EFFECTS OF HOT BONING AND CURING AGENT ON THE PROCESSING PROPERTIES OF SEMI-DRIED BEEF JERKY

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***Abstract*—the objective of this study was to examine hot-boning / cold-boning and curing solution agent (salt / soy sauce) for enhanced beef jerky's processing properties. Treatments were prepared with four conditions follows; jreky with cold-boned beef and salt solution, with cold-boned beef and soy sauce solution, with hot-boned beef and salt solution, and with hot-boned beef and soy sauce solution. After hand-mixing (for 3 min) and tumbling (for 30 min) for the distribution of curing ingredient, the cured meats dried for 180 min at 55°C, for 180 min at 65°C, and for 60 min at 75°C. Cured meat and jerky with hot-boned beef had higher pH, WHC (Water holding capacity), moisture contents, MFI (Myofibrillar fragmentation index), processing yields, tenderness, and sensorial scores than samples with cold-boned and this may be due to higher pH and WHC in hot-boned meat. Regardless of raw materials, jerky with soy sauce had a significant influence on decreased pH, WHC, moisture contents, salt contents, TBA, CIE L* and b*-values, and the improvement in MFI, mechanical tenderness, and sensorial scores.**

***Index Terms*—hot-boning, jerky, salt, soy sauce**

I. INTRODUCTION

Carcass boning, or production of retail cuts containing bones, can be performed in the traditional manner on a chilled carcass for products designated for the retail steak and roast trade and for sausage manufacture and minced meat, but another boning technique is to utilize the pre-rigor hot carcass, from which the tissue is primarily used for meat or sausage manufacturing (Ockerman & Basu, 2004). Hot boning is the traditional method of cutting carcass which is usually undertaken the day after slaughter when rigor mortis is complete, and has the potential advantages over cold boning of higher meat yield, labor saving (20%), less weight loss during chilling (1.5%), less drip loss in vacuum packages (0.1-0.6%), a more uniform product, a darker color, saving in refrigerator space (50-55%) and refrigeration cost (40-50%), shorter processing time (40-50%), and lower transpot costs (Ockerman & Basu, 2004; Pisula & Tyburcy, 1996; Waylan & Kastner, 2004).

Salt is the most commonly used functional ingredient in meat product manufacture, which is used primarily for flavor with microbial inhibition, extension of shelf-life and increased protein hydration as secondary functions. It increases protein hydration by increasing the ionic strength in meat products, and increased protein hydration leads to increased water binding in intact muscle pieces and increased soluble protein in comminuted meat products. However, as much of the protein that is brought into solution with addition of salt is myosin, and soluble myosin has excellent emulsification and gelling properties, salt addition is critical for creating a stable structure in finely comminuted products (Mills, 2004). Soy sauce, which is produced in large quantities in Asia and the USA, is made with a long, elaborate fermentation process with various fungi, bacteria, and yeast (Lam & de Lumen, 2003). In Korea, the home-made soy sauce is prepared by a traditional method, in which cooked soybeans are mashed and made into small balls (called *meju*), which are dried in the sun drying the day and kept warm at night for several days in the winter, and then the ripened *meju*-brine mixture is separated into supernatant liquid (soy sauce) and sediment residue (soybean paste) (Sasaki & Nonomura, 2003). Soy sauce manufacturing was modernized much earlier than other soy foods, and both fermentation and acid hydrolysis are used to produce different types of soy sauce that are now commonly available around the world (Snyder & Wilson, 2003). All the production processes, such as the heat treatment of raw material, the culturing by moulds, lactic acid and yeast fermentation, ageing of mash and pasteurization, are related to the formulation of flavor compounds, and among these processes, the yeast fermentation in mash and pasteurization contribute most to aroma and flavor (Sasaki & Nonomura, 2003). In Asia, cured (or marinated) foods are prepared by food stuffs with these ingredients, and cured in the presence of water within a certain period of time (Lan & Chen, 2002).

So far, limited research has been conducted on hot-boned meat curing and agent in jerky processing. Therefore, this study was to evaluate the quality properties of semi-dried beef jerky prepared under various raw meat and curing agent, and find out whether hot-boning and curing agent can be effectively utilized for jerky processing.

