2014 International Conference on Food and Nutrition Technology
IPCBEE vol. 72 (2014) © (2014) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2014. V72. 7

Characteristics of Low-NaCl Emulsion Sausage with Added by Soybean Fiber and Sugar Cane Fiber

Dong-Heon Song [1], Hyun-Wook Kim [1], Yun-Bin Lim [1], Tae-Jun Jeong [1] and Cheon-Jei Kim[1 +]

[1] Department of Food Science and Biotechnology of Animal Resource, Konkuk University, Seoul 143-701, Korea

Abstract. This study was to evaluate the effects of fiber hydrate on quality characteristics of low-NaCl emulsion sausage. The low- NaCl emulsion sausages were formulated with 10% soybean fiber hydrate or 10% sugar cane fiber hydrate based on total weight. Emulsion sausage was produced with five different formulations: control (only 1.5% NaCl), SB12 (Soybean fiber hydrate with add NaCl 1.2%), SB10 (Soybean fiber hydrate with add NaCl 1.0%), SC12 (Sugar cane fiber hydrate with add NaCl 1.2%), SC10 (Sugar cane hydrate with add NaCl 1.0%). The SB12 and SB10 higher than other treatments in pH value of emulsion sausage ($p<0.05$). The cooking yields of emulsion sausage with 1.2% NaCl treatments (SB12 and SC12) were higher than the control ($p<0.05$). The SB12 had the highest hardness ($p<0.05$), and other treatments did not show any difference between ($p>0.05$). Springiness of control and other treatments had no significantly difference ($p>0.05$). In this study, control and low-NaCl sausages were not significantly different color, flavor and juiciness of sensory properties. Thus, quality characteristics of reduced low-NaCl emulsion sausage can enhance the physical properties with adding fiber hydrate.

Keywords: sodium chloride, dietary fiber, low-sodium sausage

1. Introduction

Excessive intake of dietary NaCl causes high blood pressure and heart disease. Therefore, WHO was recommended daily intake of sodium of 2,500 mg/day (NaCl 5 g/day) [1]. Many peoples avoid intake of high NaCl content foods that for health. In order to meet consumer acceptability of meat product industry that it is necessary to develop low-NaCl meat products. But, the NaCl is essentially used to improve functionality and shelf-life safety in processed meat products such as hamburger patties, ham and sausage. In particular, NaCl is capable of extracting myofibrillar proteins, formatting texture properties and increasing flavour during on manufacturing process of the emulsion sausages (addition 1.5-2.0 %) [2]. On the other hand, decreasing NaCl content cause reduction in gel-forming ability, water holding capacity and cooking yield of sausage. Thus, functional ingredient addition is needed to improve quality of low NaCl sausage.

Dietary fiber recommend intake of 27-40 g/day by World Health Organization (WHO). Because, the intake of dietary fiber in human body had to positive effect that prevented of colon cancer and adult disease. Also, dietary fibers are not only desirable for their nutritional properties, but also for their functional and technological properties which good Ingredient into food industry. [3]. Jiménez-Colmenero [4] reported that dietary fiber has been improving cooking yield, texture, water and fat binding capacity and reducing formulation cost. Grossi *et al*. [5] had shown that the reduction-NaCl sausage manufacturing technology for high pressure with carrot fibre or potato starch added as a resulted that improved water holding capacity.

Therefore, the development of low-NaCl sausages with addition of dietary fiber is expected to improve the quality. The objective of this study was to evaluate quality characteristics of low-NaCl emulsion sausages with added fiber hydrate.

[+] Corresponding author. Tel.: +82-2-450-3684; fax: +82-2-444-6695
E-mail address: kimcj@konkuk.ac.kr

2. Materials and Method

2.1. Preparation of Fiber Hydrate

The soybean fiber and sugar cane fiber were supplied by Tof Co., Ltd., (Sungnam-Sim Kyunggi-Do, Korea). The fiber hydrate was manufactured based on the following formulation: 8.4% fiber, 1.6% xanthan and 90% water mixed using hand blender (HMF-1265, Hanil electric, Korea) for 5min and stored at 4℃ until required for product manufactures.

