EFFECTS OF BREWER'S SPENT GRAIN DIETARY FIBER ON QUALITY CHARACTERISTICS OF LOW-FAT CHICKEN SAUSAGES

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Abstract – Effects of replacing pork back fat with brewer's spent grain (BSG) pre-emulsion at levels of 20, 25, and 30% on physicochemical of low-fat emulsion chicken sausage were evaluated. The pH of low-fat sausages formulated with BSG pre-emulsion was lower than that of control (*P* < 0.05). The cooking yield and apparent viscosity of chicken emulsion sausages increasing with increased in proportion to BSG pre-emulsion (*P* < 0.05). With increasing BSG pre-emulsion levels, fat contents and energy values were decreased in chicken emulsion sausages (*P* < 0.05). This study suggests that 20-25% of BSG pre-emulsion successfully replaced pork back fat in chicken emulsion sausages.

Key Words – Chicken sausage, Low-fat, Dietary fiber

I. INTRODUCTION

Current consumers are health conscious and they demand low-fat and functional meat products. It is well known that high consumption of animal fat is lead to coronary heart disease, obesity and cancer. However, fat is an important constituent of processed meat products. For these reason, the meat industry have been attempted to develop new technologies. The most common method is use of low-fat substitutes of the sausages.

Especially, adding dietary fiber into meat emulsion products has been continuously studied. Xanthan gum, carrageenan, and locust bean gum have been used in many low-fat products for improvement of rheological properties and emulsion stability [1].

Barley is an important cereal and used for production of many food and alcoholic drinks. Brewer's spent grain (BSG) which is one of the largest by-products of brewing process, is recognized as functional material rich in protein and fiber [2]. However, a few studies have been conducted on the extracted dietary fibers of BSG into meat products.

Therefore, the aim of this study was to evaluate the effect of dietary fibers extracted from BSG on quality characteristics of low-fat emulsion chicken sausages.

II. MATERIALS AND METHODS

1. Preparation of dietary fiber extracts from brewer's spent grain (BSG)

BSG was obtained from a commercial brewery (HITEJINRO Co., Ltd., Korea). Dietary fiber was extracted using the modified method of Choi et al. [3] based on the AOAC enzymatic-gravimetric method [4].

2. Pre-emulsion of brewer's spent grain (BSG) preparation

Firstly, 5% carboxymethyl cellulose and 80% ice were homogenized and ground for 1 min in a silent cutter (Cutter Nr-963009, Scharfen, Germany). 15% BSG dietary fiber extracts were added to the pre-emulsion, which were then homogenized for 5 min. After emulsification, BSG pre-emulsion stored at 0 °C until required for product manufacture.

3. Low-fat chicken sausages preparation and processing

Fresh chicken breast meat (*M. pectoralis major*) and pork back fat were purchased from a local processor at 48 h postmortem. The chicken materials were initially ground through an 8 mm plate. The pork back fat was also ground through an 8 mm plate. The first meat batter served as the control and was prepared with 15% pork back fat. The next samples consisted of three meat batters which differed in composition with respect to the addition of pre-emulsion (20, 25, and 30%). The four different emulsion sausages were formulated (Table 1) as follows: raw meat was homogenized and ground for 1 min in a silent cutter (Cutter Nr-963009, Scharfen, Germany). 1.4% NPS, 0.5% ascorbic acid, 0.8% sugar, 0.3% monosodium L-glutamate, 0.3% garlic powder, and 0.6% spice (Nuremberg) were added to the meat. The pre-emulsion was added to meat batters, which were then homogenized for 6 min. 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, chicken 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 batters were then heated at 75±2 ˚C for 30 min in a water bath (Dae Han Co, Model 10-101, Korea). The cooked meat batters were then cooled with cold water.

