Quality Characteristics of Chicken Emulsion Sausages with Different Levels of *Makgeolli* Lees Fiber

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**Abstracts**

*Makgeolli* lees is a by-product of the *makgeolli* brew processing. *Makgeolli* lees contains high levels of fibers, which can be separated and used to develop foods rich in dietary fibers. The purpose of this study was to determine the effect of *makgeolli* fibers (0-4%) on proximate composition, caloric content, pH, color, cooking yield, textural profile, and sensory characteristics of chicken-emulsion sausages. The moisture content of 1, 2, and 3% *makgeolli* lees fiber-amended product was higher than the control, while that of the 4% product was not. Total calorie estimates of *makgeolli* lees fiber-amended sausages were lower than the control, except for in the case of the 4% treatment. Moreover, chicken sausages supplemented with *makgeolli* lees fiber had higher cooking yields and improved textural properties. Chicken emulsion sausages prepared with *makgeolli* lees fiber had improved overall acceptability, and the best results of sensory characteristics were obtained for the emulsion sausages containing 2% *makgeolli* lees fiber.

**Key words:** *makgeolli* lees, dietary fiber, chicken, emulsion sausage, sensory characteristics

**Introduction**

Chicken meat and products have grown in popularity due to their nutritional characteristics, while also providing an excellent source of animal protein for consumers in developing countries (Deumier and Collignan, 2003). Chicken meat provides high protein and low fat, and chicken lipids are characterized by relatively high levels of unsaturated fatty acids, which are considered to be positive and healthy by consumers (Bonoli et al., 2007; Hwang et al., 2011). In particular, chicken emulsion sausage is a popular chicken meat-based product. Chicken meat processors are responding to the marketplace demand by producing reduced fat chicken meat products (Hwang et al., 2011). The production and consumption of chicken sausages has been increasing globally. These sausages are becoming more popular due to their sensory characteristics and ease of preparation, which reflects the development of more functionality-enhanced chicken emulsion sausages with added dietary fiber.

Traditional Korean rice wine (*makgeolli*) is one of the most popular alcoholic beverages in Korea (Bae et al., 2010). Korean rice wine is brewed by conventional methods using *nuruk* or *koji* and is comprised of water, yeast, and rice that have been fermented for about 16 days without distillation (Jeong et al., 2006; Kim et al., 1995; Park and Lee, 2002). *Makgeolli* contains polyphenols, polysaccharides, and polysaccharide-peptide complexes (Blan-dino et al., 2003; Jeong and Park, 2006; Lee et al., 1996; Lee et al., 2009), and assorted bioactive components have been evaluated for their positive effects on health. *Makgeolli* lees (also known as *juback* or *sulchigegie*) is a by-product of *makgeolli* brew processing. Commonly used as animal feeds or fertilizers (Won et al., 2006). *Makgeolli* lees is produced in large amounts annually in Korea, and it provides energy, dietary fiber, proteins, minerals, vitamins, alcohol, and organic acids required for human health (Jeong and Park, 2006; Park and Lee, 2002). *Makgeolli* lees is highly nutritious, lowers blood cholesterol, decreases the incidence of atherosclerosis, and has a laxative effect (Kim and Cho, 2006). *Makgeolli* powder has been studied for use in functional foods (Jeong and Park, 2006). However, no studies have yet...
been reported on the makgeolli lees extracted from makgeolli fiber, and its incorporation into chicken meat emulsion sausage. Dietary fiber has been studied alone or combined with other ingredients to prepare meat product formulations. The technological effect on foods differs according to the quantity and nature of the dietary fiber. Thus, makgeolli lees fiber is not only desired for its nutritional properties, but also for its functional and technological properties (Cho and Lee, 1996). Therefore, the objective of this study was to evaluate and compare the compositional, nutritional, and sensory properties of chicken emulsion sausages produced with different concentrations of makgeolli lees fiber.

**Materials and Methods**

**Preparation and processing of makgeolli lees fiber extract**

Dietary fiber was extracted using the modified AOAC enzymatic-gravimetric method (2007). Makgeolli lees was obtained from the Seoul Takju Map Association (Korea). Alcoholic components were removed by washing three times with four volumes of water (25°C), and the residue was dried (55°C) overnight in an air oven and then cooled. The makgeolli lees was gelatinized with 0.6% termamyl (heat stable alpha-amylase) at 95°C for 1 h to remove starch, followed by filtration. The residue was then washed three times with four volumes of heated water (100°C) and allowed to equilibrate to room temperature (20°C, 6 h). The residue was then washed with 99.9% ethanol (preheated to 60°C) and filtered. The residue was dried (55°C) overnight in an air oven and cooled. The makgeolli lees fiber (moisture content: 3.42±0.14%; fat content: 5.98±0.28%; protein content: 15.51±0.78%; ash content: 0.60±0.06%; dietary fiber content: 60.39±3.81%; CIE L*-value: 67.35±1.02; CIE a*-value: 4.62±0.45; CIE b*-value: 16.09±0.85; pH: 4.76±0.24) was then placed in polyethylene bags and vacuum packaged using a model FJ-500XL vacuum packaging system (Fujee Tech, Korea) and stored at 4°C until used for product manufacture. Suitable amounts of the muscle and fat were tempered at 4°C for 24 h prior to meat batter preparation. Each sample batch consisted of five meat batters differing in composition with respect to the addition of makgeolli lees fiber level (0, 1, 2, 3, and 4%). All emulsion sausages were composed by 50% chicken breast meat, 30% pork back fat, and 20% ice. Raw meat was homogenized and ground for 1 min in a model Nr-963009 silent cutter (Hermann Scharfen, Germany), and 1.5% salt (NaCl), 0.15% sodium tripolyphosphate, 0.4% sorbitol, 0.08% monosodium L-glutamate, 0.07% onion powder, and 0.07% ginger powder were added to meat that had been previously dissolved in water, chilled (2°C), and then mixed for 1 min. Makgeolli lees fiber was added to the meat batter, which was homogenized for 6 min. A model KM330 temperature probe (Kane-May, Germany) was used to monitor the temperature of the emulsion, which was maintained below 10°C during batter preparation. After emulsification, the chicken meat batter was stuffed into collagen casings (#240, NIPPI, Japan; approximate diameter of 25 mm) using a model IS-8 stuffer (Sirman, Italy). The meat batter was then heated at 75±2°C for 30 min in a water bath (Dae Han Co, Model 10-101, Korea), and internal temperature of emulsion sausage is 75°C. The cooked meat batter was then cooled with cold water. Ten kilogram batches of each chicken emulsion sausage were prepared in this manner. All analyses were carried out in triplicate for each formulation.

**Proximate composition**

Compositional properties of the chicken meat sausages were determined using AOAC guidelines (2007). Moisture content was determined by weight loss after 12 h of drying at 105°C in a model SW-90D drying oven (Sang Woo Scientific Co., Korea). Crude fat content was determined by the Soxhlet method using a Soxtec® Avanti2050 solvent auto-extraction system (Foss Tecator AB, Sweden), and crude protein was determined by the Kjeldahl method with a Kjeltect® 2300 automatic Kjeldahl nitrogen analyzer (Foss Tecator). Crude ash was determined according to AOAC method 923.03.

**Caloric content**

Total calorie estimates (kcal) for the chicken meat