2.2. Preparation of Sausage

Fresh pork meat and pork back fat were purchased from a local processor at post-mortem 48 h. All subcutaneous and inter-muscular fat and disable connective tissue were removed from muscles. Pork meat and pork back fat were ground through an 8-mm plate using a meat grinder (PM-70, Mainca, Barcelona, Spain). Each sample batch consisted of five different emulsion sausages were formulated are given in Table 1. For each batch of the sausage, meat, fat, ice, fiber hydrate and other ingredients were emulsified by using a bowl cutter (Nr-963009, Scharfen, Witten, Germany). After emulsification, the meat batter was stuffed into collagen casings (#240, NIPPI Inc., Tokyo, Japan; approximate diameter of 25 mm) using a stuffer (Stuffer IS-8, Sirman, Italy). The meat batter was then heated at 75±2℃ for 30 min in a water bath (Dae Han Co, Model 10-101, Seoul, South Korea), and internal temperature of emulsion sausage is 75℃. The emulsion sausages also were vacuum-packaged with Nylon/PE film and stored in a 4℃ refrigerator for analyses.

Table 1. The emulsion sausage formulation with various NaCl levels and fiber hydrate

Ingredients	Control[1)]	SB12	SB10	SC12	SC10
Pork meat (%)	60	60	60	60	60
Pork fat (%)	20	20	20	20	20
Ice	20	10	10	10	10
Fiber hydrate	-	10	10	10	10
NaCl	1.5	1.2	1.0	1.2	1.0
Nitrite	0.009	0.009	0.009	0.009	0.009
Spice	0.5	0.5	0.5	0.5	0.5
Sugar	0.5	0.5	0.5	0.5	0.5
Ascorbic acid	0.05	0.05	0.05	0.05	0.05

[1)] Treatments: Control, only 1.5% NaCl; SB12, soybean fiber hydrate with added NaCl 1.2%; SB10, soybean fiber hydrate with added NaCl 1.0%; SC12, sugar cane fiber hydrate with added NaCl 1.2%; SC10, sugar cane hydrate with added NaCl 1.0%.

2.3. Analysis of Samples

2.3.1 pH and Color

The pH values of each sample were measured in a homogenate prepared with 5 g of sample and distilled water (20 mL) using a model 340 pH meter (Mettler-Toledo GmbH). All determinations were performed in triplicate. The color of each sample was determined using a colorimeter (Minolta Chroma meter CR-210, Japan; illuminate C, calibrated with a white plate, L^*=+97.83, a^*=-0.43, b^*=+1.98). Six measurements for each of two replicates were taken. Lightness (CIE L^*-value), redness (CIE a^*-value), and yellowness (CIE b^*-value) values were recorded.

2.3.2 Cooking Yields

Cooking yields (%) was determined for individual samples by calculating the weight differences before and after cooking as follows: Cooking yields (%) = weight of after cooking weight (g) / weight of before cooking weight (g) ×100

2.3.3 Texture Profile Analysis (TPA)

Texture profile analysis was performed at room temperature with a texture analyser (TA-XT2*i*, Stable Micro Systems, England). Prior to analysis, samples were allowed to equilibrate to room temperature (25℃, 3 h). The conditions of texture analysis were as described follows: pre-test speed 2.0 mm/s, post-test speed

5.0 mm/s, maximum load 2 kg, head speed 2.0 mm/s, distance 8.0 mm, and force 10 g. Texture profile analysis (TPA) values were determined by graphing force versus time. Values for hardness (kg), springiness, cohesiveness, gumminess (kg), and chewiness (kg) were determined as described by Bourne [6].

2.3.4 Sensory Evaluation

Emulsion sausages samples were evaluated for color, flavor, chewiness, springiness, juiciness, off-flavor, saltiness and overall acceptability. The sausages samples as previously described were cooled to the room temperature at 25 ℃ and cut and served to the panellists random order. All sensory evaluations were performed under fluorescent lighting. Panellists were instructed to cleanse their palates between samples using water. The color (1 = extremely undesirable, 10 = extremely desirable), flavor (1 = extremely undesirable, 10 = extremely desirable), chewiness (1 = extremely undesirable, 10 = extremely desirable), springiness (1 = extremely inelastic, 10 = extremely elastic), juiciness (1 = extremely dry, 10 = extremely juicy), off-flavor (1 = extremely desirable, 10 = extremely undesirable), saltiness (1 = extremely insipid, 10 = extremely salty), and overall acceptability (1 = extremely undesirable, 10 = extremely desirable) of the cooked samples were evaluated using a 10-point descriptive scale.

