Effects of Mungbean Flour Level in Combination with Microbial Transglutaminase on Physicochemical and Textural Properties of Low-salt Pork Model Sausages

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Abstract

This study was performed to evaluate the effects of various levels of mungbean flour (MF) (0-2.4%) on the quality characteristics of pork model sausages (PMS) in experiment 1 and also select the optimum level of MF to enhance the water retention and gelling properties of low-salt PMS (LSPMS) with or without microbial transglutaminase (MTGase) in experiment 2. In experiment 1, the addition of MF did not affect pH, chemical compositions (fat and moisture contents), color values, and functional properties (expressible moisture, EM (%) and cooking yield, CY (%)) of PMS. However, the addition of MF increased the chewiness of PMS and hardness if the mungbean flour at the level of more than 1.2% was incorporated. Since the interaction between the microbial transglutaminase (MTGase) treatment and MF level was not significant (p>0.05), data were pooled by different factors (MTGase treatment and MF level) in experiment 2. MF improved the water binding ability and textural springiness of LSPMS. On the other hand, MTGase treatment decreased the pH and cooking yield (%) of LSPMS, but increased most textural properties. In conclusion, the addition of MF could enhance the water retention and textural properties of PMS and LSPMS, regardless of MTGase, when it was added to over 1.2%. Based on these results, mungbean protein may interact with MTGase on the low-salt comminuted meat systems. Therefore, further study might be needed to understand the mechanisms of interaction between MTGase and functional components induced from MF.

Key words: low-salt pork sausages, microbial transglutaminase, mungbean flour, physicochemical and textural properties

Introduction

Since the demands for the ‘Well-being’ and ‘Lifestyles of Health and Sustainability, LOHAS’ increased, lots of researches have been focused on the reformulation of several ingredients such as fat, saturated fatty acids, salt, nitrite, that can cause health problems (Jimenez-Colmenero et al., 2001). The World Health Organization (WHO) and Scientific Advisory Committee on Nutrition also recommended that intake of excessive fat and salt should reduce to prevent metabolic diseases (AHA 2000; SACN, 2003). Thus, reduced levels of fat and salt are required to process meat and meat products with health (Jimenez-Colmenero et al., 2001). Research results are necessary to show meat and meat products containing functional ingredients to compensate for the fat and salt (Arihara, 2006; Fernandez-Gines et al., 2005).

Since reducing salt in meat processing leads to the decreases of salt soluble protein extraction, low-salt meat products cause reduced yield and textural problems (Trout and Schmidt, 1984). To solve these problems, various functional ingredients in the manufacture of emulsified-meat products were applied to improve the yields and textural characteristics. Chin and Lee (2002) reported that functional ingredients, such as non-meat proteins and non-starch polysaccharides, are required to develop the low-fat/salt meat products. Among non-meat proteins, soy protein isolate (SPI) has been extensively used in processed meat industry (Rakosky, 1970), because it improved functional and textural properties of low-fat/salt meat products when it was combined with other functional ingredients (Min and Green, 2008).

Microbial transglutaminase (MTGase) has been widely used for food industry to improve the textural characteristics. Especially, MTGase can make a gel without heating process, and heat-induced gels were not melted even at an increased temperature (Motoki and Seguro, 1998). These characteristics were partially due to the formation of cross-linkages (ε-(γ-glutamyl)lysyl) by catalyzing between
glutamine and lysine (Kashiwagi et al., 2002). Motoki and Seguro (1998) described that MTGase treatments can form the gels as combined with food proteins. It also induced to form emulsion gel in combination with sugar or salt, resulting in improved gel strength after heating. For these characteristics, MTGase was used to modify the functional properties of various kinds of food products (Kuraishi et al., 2001). Recently, application of MTGase has also concerned in plant proteins (Dube et al., 2007).