Table 1. Chicken emulsion sausage formulations with BSG pre-emulsion levels

Ingredients (%)	Treatments[1)]			
	Control	T1	T2	T3
Chicken breast	70	70	70	70
Back fat	15	10	5	0
Ice	15	(16)[2)]	(20)	(24)
BSG pre-emulsion	-	20	25	30
Total	100	100	100	100
NPS[3)]	1.4	1.4	1.4	1.4
Ascorbic acid	0.5	0.5	0.5	0.5
Sugar	0.8	0.8	0.8	0.8
Garlic powder	0.3	0.3	0.3	0.3
MSG[4)]	0.3	0.3	0.3	0.3
Nuremberg	0.6	0.6	0.6	0.6

[1)] Control: chicken emulsion sausage with no addition, 15% fat addition; T1: chicken emulsion sausage with 20% BSG pre-emulsion, 10% fat addition; T2: chicken emulsion sausage with 25% BSG pre-emulsion, 5% fat addition; T3: chicken emulsion sausage with 30% BSG pre-emulsion, no fat addition.
[2)] Figure in parenthesis is calculated as content pre-emulsion ingredients based on total weight.
[3)] NPS: nitrite pickled salt (99.4:0.6).
[4)] MSG: Monosodium L-glutamate.

4. Analysis of low-fat chicken sausages

4.1 pH measurement

The pH values of restructured chicken sausage were determined in a homogenate prepared with 5 g of sample and distilled water (20 ml), using a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland). All determinations were performed in triplicate.

4.2 Cooking yield

Cooking yield was determined by calculating the weight difference before and after cooking, as follows; Cooking yield (%) = [cooked sausage weight (g) / raw sausage weight (g)] × 100

4.3 Proximate composition

Moisture (950.46B, oven air-drying method), protein (981.10), fat (960.69, ether extractable component), and ash (920.153, muffle furnace) contents were determined according to the AOAC [4] procedure. Carbohydrate contents were calculated by the difference among the parameters.

4.4 Caloric content

Total calorie estimates (Kcal) for sausages were calculated on the basis of a 100-g portion using Atwater values for fat (9 Kcal/g), protein (4.02 Kcal/g), and carbohydrate (3.87 Kcal/g).

4.5 Apparent viscosity

The chicken emulsion meat batter viscosity was measured in triplicate with a rotational viscometer (HAKKE Viscotester®500, Thermo Electron Corporation, Karlsruhe, Germany) set at 10 rpm. The standard cylinder sensor (SV-2) was positioned in a 25 ml metal cup filled with batter and allowed to rotate under a constant share rate at s-1 for 60 s before each reading was taken. Apparent viscosity values in centipoises were obtained. The temperature of each sample at the time (18±1 °C) of viscosity testing was also recorded [5].

5. 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 [6]. Duncan's multiple range test ($P < 0.05$) was used to determine the differences between treatment means.

III. CONCLUSION

The pH values of meat batter and low-fat sausages formulated with various BSG pre-emulsion levels are given in Table 2.

Table 2. Effects of pH value and cooking yield of low-fat chicken sausages formulated with BSG pre-emulsion

Treatments[1)]	pH		Cooking yield (%)
	Meat batter	Emulsion sausage	
Control	5.30±0.02[b]	5.62±0.02	89.37±2.89[b]
T1	5.34±0.02[a]	5.61±0.04	95.74±0.64[a]
T2	5.35±0.02[a]	5.61±0.04	95.28±0.99[a]
T3	5.36±0.02[a]	5.63±0.03	95.42±0.31[a]

All values are mean ± standard deviation of three replicates.

[1)] Control: chicken emulsion sausage with no addition, 15% fat addition; T1: chicken emulsion sausage with 20% BSG pre-emulsion, 10% fat addition; T2: chicken emulsion sausage with 25% BSG pre-emulsion, 5% fat addition; T3: chicken emulsion sausage with 30% BSG pre-emulsion, no fat addition.

[a, b] Means within a column with different letters are significantly different ($P < 0.05$).

The pH is the rudimentary factor affecting physicochemical property meat and meat products. Also the pH influences freshness, tenderness, water-holding capacity and binding capacity of meats and meat products [7]. The pH values of uncooked meat batter were increased with increasing BSG pre-emulsion level increasing ($P <$ 0.05). However, there were no significant differences in the pH values of low-fat sausages (P > 0.05).

The addition of BSG pre-emulsion significantly affected the cooking yield of low-fat emulsion sausages ($P < 0.05$). The cooking yield of samples with added BSG pre-emulsion was higher than that of the control. In our study, dietary fiber in BSG pre-emulsion might improve the cooking yield of low-fat sausage. In particular, dietary fiber has ability to bind water and fat that strongly restricts molecular mobility. However, there were no significant differences among treatments (T1, T2 and T3).

Figure 1 shows the results for fat contents and energy values of low-fat sausages formulated with various BSG pre-emulsion levels.

