials were effective fat replacer. In this study, GW2 containing 3% PGP and 3% WF was best addition level to replace animal fat for satisfying various aspects of quality characteristics.

Table 4 Texture profile analysis (TPA) in low fat emulsion type sausages with different level of PGP and WF

Traits	Treatments[1)]			
	Con	GW1	GW2	GW3
Hardness (N)	50.10± 1.41^{D}	59.89± 0.61^{C}	74.39± 0.59^{B}	87.86± 0.71^{D}
Cohesiveness	0.65± 0.09	0.54± 0.16	0.54± 0.04	0.52± 0.08
Springiness	0.85± 0.01^{B}	0.88± 0.01^{A}	0.87± 0.02^{A}	0.87± 0.01^{A}
Gumminess (N)	32.55± 4.38^{B}	31.91± 9.07^{B}	40.56± 5.88^{AB}	45.62± 7.62^{A}
Chewiness (N)	27.70± 3.67^{B}	27.99± 8.21^{B}	35.26± 4.70^{AB}	39.73± 6.39^{A}

All values are mean ± SD of the three replicates.
$^{A\text{-}D}$ Means sharing different letters in the same row are significantly different (P<0.05).
[1)]Treatments are the same as in Table.1

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Table 5 Sensory evaluation in low fat emulsion type sausages with different level of PGP and WF

Traits	Treatments[1)]			
	Con	GW1	GW2	GW3
Color[2)]	8.11± 0.33	8.11± 0.33	8.00± 0.50	7.78± 0.44
Flavor	8.33± 0.50	8.11± 0.60	8.00± 0.71	8.11± 0.78
Tenderness	8.22± 0.44^{A}	7.89± 0.93^{AB}	7.44± 0.88^{AB}	7.33± 0.87^{B}
Juiciness	8,33± 0.50^{A}	7.89± 0.78^{AB}	7.56± 0.88^{AB}	7.11± 1.05^{B}
Warm-off flavor	9.22± 0.67	8.78± 0.67	8.78± 0.67	8.78± 0.67
Overall acceptability	8,33± 0.50^{A}	8.22± 0.67^{A}	7.56± 0.88^{B}	7.33± 0.50^{B}

All values are mean ± SD of the three replicates.
$^{A,\ B}$Means sharing different letters in the same row are significantly different (P<0.05).
[1]Treatments are the same as in Table.2
[2] Color, Flavor, Tenderness, Juiciness, Warmed-over flavor, and Overall acceptability: 1 = extremely undesirable, 10 = extremely desirable

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