II. MATERIALS AND METHODS

Raw materials and curing solution preparation

Twelve feedlot-fed Korean native cow (Hanwoo, 24 months of age, live weights: 574-681 kg, slaughter weights: 353-435 kg) were obtained at a local municipal slaughterhouse, transported to the Konkuk University Meat Science Laboratory. After the meat samples were cut into two parts of equal size, half of the carcasses were hot-boned within 90 min post-mortem and the other half (cold-boned samples) were chilled at 4℃ until 48 h. The meat was trimmed of all subcutaneous fat before use for jerky processing.

Preparation of jerky

The ground beef meat (Φ – 8 mm) was mixed with curing solution by hand for 3 min. The meat was then continuously tumbled in a tumbler (MGH-20, Vackona, Liesen, Germany) at 4℃ for 30 min at 25 rpm. Cured meat was stuffed into cellulose casing (Φ – 20 mm), and dried in a convection dry oven (Enex-CO-600, Enex, Yongin, Korea) for 180 min at 55℃, for 180 min at 65℃, and for 60 min at 75℃ (Choi et al., 2008).

Methods

The pH of samples was determined with a pH meter (Model 340, Mettler-Toledo GmbH, Schwerzenbach, Switzerland). pH values were measured by blending a 5 g sample with 20 ml distilled water for 60 s in a homogenizer (Ultra-Turrax T25, Janke & Kunkel, Staufen, Germany). The water holding capacity of raw and cured meat was measured by the procedure of Grau and Hamm (1953). Briefly, a 300 mg sample of muscle was placed in a filter press device and compressed for 3 min. WHC was calculated from samples as a ratio of the meat film area to the total area; hence, a larger value suggests a higher WHC. Instrumental color measurements were taken with a color meter (Chroma meter CR-210, Minolta, Japan; illuminate C, calibrated with white standard plate L^* = 97.83, a^* = -0.43, b^* = +1.98) by measuring on the surface of cured meats. Moisture content was determined by weight loss after 24 h of drying at 105℃ in a drying oven (SW-90D, Sang Woo Scientific Co., Bucheon, South Korea) as recommended by AOAC (1995). Samples for water activity were minced into pieces approximately 1 mm^3 in size, and the water activity of each sample was determined in duplicate with a hygrometer (BT-RS1, Rotronic ag., Bassersdorf, Switzerland). Processing yields were determined by calculating the weight differences of jerky before and after drying. The salt concentration of each sample was measured with a salt meter (TM-30D, Takemura Electric Works Ltd., Tokyo, Japan). Thiobarbituric acid (TBA) values were determined using the distillation method of Tarladgis, Watts, Younathan, and Dugan (1960). Myofibrils were obtained according to the method of Olson, Parrish, and Stromer (1976) using MFI buffer (20 mM K_2HPO_4/KH_2PO_4, pH 7, 100 mM KCl, 1 mM EDTA, 1 mM NaN_3). The myofibrils were suspended in MFI buffer. An aliquot of myofibril suspension was diluted with the MFI buffer to 0.5 mg/ml protein concentration and the absorbance of this suspension was measured at 540 nm. MFI values were recorded as absorbance units per 0.5 mg/ml myofibril protein concentration multiplied by 200 (Yu, Lee, Jeong, Choi, & Kim, 2009). Shear force values were determined with a Warner-Bratzler shear attachment on a texture analyzer (TA-XT2*i*, Stable Micro Systems Ltd., Surrey, UK). Test speeds were set at 2 mm/s. Data were collected and analyzed from the shear force values to obtain for the maximum force required to shear through each sample and were then converted into *N*. Each jerky sample was subjected to sensory evaluations. The samples were served to 12 panel members with previous experience. Panelists were presented with randomly coded samples. The color (1 = extremely undesirable, 10 = extremely desirable), flavor (1 = extremely undesirable, 10 = extremely desirable), tenderness (1 = extremely tough, 10 = extremely tender), juiciness (1 = extremely dry, 10 = extremely juicy), and overall acceptability (1 = extremely undesirable, 10 = extremely desirable) of the samples were evaluated using a 10-point horizontal scale. Panelists were required to cleanse their palate between samples with water (Choi et al., 2008; Keeton, 1983). An analysis of variance were performed on all the variables measured using the General Linear Model (GLM) procedure of the SAS statistical package (SAS Inst., 1999). The Duncan's multiple range test (p<0.05) was used to determine differences between treatment means.