Legumes have been extensively used as economical food protein resources in the undeveloped countries. Nutritional values and functions of legume seed proteins (LSP) were reported by several previous reports (Duranti and Gius, 1997; Martins and Netto, 2006). Especially, LSP was suggested as a health beneficial compound to reduce risk of coronary heart diseases and cancers (AHA, 2006; Larkin et al., 2008). Recently, Korean researchers identified legume seeds to prevent the stomach cancer (Ko et al., 2010).

Mungbean (Vigna radiata (L.) Wilczek) is one of the legumes and pulses as protein-rich edible seeds, and referred to as grain legumes (Poehlman, 1991). Recently, the seeds of mungbean had antioxidant activity and contained other health-enhancing materials such as isoflavones and phenolic compounds (Anwar et al., 2007; Oh et al., 2003). Mungbean flour (MF) was prepared by grinding, sieving, and dry milling with a fine screen (200 mesh/inch), and isolated by wet-milling and air-classification processes. Flour yields approximately 75% from original weight of mungbean seeds (Poehlman, 1991). MF had lower water absorption capacity (WAC) than other legume flours, such as chickpea and lentil, but higher than that of wheat flour (Sosulski et al., 1976). Based on these previous results, MF and its products could be applied to meat system as water and meat binder (Lee and Chin, 2009). However, no research was performed the effect of various mungbean flour levels on the quality characteristics of pork model sausages and also select the optimum level of mungbean flour to enhance the water retention and gelling properties of low-salt pork model sausages.

Thus, this study was performed to evaluate the effects of various mungbean flour levels on the quality characteristics of pork model sausages and also select the optimum level of mungbean flour to enhance the water retention and gelling properties of low-salt pork model sausages with or without microbial transglutaminase.

Materials and Methods

Materials

Fresh pork shoulder meats were taken from the cross-bred pigs (Landrace × Yorkshire × Duroc, grade A, 110 kg live weight) that were slaughtered at a local retail meat market and stored in a refrigerator for 24 h. Pork meats were trimmed of all visible fats and connective tissues, and stored in a -30°C freezer until used. Microbial transglutaminase (MTGase) was provided by Ajinomoto Food Ingredients (TG-TI, USA), and mungbean flour was purchased from local market (Hamyang NongHyup, Korea).

The manufacture of pork model sausages

Pork model sausages were manufactured with various levels of mungbean flour (experiment 1) and low-salt (<1%) pork model sausages were also manufactured with various levels of mungbean flour with or without MTGase (experiment 2), according to the procedure of Lee et al. (2008). The pork shoulder meats were mixed with different formulations (Table 1). And then, the comminuted meat batters were mixed for 1 min using hand-type food mixer (Bowl RestTM Mixer, Hamilton Beach/Proctor-Silex, Inc., USA). Pork meat batters were stuffed into centrifuge tubes, and then centrifuged for 1 min to remove bubbles. These sausage batters were stored in a refrigerator for 2 h to incubate with MTGase (Sakamoto et al., 1994). After sausage batters were cooked in a water bath (VS-1901W, Vision Scientific Co. Ltd., Korea) until the internal temperature reached to 72°C (heating at 80°C), they were quickly chilled in an ice and stored at a refrigerator until analyzed.

Compositions analyses and sample pH

The chemical compositions (moisture and fat contents) of samples were measured by dry oven (moisture content (%), 950.46) and Soxhlet extraction (fat content (%), 991.36) methods according to AOAC (2000). A 10 g of sausage samples were mixed with 90 mL deionized-water and then pH values of homogenized samples were measured using a pH meter (Model 340, Mettler-Toledo, Switzerland).

Color measurements

The core color of the sausage sample was measured using Color Reader (CR-10, Minolta Co. Ltd., Japan). Color values were expressed by Hunter L (lightness), a (redness), and b (yellowness) (White plate standard: L=91.3±0.95, a=1.43±0.35, b=-1.30±1.21).

Cooking yield

Cooking yields of sausage samples were measured by weighing before and after cooking at 80°C until the inter-