Effects of Salt Concentration and Drying Time on the Quality Characteristics of Pork Jerky during Dehydration

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Abstract

This study was conducted in order to evaluate the effects of brine pre-soaking at different concentrations and drying time on the quality characteristics of pork jerky. The physicochemical properties of pork jerky including final moisture content, water activity ($a_w$), shear force, microstructure, and thiobarbituric acid reactive substance (TBARS) values were investigated. The sensory attributes of pork jerky were evaluated and used as parameters for determining the optimum drying condition. The sliced pork samples were pre-soaked at salt concentrations ranging from 0 to 10% for 3 h and then dried at 70°C for up to 10 h. The pre-soaked samples in the salt solution showed higher final moisture content than the control sample after drying for 10 h. The final moisture content of pork jerky increased with increasing salt concentrations. On the other hand, the water activity with regards to the pre-soaked samples in a 10% salt solution showed the lowest value for up to 8 h drying. The shear force values of pork jerky decreased with increasing salt concentration while the TBARS values of the samples increased with increasing salt concentrations. Sensory evaluation suggested that the color, flavor, juiciness, and tenderness of the pork jerky samples were improved by pre-soaking in a 2% salt solution and the highest likeability score of pork jerky among the samples were obtained by pre-soaking in a 2% salt solution prior to drying.

Key words: pork jerky, salt concentration, drying condition, optimization, sensory evaluation

Introduction

Jerky is a product that is easy to prepare, lightweight, and rich in nutrient content (Harrison et al., 1997). Jerky is also relatively simple to process, has a typical flavor, and needs no refrigeration during commercial distribution due to its low water activity ($a_w$). Numerous recipes for making jerky are available and they are based on using meat from several species, applying different marinate techniques, and varying drying processes. The final product reaches an $a_w$ of 0.70-0.75 when ready for consumption, and is normally shelf stable for 6 months if left unpacked to inhibit microbial activity (Torres et al., 1994). Hurdles to microbial survival and growth include drying temperature, low $a_w$ (<0.85), and preservatives such as salt and organic acids depending on the composition of the marinate mixture (Gailani and Fung, 1986; Quinton et al., 1997). It is essential that intermediate moisture (IM) meat products such as jerky should be dried to water activity acceptable for proper shelf-life.

The osmotic dehydration process can be characterized by equilibrium and dynamic periods (Rahman, 1992). In the dynamic period, the mass transfer rates are increased or decreased until equilibrium is reached. The study of the equilibrium state is necessary for the modeling of osmotic process until operation and also important for a good understanding of the mass transfer mechanisms involved in this system (Barat et al., 1998). The distribution coefficient for processed pork jerky is defined as the ratio of the salt concentration in pork muscle and salt at equilibrium in the drying condition. Although a variety of compounds can be used in curing meat, the basic curing ingredients are salt, sugar, and some other sweeteners. The osmotic agents more employed are hypertonic solutions of salt and sugar and also, ternary mixtures with both compound (Chenlo et al., 2006).

The dimensionless parameter that evaluates the water transferred from the sample is denominated as water loss. Salt (sodium chloride), in particular, produces a strong decreased water activity and higher osmotic pressures than the same sugar concentration used (Lazarides et al.,...
An acceptable level of salt in hams has been reported to be about 2-3% (Pearson and Wolzak, 1982). Of course, higher and lower salt levels are common and are a matter of personal preference. Previous published work has demonstrated improved yields, tenderness, and moisture retention (Detienne and Wicker, 1999). However, published studies have not included optimization of marinate technology in pork jerky.

The objective of this study is to investigate the effects of pre-soaking salt concentration and drying time on the physicochemical and sensory properties of pork jerky to manufacture the products according to consumer likeability and shelf-life safety using pork loin muscle.