III. RESULTS AND DISCUSSION

Temperatures of cold-boned and hot-boned beef meat at the jerky processing were 4.08 and 36.55℃, respectively, and the hot-boned meat had significantly higher pH and water holding capacity (WHC) than had cold-boned beef.

Additionally, the difference in meat instrumental color was observed between the raw meat, hot-boned beef had significantly lower the CIE L^*, a^*, and b^*-values than cold-boned.

The cured meat with hot-boned beef, regardless of the curing agent, had significantly higher pH and WHC than cold-boned, and for both hot- and cold-boned meat, samples prepared with soy sauce had significantly lower pH and WHC than with salt. This may be due to hot-boned meat having a higher pH and WHC and to soy sauce in the curing solution lowering pH. Also, boning method and curing agent did affect the color of cured meats, the cured samples with salt had significantly lighter and redder than with soy sauce, and within the same curing agent, the cured meat with hot-boned beef was similar to the properties of raw meat having lower CIE L^*, a^* and b^*-values.

The beef jerky prepared with soy sauce had significantly lower pH, moisture contents, and water activity than with salt, except for water activity within hot-boning treatments; this was due to the properties of soy sauce having a lower pH and WHC. In addition, the jerky samples with hot-boned beef had significantly higher pH, moisture contents and water activity than samples with cold-boned because hot-boned raw and cured meat had higher pH and WHC. In addition, the moisture contents and water activity of the semi-dried beef jerky prepared for this study was in the broad range of 29-42% and 0.83-0.89.

The semi-dried jerky prepared with cold-boned meat and salt solution had higher salt concentration than other treatments, and there were no differences ($p>0.05$) within the hot-boned meat treatments. Also, with curing solution distinct changes were observed in the TBA values of analyzed. The differences in TBA value were found among the treatments in the same raw materials, and samples with soy solution had significantly lower TBA values than with salt solution. An increase of salt concentration in the semi-dried beef jerky led to an increase of TBA values in final products, except for the slightly differences in salt concentrations within hot-boning treatments.

The jerky with hot-boned beef, regardless of the curing agent, had significantly higher yields than cold-boned, and this may be due to hot-boned beef meat and jerky having a significantly higher WHC and moisture contents. Also, in this study, tenderness of semi-dried jerky was expressed by comparing with the shear force and myofibrillar fragmentation index (MFI) in samples. The beef jerky prepared with hot-boned meat, regardless of the curing agent, had significantly lower shear force and higher MFI than cold-boned, and for both hot- and cold-boned beef, samples with soy sauce solution had significantly lower shear force and higher MFI than with salt solution. Especially, the product manufactured with hot-boned beef and soy sauce in curing solution had significantly lower shear force and higher MFI than other treatments, and therefore the hot-boning process and soy sauce resulted in textural enhancement of beef jerky in manufacturing.

Hot boning had a significant influence on the all sensorial traits of jerky samples, and within hot-boning treatments, the flavor and overall acceptance in the jerky with soy sauce solutions had significantly higher scores than did with salt solutions. Also, in cold boning jerky, soy sauce had a significantly positive effect on the semi-dried beef jerky in sensorial color and overall acceptance. The sensorial properties of jerky improved with hot-boning and soy sauce and this may be due to the increase in moisture contents and WHC in hot-boned meat and the tenderizing ability of soy sauce.

IV. CONCLUSION

This study was carried out to compare boning methods and curing agents and the quality characteristics of semi-dried beef jerky prepared under various raw materials and curing solutions. The use of hot boned beef meat correlated positively with pH, WHC, moisture contents, MFI, processing yields, mechanical tenderness and sensorial properties of cured meat and jerky samples. In addition, soy sauce improved the textural and sensorial properties of beef jerky, and the decreased TBA values in jerky with soy sauce solution were responsible for the decreased salt concentration. Therefore, the combination of hot-boning and soy sauce had a positive effect on the semi-dried beef jerky in textural and sensory properties.

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