2.3.5 Statistical Analysis

An analysis of variance was performed on all the variables measured using the general linear model (GLM) procedure of the SPSS statistical package (ver. 18). Duncan's multiple range test (p<0.05) was used to determine the differences among treatments.

3. Results and Discussion

The pH and color parameters of the meat batter and emulsion sausage containing fiber hydrate and NaCl level are shown in Table 2. Meat batter of SC12 and SC10 showed significantly the lowest pH values that cause by low pH value of sugar cane fiber hydrate (pH 4.15±0.02, data not shown). The SB12 and SB10 have the highest value in pH of emulsion sausages (p<0.05). The CIE L^* value of emulsion sausage with SB12 was higher than control (p<0.05). According to Fernández-López [7], the increase in water holding capacity (WHC) reduces water availability on the meat surface, thus reducing light reflection and lightness values. And the increase in WHC by NaCl addition that this would the reduced water at the meat surface and thus increase the myoglobin concentration. This study is shown similar results, the highest in CIE a^* value of control (p<0.05).

Table 2. Effects of fiber hydrate and NaCl levels on pH and color of meat batter and sausage

Trait		Control[1)]	SB12	SB10	SC12	SC10
Meat batter	pH	5.76±0.02^A	5.75±0.02^A	5.74±0.02^A	5.68±0.02^B	5.70±0.02^B
	CIE L^*	73.65±0.33^B	74.45±0.71^A	73.21±0.27^B	73.21±0.21^B	72.25±0.16^C
	CIE a^*	9.90±0.26^A	8.77±0.21^B	9.58±0.33^A	9.80±0.10^A	9.75±0.22^A
	CIE b^*	13.68±0.35^C	14.00±0.45^{BC}	14.33±0.32^B	14.79±0.21^A	15.04±0.27^A
Emulsion sausage	pH	5.90±0.02^B	5.94±0.02^A	5.93±0.03^A	5.88±0.02^B	5.92±0.02^{AB}
	CIE L^*	66.89±1.88^{AB}	66.08±1.71^B	67.28±0.93^{AB}	68.39±0.62^A	66.23±0.41^B
	CIE a^*	13.91±1.92^A	12.09±0.47^B	13.04±0.41^{AB}	12.61±0.87^{AB}	11.73±0.45^B
	CIE b^*	18.85±1.32	18.95±1.23	19.46±0.59	19.90±0.78	19.17±0.40

Values are Mean±Standard deviation in two replicate (n = 6).

[1)] Treatments: Control, only 1.5% NaCl; SB12, soybean fiber hydrate with added NaCl 1.2%; SB10, soybean fiber hydrate with added NaCl 1.0%; SC12, sugar cane fiber hydrate with added NaCl 1.2%; SC10, sugar cane hydrate with added NaCl 1.0%.

[A-C] Means within a row with different letters are significantly different (p<0.05).

The cooking yields of emulsion sausage with various concentrations of NaCl and fiber hydrate are shown in Fig. 1. The cooking yields of emulsion sausage with 1.2% NaCl treatments (SB12 and SC12) were higher than the control (p<0.05). This results may be due to dietary fibers have high water holding capacity and binding capacity of dietary fibers. This result is similar to numerous studies have been reported that cooking yield was improved sausages with adding dietary fibers. Choi *et al*. [8] reported that in meat batter with added wheat fiber increased cooking yields. Also, Turhan *et al*. [9] reported that low-fat meat products with added hazelnut pellicle had decreased cooking loss.