Materials and Methods

Preparation of dried pork jerky samples

The muscle (*longissimus dorsi*) of fresh pork was purchased from a local processor at 48 h postmortem. The pH of the pork loin was 5.54-5.58. All subcutaneous and visible connective tissue were removed from the fresh muscles. After dissection, all muscles were frozen and stored at -20°C until use (within 2 d). The frozen pork was thawed at 4°C overnight, sliced to 0.5 cm thickness with a meat slicer (HFS 350G, Hankook Fugee Industries Co. Ltd., Korea), and cut into pieces of 10×4.0×0.5 cm³ size. Sliced pork jerky samples were cut in the same direction as the muscle fibers. Salt was purchased from a local food additives plant. The sliced pork samples were added different salt amounts from 0 to 10% (based on raw meat weight; v/w) for time ranging 0 to 10 h at 70°C using dryer (DS80-1, Dasol Scientific Co. Ltd., Korea), and cut into pieces of 10×4.0×0.5 cm³ size. Sliced pork jerky samples were cut in the same direction as the muscle fibers. Salt was purchased from a local food additives plant. The sliced pork samples were added different salt amounts from 0 to 10% (based on raw meat weight; v/w) for time ranging 0 to 10 h at 70°C using dryer (DS80-1, Dasol Scientific Co. Ltd., Korea). After drying and cooling at room temperature, samples were measured for moisture content, water activity, shear force, SEM (scanning electron microscope), lipid oxidation, and critical point dried using hexamethyl-disilazane (HMDS; Sigma H-4875) three times for 20 min at cold temperature. The next specimens were mounted on a holder with double-sided tape and sputter-coated with gold using an ion-sputtering device (JFC-1100E, JEOL, USA (Yang et al., 2009). The predicted curve was obtained by fitting experimental data to the equations following the exponential curve of different salt concentrations for soaking.

\[ y = 0.1915 e^{5.6425x} (0\%), \ 0.3194 e^{5.3086x} (2\%), \ 0.6636 e^{3.9337x} (5\%), \text{ and } 1.6426 e^{4.7359x} (10\%) \]

Where \( y \) is the predicted moisture content, \( x \) is \( a_w \).

Shear force

Shear force (kg/cm²) was measured using the Instron Universal Testing Machine (Model 3343) with a V-shaped shear blade. From each six samples, as close as practicable to 0.5×4.0 cm (approximately 2.0 cm²) cross-section (of the fibers) was cut for cutting force measurements. The pork jerky samples were placed at right angles to the blade. The crosshead speed was 100 mm/min and the full scale load was 50 kg.

Microstructure

The microstructure changes in pork jerky was evaluated using a field emission scanning electron microscope (FE SEM; XL30S, Philips, Netherlands) after preparing the samples by a method reported previously (Carroll and Lee, 1981). The specimens (muscle; 3×4×5 mm), cut longwise to the muscle fibers, were fixed with 2.5% glutaraldehyde in 0.1 M phosphate buffer (PB) at pH 7.2 for 3 h at cold temperature (2-4°C). The specimens were rinsed with 0.1 M PB (three times) for 15 min at cold temperature and fixed with 1% O₂/O₃ in 0.1 M phosphate buffer for 2 h at cold temperature. After fixing, the specimens were then rinsed with distilled water and dehydrated in 50, 60, 70, 80, 90, 95% and absolute ethanol for 15 min in each solution. After dehydration, specimens were settled in acetone for 15 min and critical point dried using hexamethyl-disilazane (HMDS; Sigma H-4875) three times for 20 min at cold temperature. The next specimens were mounted on a holder with double-sided tape and sputter-coated with gold using an ion-sputtering device (JFC-1100E, JEOL, Korea). The strips were dried in an air oven at 102°C for 4 h and the total moisture content of individual pork strips was determined from their pre-dry and dry weights expressed as the percentage of pre-dry weight and gram water per gram dry weight.

Three pieces of pork 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 (\( a_w = 0.853 \)).

The data analysis for the relationship between water activity and moisture content of jerky products at various drying times was performed by the Microsoft Office Excel Program manufactured by Microsoft Corp., Roselle, IL, USA (Yang et al., 2009). The predicted curve was obtained by fitting experimental data to the equations following the exponential curve of different salt concentrations for soaking.

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