Quality Properties of Beef Jerky Replaced Salt with Soy Sauce, Red Pepper Paste and Soybean Paste during Storage

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Abstract

The aim of this study was to investigate the quality properties of beef jerky replaced salt with soy sauce, red pepper paste, and soybean paste. The quality properties of beef jerky including final water activity (a_w), moisture content, pH, color, shear force, total plate counts, thiobarbituric acid reactive substance (TBARS) values, and sensory evaluations were investigated. The sliced beef samples were marinated in salt (control), soy sauce (T1), red pepper paste (T2), and soybean paste (T3) for 24 h and then dried at 70°C for 6-8 h. The water activity of finished beef jerky varied from 0.72 to 0.70. The water activity for control and T1 samples decreased more rapidly as drying proceeded up to 6 h. The samples with salt replacement showed a lower pH and lightness than the control (p<0.05). The T1 sample showed a significant decrease in total plate counts after 21 d of storage (p<0.05). The TBARS for all treatments increased with storage days (p<0.05). The TBARS were significantly lower in T2 and T3 samples compared to control and T1 until 21 d of storage (p<0.05). The samples with salt replacement showed a lower intensity of saltiness than the control. Sensory evaluations found that the replaced soy sauce of beef jerky samples had better overall acceptability scores than the other treatment samples. It was concluded that replacing salt with soy sauce can delay lipid oxidation and enhance the sensory acceptance of beef jerky.

Key words: beef jerky, replaced salt, soy sauce, red pepper paste, soybean paste

Introduction

Jerky is made from sliced whole muscles which have been marinated and dried. Also, jerky products can be made with various marinade techniques, meats from different species and drying conditions (Yang et al., 2009). It is relatively simple to process, with a typical flavor, and usually requires no refrigeration during commercial distribution, due to low water activity. The final product reaches a water activity of 0.70-0.75 when it is ready for consumption, and is normally shelf stable for 6 months if left packed to inhibit microbial activity (Torres et al., 1994). Hurdles to microbial survival and growth include drying temperature, low water activity, and preservatives such as salt and organic acids depending on the composition of the marinate mixture (Gailani and Fung, 1986; Quinton et al., 1997).

Salt (sodium chloride) is one of the most frequently used ingredients in meat processing. Salt affects the flavor, texture and shelf life of meat products. Besides the perceived saltiness, salt brings out the characteristic taste of the meat product enhancing the flavor (Gillette, 1985). In particular, salt produces a strong decrease in water activity and high osmotic pressures (Lazarides et al., 1995). However, the meat industry has explored various options to lower sodium in processed meats. An increased effort has been made to reduce the amount of salt in foodstuffs (Costa-Cordero et al., 2009). The World Health Organization (WHO) has also recommended a reduction of salt content of meat products (WHO, 2007). There is a trend to reduce the salt content in foods because excessive sodium intake contributes to high blood pressure in salt susceptible consumers (Hee and Mac Gregor, 2010). A possible approach to reduce the sodium content is the partial and total replacement of sodium chloride with other chloride salts (KCl, CaCl₂ and MgCl₂) or phosphates (Sofos, 1989; Terrell, 1983). However, these techniques have different questions like the possible reduction
of the salty flavor (metallic and bitter), anomalous color and textures, and microbiological stability (Toldrá, 2006).

In Korea, fermented soybean foods such as *doenjang* (soybean paste), *ganjang* (soybean sauce) and *gochujang* (red pepper paste) have been a major source of protein in the Korean diet (Cho et al., 2009). Organic acids occur in fermented products as a result of hydrolysis, biochemical metabolism and microbial activity (Shukla et al., 2010). Kremer et al. (2009) demonstrated that soy sauce could possibly achieve a reduction of salt in foods without leading to significant losses in taste intensity or product appreciation. Also, soy sauce is a healthy salt replacement (Keast and Breslin, 2002), as it is a flavor enhancer and modifier.

Therefore, the objective of this study is to investigate the effect of replacing salt with soy sauce, red pepper paste and soybean paste on the physicochemical and sensory properties of beef jerky, and to determine if curing agents can be effectively utilized for beef jerky processing.

**Materials and Methods**

**Preparation of pork jerky samples**

A total of three cattle (Korean native cattle, Hanwoo, market weight 425-475 kg) were randomly selected at a commercial slaughter plant. The muscle of beef *semimembranosus* was dissected from the carcasses 48 h post-mortem. All subcutaneous and intermuscular fat and visible connective tissue were removed from the fresh muscles. The sample was sliced to 0.5 cm thick pieces with a meat slicer (HFS 350G, Hankook Fujee Industries Co. Ltd., Korea). Sliced jerky samples were cut parallel in the same direction as muscle fibers. Commercial salt, soy sauce, red pepper paste and soybean paste were purchased from a local food additives plant. Salt, soy sauce, red pepper paste and soybean paste solution were diluted with ice water for adding the same salinity content. In consequence, the red pepper paste and soybean paste solutions were homogenized with a Polytron homogenizer (T25-B, IKA Sdn. Bhd., Malaysia) at 8,000 rpm for 30 s. The slurry was filtered through two layers of cheese cloth to remove the impurities. Prior to the processing of beef jerky, the salinity of salt, soy sauce, red pepper paste and soybean paste were adjusted. The sliced samples were then cured for 12 h in a cure solution containing 10% water, 2% salt solution (soy sauce, red pepper paste and soybean paste), 6% sugar, 0.2% pepper, and 0.028% sodium nitrate (based on raw meat weight; v/w).

After curing, all samples were dried using a dryer (DS80-1, Dasol Scientific Co. Ltd., Korea) at a temperature of 70°C. There was adequate air distribution between samples receiving the same drying treatment. Water activity measurements were then taken, to the target $a_w<0.75$. After drying and cooling to ambient temperature the jerky samples were packed (single package) and placed at room temperature (25°C) for 21 d.

**Analytical methods**

**Salinity**

The salinity was measured a digital salinity meter (Takemura, TM-30D, Japan). Approximately 3 g of the jerky sample was cut into small pieces and 27 mL of distilled water was added. Slurry was then made using a homogenizer (T25basic, IKA, Malaysia) and salinity was recorded.

**Water activity ($a_w$) and moisture content**

Three pieces of the beef jerky samples from each treatment were selected and cut into fine pieces using sharp scissors. The pieces were filled into water activity cups, and their water activity was measured with a water activity meter (AQS-2, Nagy mess system, Germany), calibrated at ambient temperature 20°C with distilled water ($a_w=1.000$) and saturated solutions of NaCl ($a_w=0.756$) and KCl ($a_w=0.853$).

Moisture content was determined according to AOAC (2000). The strips were dried in an air oven at 102°C for 24 h and the total moisture content of individual beef strips was determined from their pre-dry and dry weights expressed as the percentage of pre-dry weight and gram water per gram of dry weight.

**pH**

The pH was measured in triplicate using a digital pH meter (MP230, Mettler, Switzerland). Approximately 3 g of the jerky sample was cut into small pieces and 27 mL of distilled water was added. Slurry was then made using a homogenizer (T25basic, IKA, Malaysia) and pH was recorded. The pH meter was calibrated daily with standard buffers of pH 4.0 and 7.0 at 25°C.

**Instrument color (lightness)**

The surface lightness color value of the jerky samples were measured by the CIE $L^*$ system using a Minolta Chroma meter CR-200 (Minolta Camera Co., Osaka, Japan), whereby measurements are standardized with respect to a white calibration plate ($L^*=89.2$, $a^*=0.921$ and...