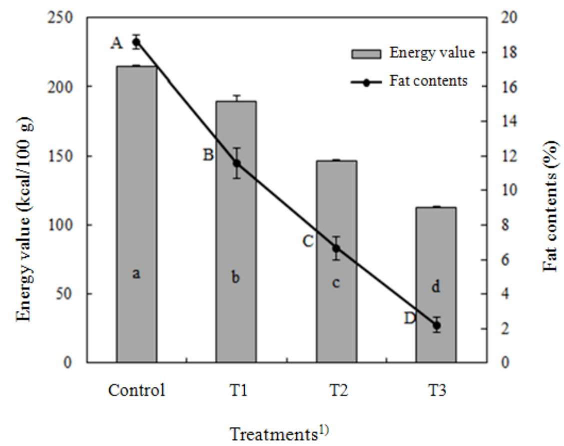

Figure 1. Fat contents and energy value of chicken emulsion sausages formulations with various BSG pre-emulsion levels.

All values are mean ± SD.

[1)] Control: chicken emulsion sausage with no addition, 15% fat addition; T1: chicken emulsion sausage with 20% BSG pre-emulsion, 10% fat addition; T2: chicken emulsion sausage with 25% BSG pre-emulsion, 5% fat addition; T3: chicken emulsion sausage with 30% BSG pre-emulsion, no fat addition.

A-D Mean sharing different letters in the fat contents are significantly different ($P < 0.05$).

a-d Mean sharing different letters in the energy values are significantly different ($P < 0.05$).

There were differences in fat contents and energy values of emulsion sausage were statistically significant ($P < 0.05$). The fat contents varied between 2.20 and 23.61%. As expected, the fat contents were lower in all treatments than that control ($P < 0.05$). It is considered that the reduction fat contents lead to the low energy values of all treatments. As BSG pre-emulsion increased among the treatments, energy values decreased ($P < 0.05$) and T3 treatment showed the lowest energy value. The various levels of BSG pre-emulsion significantly affected the viscosity of low-fat meat emulsion systems (Figure 2). The apparent viscosity values of all samples were decreased with rotation time. Yapar et al. [8] reported that the meat emulsion system containing high-fat had the increased the viscosity. Despite the low-fat sausages had lower fat content than that of control, the low-fat chicken sausage had higher apparent viscosity.

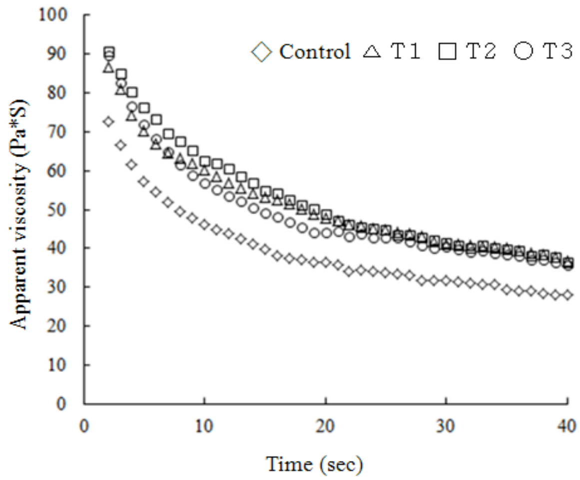

Figure 2. Change in apparent viscosity of chicken meat batters containing BSG pre-emulsion stirred for 40 sec. (◇) Control: chicken emulsion sausage with no addition, 15% fat addition; (△) T1: chicken emulsion sausage with 20% BSG pre-emulsion, 10% fat addition; (□) T2: chicken emulsion sausage with 25% BSG pre-emulsion, 5% fat addition; (○) T3: chicken emulsion sausage with 30% BSG pre-emulsion, no fat addition.

Among the treatments, T2 had the highest maximum apparent viscosity. These results are due to the dietary fiber in BSG pre-emulsion. According to Dogan et al. [9], the viscosity of meat batter is affected by dietary fiber which has water holding ability. Thus, BSG pre-emulsion could improve the viscosity of low-fat emulsion.

IV. CONCLUSION

In this study, low-fat chicken sausages incorporating BSG pre-emulsion were successfully produced. Low-fat chicken sausages containing BSG pre-emulsion show improvement physicochemical properties as well as lower energy values than that of control. Therefore, the replacement of back fat with 20-25% BSG pre-emulsion can be used for a great source of dietary fiber in low-fat chicken sausages.

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