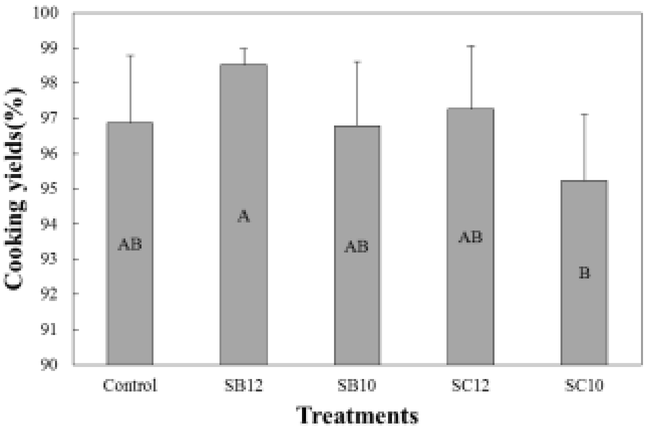

Fig. 1. Comparison on cooking yields of emulsion sausages with various addition levels of NaCl and fiber hydrate. A,B Means with different letters are significantly different ($p<0.05$). 1)Treatments: Control, only 1.5% NaCl; SB12, Soybean fiber hydrate with added NaCl 1.2%; SB10, Soybean fiber hydrate with added NaCl 1.0%; SC12, Sugar cane fiber hydrate with added NaCl 1.2%; SC10, Sugar cane hydrate with added NaCl 1.0%.

The textural profile analysis of emulsion sausage was affected by the fiber type and proportion NaCl levels (Table 3). The treatments with soybean fiber and 1.2% added NaCl had the highest hardness ($p<0.05$), and other treatment did not show any difference between ($p>0.05$). The springiness of control and other treatments had no significantly difference ($p>0.05$). The SB10 is similar to texture of the control. This resulted is may be due to ability of bind to dietary fiber. On the other, the SC treatment was shown lower values of gumminess and chewiness than other treatments ($p<0.05$).

Table 3. Effects of fiber hydrate and various NaCl levels on textural profile analysis of emulsion sausages

Trait	Control1)	SB12	SB10	SC12	SC10
Hardness (kg)	0.18 ± 0.01^{B}	0.21 ± 0.02^{A}	0.18 ± 0.01^{B}	0.17 ± 0.01^{B}	0.17 ± 0.02^{B}
Springiness	0.88 ± 0.05	0.83 ± 0.07	0.86 ± 0.03	0.86 ± 0.01	0.86 ± 0.02
Cohesiveness	0.47 ± 0.04^{A}	0.44 ± 0.03^{AB}	0.45 ± 0.01^{AB}	0.44 ± 0.01^{AB}	0.42 ± 0.02^{B}
Gumminess (kg)	0.09 ± 0.01^{A}	0.09 ± 0.01^{A}	0.08 ± 0.01^{AB}	0.07 ± 0.01^{B}	0.07 ± 0.01^{B}
Chewiness (kg)	0.08 ± 0.01^{A}	0.07 ± 0.01^{A}	0.07 ± 0.01^{A}	0.06 ± 0.01^{B}	0.06 ± 0.01^{B}

Values are Mean±Standard deviation in two replicate (n = 6).

1) Treatments: Control, only 1.5% NaCl; SB12, soybean fiber hydrate with added NaCl 1.2%; SB10, soybean fiber hydrate with added NaCl 1.0%; SC12, sugar cane fiber hydrate with added NaCl 1.2%; SC10, sugar cane hydrate with added NaCl 1.0%.

A,B Means within a row with different letters are significantly different ($p<0.05$).

The sensory evaluation of emulsion sausage with fiber hydrate and reduced NaCl contents is shown in Table 4. The emulsion sausage treated with 1.5% NaCl showed the highest chewiness, springiness and overall acceptability score. In this study, control and low-NaCl sausages was not significantly different color, flavor and juiciness of sensory properties. Conversely, according to Ruusunen *et al*. [10], the firmness in sensory evaluation of low-NaCl bologna sausage was improved by addition of cellulose.

