EFFECTS OF COLLOIDAL MICROCRYSTALLINE CELLULOSE AND COLLAGEN POWEDER MIXTURE ON LOW FAT SAUSAGE AS FAT REPLACER

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Abstract – The objective of this study was to evaluate the effects of colloidal microcrystalline cellulose (CMC), collagen powder mixture (MCM) on low fat sausage as fat replacer. This study was investigated fat contents, cooking loss, emulsion stability, texture profile analysis (TPA) and sensory evaluation of low fat sausage while replacing pork fat from 25% to 75%. The following four treatment groups were measured: Control (without MCM), RF1 (replacing 25% pork back fat with MCM), RF2 (replacing 50% pork back fat with MCM), RF3 (replacing 75% pork back fat with MCM). Cooking loss and water loss of treatments were higher than control (p<0.05). However fat loss and sensory evaluation value of all treatments showed no significant differences with control (p>0.05). In textural properties, Control had the highest springiness, whereas low fat treatments had higher hardness, cohesiveness, gumminess, and chewiness (p<0.05). The results of this study show that MCM should successfully reduce and replace pork back fat without quality deterioration of emulsion sausage.

Key Words – fiber-collagen powder mixture, quality characteristics, reduced-fat sausage.

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I. INTRODUCTION

Emulsion type sausage is typical and traditional meat product that had widely consumed. Normal emulsion-type sausage was high in fat content that reached 20 to 30%. Fat content in sausage play important role that contains improving quality characteristics and enhancing tenderness and flavor [1]. However recent consumers tend to avoid food with a high fat content, because high fat consumption can cause various adult diseases such as cardiovascular disease, obesity, and high blood pressure. For these reason, many researchers studied various kinds of fat replacers which didn't decrease quality characteristics of meat product.

CMC is one of coordinative dietary fiber that is used as fat replacer. Monika *et al*. reported microcrystalline cellulose reduces of bat around 50% in fried beef patties [2]. Collagen is protein of the connective tissues in animal. Previous study reported that collagen improved cooking yield and product color on frankfurter-type sausage [3].

The aim of this study was evaluated the suitability of MCM as a fat replacer by investigating fat contents, cooking loss, emulsion stability, TPA, and sensory evaluation of low fat sausage.

II. MATERIALS AND METHODS

2.1. Preparation of CMC and collagen powder mixture and emulsion type sausage

CMC used Vitacel® MCG (J. Rettenmaier & Söhne GmbH, Germany) and collagen powder used CAPork 90 (CAP DIANA, France). Mxture (MCM) was prepared with the following formulations: CMC (10%), collagen poweder (10%), and ice (80%). For the MCM, CMC, collagen powder and ice were emulsified using a silent cutter (Nr-963009, Scharfen, Germany).

Fresh pork hams and back fats were purchased from a pilot plant at local market, Korea, 48 h postmortem. A ll subcutaneous and intramuscular fat and visible connective tissues were removed from the fresh ham muscles. The formulation of the emulsion type sausages with MCM 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, MCM, ice, salt, phosphate, and isolated soy protein (ISP) and so on were emulsified using a silent cutter (Nr-963009, Scharfen, Germany). After emulsification, the meat batter was stuffed into collagen casings (#240, NIPPI Inc., Japan; approximate 25 mm diameter) using a stuffer (IS-8, Sirman, Italy), and the samples were heated at 75 °C for 40 min in a smoker (MAXI 3501, Kerres, Germany). The cooked sausages were then cooled with cold water and stored at 4 °C until testing.

Table 1. Formulations (%) of low fat sausages with different addition level of MCM

Traits	Treatments[1)]			
	Control	RF1	RF2	RF3
Pork meat	60	60	60	60
Pork back fat	20	15	10	5
MCM	-	5	10	15
Ice	20	20	20	20
Total	100	100	100	100
Salt	1.2	1.2	1.2	1.2
ISP	0.4	0.4	0.4	0.4
Phosphate[1)]	0.3	0.3	0.3	0.3

[1)] Phosphate: sodium tri-polyphosphate

2.2. Fat contents

The fat contents were determined using the Sohxlet method with a solvent extraction system (Soxtec® Avanti 2050 Auto System, Foss Tecator AB, Höganas, Sweden).

2.3. Cooking loss

The meat mixture was weighed (80 g) and stuffed into collagen casings and then heat processed at 75 ± 1 °C for 40 min. After cooling for 30 min, the cooked sausages were weighed and the percentage cooking loss was calculated from the weights.

Cooking loss (%) = [1-weight of sausage after cooking (g) / weight of sausage before cooking (g)] × 100

2.4. Emulsion stability

The meat batters were analyzed for emulsion stability using the method of Ensor *et al* with the following modifications [4]. 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

2.5. Texture profile analysis (TPA)

The TPA was performed in triplicate 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 mm 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 (kg), cohesiveness, springiness, gumminess (kg), and chewiness (kg) values.

