Effects of Dietary Fiber Extracts from Brewer’s Spent Grain on Quality Characteristics of Chicken Patties Cooked in Convective Oven

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Abstract

Brewer’s spent grain (BSG) is a by-product of beer manufacturing. This study was conducted to evaluate the effect of dietary fiber extracts from brewer’s spent grain on quality characteristics of chicken patties. The total fiber content of BSG dietary fiber extracts after extraction increased from 58.11% to 68.57%, and the extracted dietary fiber extracts were added to chicken patties at 0, 1, 2, 3, and 4%, respectively. The effects of the BSG dietary fiber extracts on pH, color, cooking loss, reduction in patty diameter, salt-soluble protein solubility, texture, and sensory characteristics of chicken patties were evaluated. The addition of BSG dietary fiber extracts decreased pH and lightness values, and increased redness and yellowness. Chicken patties formulated with 3-4% BSG dietary fiber extracts had the lowest cooking loss among all treatments (p<0.05). The diameter of chicken patties was not affected by the addition of BSG dietary fiber extracts. Additionally, no significant difference was observed in salt-soluble protein solubility after adding 3% BSG dietary fiber extracts compared to that in the control. Textural and sensory properties were different among the chicken patties, and the 3% BSG dietary fiber-added chicken patty had the highest acceptability. Our results indicate that 3% BSG dietary fiber extract can be used as a good source of dietary fiber for improving the quality characteristics of chicken patties.

Key words: brewer’s spent grain, dietary fiber, chicken patty

Introduction

Dietary fiber has received much attention from the food industry as a functional ingredient to improve food quality and to provide physiological benefits such as regulation of cholesterol and prevention of diabetes and intestinal cancer (Özvural et al., 2009). In particular, dietary fiber is extensively used to improve textural and sensory properties in many sectors of the meat industry (Waszkowiak and Szymanadera-Buszka, 2008). Applications of dietary fiber extracted from cereals, fruits, and vegetables, including apple, lemon, oat bran, peach, rye bran, and wheat (Fernández-Ginés et al., 2004; García et al., 2002; Yılmaz, 2004), have been extensively examined, considering the characteristics and types of applied meat products. Applying dietary fiber in by-products derived from the agri-food industry has been examined in several foods. Improved quality of low-fat beef burgers was observed by adding 1-2% hazelnut pellicle (Turhan et al., 2005). Choi et al. (2011) added extracted rice bran fiber, which is generated during rice polishing, to pork salt-soluble proteins. The results indicated that adding rice bran fiber increased apparent viscosity. Additionally, Choi et al. (2013) reported that makgeolli lees fiber, which is a by-product of makgeolli (Korean traditional alcoholic drink), improves the textural and sensory properties of chicken emulsion sausage.

Barley is one of the most important cereals in the world and has been used as a main ingredient to make various foods. In particular, malt, which is generated from barely grain, is important to produce alcoholic drinks, including beer and whisky (Jadhav et al., 1998). Various by-products derived from main ingredients such as spent grains, spent hops, and surplus yeast are generated during beer manufacturing (Aliyu and Bala, 2011). Approximately 85% of the total brewing by-product is brewer’s spent grain (BSG), which has been recognized as a func-
tional material, and is rich in dietary fiber and low cost by-products (Gupta et al., 2010; Musatto et al., 2006; Robertson et al., 2010). Musatto et al. (2008) also reported that BSG contains cellulose (16.8%), hemicellulose (28.4%), and lignin (27.8%). Thus, BSG seems to be a good dietary fiber source to enhance meat product quality and to develop functional and low-fat meat products. Özvural et al. (2009) prepared frankfurters using BSG and concluded that BSG is a high source of dietary fiber to produce low fat meat products. However, information on BSG dietary fiber extracts remains limited, and studies are needed to develop BSG dietary fiber extracting processes and to evaluate the effect of high-fiber BSG on meat product quality characteristics.

Therefore, the objectives of this study were to investigate the effect of incorporating a BSG dietary fiber extract into chicken breasts at five different levels on physicochemical, textural, and sensory properties of chicken patties.