Table 4. Effects of fiber hydrate and various NaCl levels on sensory evaluation of emulsion sausages

Trait	Control[1)]	SB12	SB10	SC12	SC10
Color	7.78±0.67	7.44±0.53	7.22±0.67	7.33±0.87	7.22±0.67
Flavor	7.67±0.71	7.11±1.17	6.56±1.81	6.67±1.66	6.33±1.73
Chewiness	6.78±0.97^{A}	6.44±1.13^{AB}	5.33±1.32^{BC}	5.44±1.24^{BC}	5.11±1.05^{C}
Springiness	6.56±0.88^{A}	5.89±0.78^{AB}	5.00±1.41^{B}	5.11±1.27^{B}	5.00±1.41^{B}
Juiciness	7.33±0.71	6.78±1.09	6.78±1.56	6.44±1.94	6.33±2.29
Off-flavor	2.67±1.12	2.78±1.30	2.78±1.20	2.67±1.12	3.11±0.93
Saltiness	4.78±1.48	4.11±1.69	3.67±1.32	3.44±1.81	3.33±1.66
Overall acceptability	7.67±0.87^{A}	6.78±1.30^{AB}	6.33±1.41^{B}	6.11±1.45^{B}	5.44±1.42^{B}

Values are Mean±Standard deviation in two replicate (n = 9).

[1)] Treatments: Control, only 1.5% NaCl; SB12, soybean fiber hydrate with added NaCl 1.2%; SB10, soybean fiber hydrate with added NaCl 1.0%; SC12, sugar cane fiber hydrate with added NaCl 1.2%; SC10, sugar cane hydrate with added NaCl 1.0%.

[A-C] Means within a row with different letters are significantly different (p<0.05).

In conclusion, fiber hydrate in low-NaCl emulsion sausages had effect on improve of cooking yields and texture. This results may be due to dietary fibers have high water holding capacity and binding capacity of dietary fibers. Thus, quality characteristics of reduced low-NaCl emulsion sausage can enhance the physical properties with adding fiber hydrate.

4. Acknowledgements

This research was supported by Technology Development Program (PJ009237042013) for rural development administ-ration, Republic of Korea. The authors also were partially supported by the Brain Korean 21 Plus (BK 21 Plus) Project from Ministry of Education and Human Resources Development (Republic of Korea).

5. References

[1] E. Desmond. Reducing salt: A Challenge for the meat industry. *Meat Sci*. 2006, 74(1): 188-196.

[2] R. N. Terrell . Reducing the sodium, content of processed meats. *Food Technol.* 1983, 37: 66-71.

[3] Y. S. Choi, J. H. Choi, D. J. Han, H. Y. Kim, M. A. Lee, J. Y. Jeong, H. J. Chung and C. J. Kim. Effects of replacing pork back fat with vegetable oils and rice bran fiber on the quality of reduced-fat frankfurters. *Meat Sci*. 2010, 84(3): 557-563.

[4] A. Grossi, J. Søltoft- Jensen, J. C. Knudsen, M. Christensen and V. Orlien. Reduction of salt in pork sausages by the addition of carrot fibre or potato starch and high pressure treatment. *Meat Sci*. 2012, 92(4**)**: 481-489.

[5] F. Jiménez-Colmenero. Technologies for developing low-fat meat products. *Trends Food Sci.Technol.* 1996, 7(2): 41-48.

[6] M. C. Bourne. Texture profile analysis. *Food Technol.* 1978, 32: 62-66.

[7] J. Fernández-López, E. Sayas-Barberá, J. A. Pérez-Alvarez and B. Aranda-Catalá. Effect of sodium chloride, sodium tripolyphosphate and pH on color properties of pork meat. *Color Res*. *Appl*. 2004, 29(1): 67-74.

[8] Y. S. Choi, M. A. Lee, J. Y. Jeong, J. H. Choi, D. J. Han, H. Y. Kim, E. S. Lee and C. J. Kim. Effects of wheat fiber on the quality of meat batter. *Korean Society J. Food Sci. Ani. Resour.*, 2007, 27(1: 22-28.

[9] S. Turhan, I. Sagir, and N. S. Ustun. Utilization of hazelnut pellicle in low–fat beef burgers. *Meat Sci.* 2005, 71(2): 312-316.

[10] M. Ruusunen, J. Bainionpää, E. Puolanne, M. Lyly, L.Lähtenmäki, M. Niemistö and R. Ahvenainen. Effect of sodium citrate, carboxymethyl cellulose and carrageenan level on quality characteristics of low-salt and low-fat bologna type sausages. *Meat Sci.* 2003, 64(4): 371-381.