2.6. 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 15 members from the Konkuk University.

2.7. 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) (2013) [5]. Duncan's multiple range tests (p<0.05) was used to determine differences between treatment means.

III. RESULTS AND DISCUSSION

Fat contents, cooking loss and emulsion stability of low fat sausages are exhibited in Table 2. Fat contents was proportionally decreased with replacing pork back fat ratio ($p<0.05$). However, fat contents showed slightly higher value than formulation level because higher cooking loss of treatments caused little accumulation of fat.

Generally, increasing addition level of CMC and collagen powder caused decreasing cooking loss [6], [3]. This study had shown conflicting result that cooking loss is slightly increased in spite of increasing addition level of MCM (CMC and collagen powder mixture) ($p<0.05$), because MCM was composed of mostly water. Higher water content in fat replacer had a negative effect on water loss in emulsion stability. However amount of cooking loss was minimal in relation to an addition percentage of water as a result of water holding capacity of MCM.

Table 2. Fat contents (%), cooking loss (%) and emulsion stability (%) of low fat sausages with different addition level of MCM

Traits	Treatments[1)]			
	Control	RF1	RF2	RF3
Fat contents	20.45± 0.24^{A}	16.08± 0.19^{B}	11.71± 0.49^{C}	7.35± 0.75^{D}
Cooking loss	4.95± 0.22^{C}	5.23± 0.59^{BC}	5.61± 0.28^{AB}	6.05± 0.17^{A}
Fat loss	0.40± 0.01	0.59± 0.28	0.40± 0.01	0.40± 0.01
Water loss	3.19± 0.51^{C}	9.00± 2.15^{B}	9.50± 1.55^{B}	12.06± 2.92^{A}

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) Treatments are the same as in Table 1.

Table 3 and 4 showed respectively TPA and sensory evaluation in low fat sausage replaced pork back fat with MCM. Increasing the added amount of MCM led to increase of hardness, cohesiveness, gumminess, chewiness and decrease of springiness ($p<0.05$). Similar to this result, Penfield *et al*. [7] reported that restructured beefsteak showed hard texture when decreasing fat contents. Deterioration of sensory properties is most critical problem of low fat sausage with fat replacers. However, in this study, there were no significant differences in all sensory evaluation ($p>0.05$). RF2 displayed slightly higher color, flavor tenderness, off flavor score than control ($p>0.05$). This means MCM acted effective fat replacer in low fat sausage.

Table 3. Texture profile analysis (TPA) of low fat sausages different addition level of MCM

Traits	Treatments[1)]			
	Control	RF1	RF2	RF3
Hardness (kg)	6.40± 0.78^{C}	6.37± 0.27^{B}	8.24± 0.63^{A}	8.39± 0.52^{A}
Cohesiveness	0.92± 0.02^{A}	0.81± 0.09^{B}	0.80± 0.03^{B}	0.78± 0.07^{B}
Springiness	0.27± 0.03^{C}	0.29± 0.03^{BC}	0.32± 0.03^{AB}	0.34± 0.02^{A}
Gumminess (kg)	1.38± 0.21^{C}	1.82± 0.20^{B}	2.61± 0.34^{A}	2.72± 0.21^{A}
Chewiness (kg)	1.27± 0.19^{B}	1.47± 0.20^{B}	2.08± 0.29^{A}	2.11± 0.19^{A}

All values are mean ± SD of the three replicates.

A-C Means sharing different letters in the same row are significantly different ($p<0.05$).

1) Treatments are the same as in Table 1.

Table 4. Sensory evaluation of low fat sausages with different addition level of MCM

Traits	Treatments[1)]			
	Control	RF1	RF2	RF3
Color[2)]	7.89± 0.78	7.89± 0.78	8.11± 0.60	8.00± 0.71
Flavor	7.89± 0.60	7.89± 0.60	8.00± 0.71	7.78± 0.97
Tenderness	7.78± 0.67	7.78± 0.83	8.00± 0.71	7.56± 0.88
Juiciness	7.89± 0.93	8.00± 0.87	7.89± 0.93	7.67± 1.12
Off flavor	8.00± 1.00	7.89± 1.17	8.11± 0.93	7.78± 1.20
Overall acceptability	8.00± 0.71	7.78± 0.67	8.00± 0.71	7.44± 0.88

All values are mean ± SD of the three replicates.

1) Treatments are the same as in Table 1.

2) Color, Flavor, Tenderness, Juiciness, Off flavor, and Overall acceptability: 1 = extremely undesirable, 10 = extremely desirable

IV. CONCLUSION

RF2 treatments showed suitable cooking loss, texture and higher sensory evaluation score. Optimal additional amount of MCM is a 50% pork back fat replacement level. MCM can be possible to use economical and healthy fat replacer that contains both economical material (water) and nutritional material (CMC and collagen powder).

ACKNOWLEDGEMENTS

This study was supported by the Brain Korean 21+ (BK 21+) Project from Ministry of Education, Republic of Korea.

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