Materials and Methods

Preparation of dietary fiber extracts from brewer’s spent grain (BSG)

Dietary fiber was extracted using the modified method of Choi et al. (2011) based on the AOAC enzymatic-gravimetric method (2007). BSG was obtained from a commercial brewery (Hitejinho Co., Ltd., Korea). BSG was washed three times with five volume of distilled water to remove alcoholic components and foreign bodies. To prevent rancidity in BSG, the residues were defatted with five volume of hexane (n-hexane 95%) on a shaker (BS-11, Lab. Companion, Korea) for 24 h. The defatted BSG was gelatinized with 0.6% termamyl (heat stable alpha-amylase) in a 95°C water bath for 1 h to remove starch. After filtration, the residues were washed three times with four volumes of heated distilled water (100°C) and cooled to equilibrate to room temperature (20°C). And then, the residues were washed with 99.9% ethanol (preheated to 60°C) followed by filtration. The residues were dried in a 55°C hot air dryer (Enex-Co-600, Enexs, Korea) for 24 h. The dried residues were pulverized using a milling machine (DK504, Sejungtech, Korea), and the powder was passed through the 270 mesh testing sieves (Chung Gey Industrial Mfg. Co., Korea). A yield of powder was more than 95%. The proximate composition of BSG dietary fiber extracts was determined using AOAC guidelines (2007), and the results are shown in Table 1.

<table>
<thead>
<tr>
<th>Traits (Dry basis)</th>
<th>Before extracting(1)</th>
<th>After extracting</th>
<th>Significance (t-test)(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>4.28±0.53(3)</td>
<td>4.40±0.40</td>
<td>NS</td>
</tr>
<tr>
<td>Crude protein</td>
<td>19.60±0.15</td>
<td>13.72±0.34</td>
<td>***</td>
</tr>
<tr>
<td>Crude fat</td>
<td>13.37±0.45</td>
<td>9.53±0.38</td>
<td>***</td>
</tr>
<tr>
<td>Crude ash</td>
<td>3.13±0.08</td>
<td>2.97±0.06</td>
<td>**</td>
</tr>
<tr>
<td>Total dietary fiber</td>
<td>58.11±0.07</td>
<td>68.57±0.29</td>
<td>***</td>
</tr>
</tbody>
</table>

1) The extracting condition was described in materials and methods. 
2) NS p>0.05, *p<0.05, **p<0.01, ***p<0.001 
3) All values are mean±SD (n=3).

Preparation of chicken patties

Chicken breast muscles (M. Pectoralis major) in fresh broilers (Arbor Acre strain, 5 wk of age, approximately 1.5-2.0 kg live weight) and pork back fat were obtained from a local market. Visible connective tissue and excessive fat were removed from the fresh chicken breast muscles. The chicken breast and pork back fat were initially ground using a meat grinder (PM-70, Mainca, Spain) equipped with 8 mm plate. The ground chicken breast and pork back fat were packaged with Nylon/PE film, and used on the day.

All chicken patties were composed by 60% chicken breast, 20% pork back fat, 20% ice, and 1.5% NaCl. And each sample batch consisted of five chicken patties differing in composition with respect to addition of BSG dietary fiber extracts levels (0, 1, 2, 3, and 4%). The mixture from each batch was mixed using a mixer (RM-90, Mainca, Spain) for 10 min. After the batches were held at 4°C for 1 h (Troutt and Dale, 1990), the batches were processed into 100±1 g patties with 100 mm in diameter and 15 mm in thickness using patty presses (Small ground press, Spikomat Ltd., UK). All chicken patties were then placed in Nylon/PE film, and stored -20°C to maintain shape of the chicken patties. After 24 h of manufacturing, the chicken patties were used in analysis.

Cooking method of chicken patties

The cooking final temperature was heated until the core temperatures of chicken patties reached to 75°C. As a commonly used method for cooking of poultry products (Murphy et al., 2001), the samples were heated using convective oven (OES 6.06, Convoltherm, Germany) at 150°C for 7 min. Each patty was placed in the center of a shelf in oven, until the targeted core temperature was reached. The core temperature of patty was monitored with a digital thermometer (Tes-1305, Tes Electrical Co.,