Evaluation of Microbiological, Physicochemical, and Sensory Properties of *Galbi-jjim* Prepared by *Sous-vide* and Cookchill Method at Different Temperatures

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Abstract

The aim of this study was to evaluate the physico-chemical, sensory, and microbiological properties of ready-to-eat Korean traditional seasoned beef ribs (*galbi-jjim*) prepared by sous-vide/cookchill technology during storage at three different temperatures (4, 10, and 20°C). Beef short ribs marinated in soy sauce for 24 h at 3°C were packed with vegetables under vacuum. Vacuum-packed beef ribs mixed with vegetables were heated at 90°C for 90 min in a water bath, and then immediately chilled below 3°C within 120 min in an ice slurry. Physicochemical (pH, water activity, TBARS, L*a*b* color, and texture profile), sensory (appearance, odor, flavor, texture, and acceptance) and microbiological (Coliform, *Escherichia coli*, food-borne pathogenic bacteria) properties of the samples were determined during storage at different temperatures. Results showed that pH, *a*<sub>w</sub>, and sensory evaluation of products were not affected in any consistent way as a function of either storage duration or temperature. Coliform, *E. coli* and food-borne pathogens were not detected during storage at any temperature. However, TBARS significantly increased during storage period (*p*<0.05). Based on TBARS values, SV/CC "galbi-jjim" can be stored for 15 d, 12 d and 1 d at 4, 10 and 20°C, respectively.

Key words: sous-vide/cook-chill, sensory quality, microbiological safety, temperature abuse simulation

Introduction

Many Korean traditional dishes require time-consuming and intensive labor for preparation and cooking (Paik *et al.*, 2006), whereas they have limited storage stability at normal refrigeration temperature. Consumers demand foods that are convenient, easy to prepare, high quality and preservative-free (Galimpin-Johan *et al.*, 2007; Koo *et al.*, 2008; Paik *et al.*, 2006). As two-income households, working mothers, singles, and seniors have increased, the market for convenient food has grown remarkably. Consequently, the production of intermediate food or ready-to-eat meals in cold chain have become more popular compared to traditional home-cooked meal (Johnson and Resurreccion, 2009).

*Sous-vide/cook-chill* (SV/CC) technology is a cooking procedure originated in France in the mid-1970s. SV/CC system is defined as raw or par-cooked foods are vacuum-sealed in a barrier pouch or container, cooked slowly in controlled mild heating conditions, rapidly chilled, stored at refrigeration temperatures and reheated for consumption (Creed, 1998; Ghazala *et al.*, 1995; Schellekens, 1996; SVAC, 1991). SV/CC technology is applied to catering industries, food service sectors and ready meal-type food productions (Creed, 1998; Vaudagna *et al.*, 2002).

Previous studies (González-Fandos *et al.*, 2004; Schellekens, 1996) have shown that SV/CC technology is possible to extend the shelf-life from 6 to 42 d. SV/CC applied foods are generally processed using a mild heat treatment and requires a long heating time at low temperature to retain tenderness, juiciness and microbiological safety (bacterial pathogens).

As the points of the quality, SV/CC is a highly advanced technology because of convenience, better sensory quality and retention of water-soluble nutrition than conventional cooked food (Schellekens, 1996; Vaudagna *et al.*, 2008). Nevertheless, anaerobic and temperature abuse conditions of SV/CC cooked foods can cause potential

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microbiological hazards during the product circulation and at the consumer level (Schellekens, 1996; Tansey et al., 2005). In our previous report, the optimal textural and sensory conditions of SV/CC processing were investigated to develop the ready-to-eat (RTE) Korean traditional “galbi-jjim” (Kim, Park and Shin, 2009). As a result, the control temperatures of SV/CC processed “galbi-jjim” satisfied the guidelines of ACMSF (Advisory Committee on the Microbiological Safety of Food, U.K., 2004), ECFF (European Chilled Food Federation, U.K., 1996), Food code (FDA, U.S.A., 2005) and DHSS (Department of Health and Social Security, U.K., 2003).

Therefore, the objective of this study was to evaluate the physico-chemical, sensory quality and microbiological safety of the ready-to-eat (RTE) type “galbi-jjim” product at normal refrigeration temperature (4°C) and temperature-abused conditions (10°C and 20°C) (FDA, USA, 2005; ACMSF, UK, 2004) for industrial application.

**Materials and Methods**

**Preparation of sous-vide “galbi-jjim”**

Beef short ribs for sous-vide/cookchill were purchased from a local market (Seoul, Korea) and cut into 4.9×3.1×3 cm pieces. The SV/CC “galbi-jjim” was processed as shown in Fig. 1. Briefly, the beef short ribs were submerged in cold water for 2 h to remove blood and cooked in boiling water for 60 min. The pre-cooked beef short ribs were marinated in seasoning sauce for 24 h at 3°C before vacuum packing. Beef short ribs and vegetables (carrots, gingko nuts, taro, and shiitake mushrooms) were vacuum-packed in nylon/PE/LLDPE pouch (Samhosa Co., Ltd., Seoul, Korea) using a vacuum sealing machine (SH-100/SMV-206T, Samhosa Co., Ltd., Seoul, Korea) under 760 mm Hg pressure. The products were cooked at 90°C for 90 min in a water-bath with a meat core temperature of 85°C/60 min and immediately chilled in an ice slurry jacket until the internal temperature reached ≤3°C within 1 h.

The pasteurization and chilling method was followed to UK ACMSF (2004), UK ECFF (1996), FDA (2005) and UK DHSS (2003) guidelines. Chilled products were stored at 4°C and 10°C were analyzed after 1, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 d, and those at 20°C were analyzed after 1, 3, 6, 9, 12 and 15 d. The water activity (a_w) was determined by the Conway Unit Method (Sibata Scientific Technology Ltd., Tokyo, Japan). Three gram of potassium dichromate (regent A) and potassium mitrate (reagent B) was pur into the out-side cell, separately. A sample (1 g) was placed in an aluminum weighing case and the lid, and closed to stand in a thermostat at 25 (±2)°C for 2 (±0.5) hours. The water activity (a_w) value was calculated according to the following equations:

\[ a_w = B \times X - A \times Y / X - Y \]

A: a_w value of regent (wet) A
B: a_w value of regent (wet) B
X: increase or decrease of weight with A
Y: increase or decrease of weight with A

The pH measurements (Vaudagna et al., 2008) were performed with a pH meter (Model M530 Pinnacle, Corning, USA). A sample (5 g) was mixed with distilled water (25 mL) for 30 sec using a blender (HMF-505, Han Baek Scientific Co., Seoul, Korea) for 36 d for sensory evaluation, physicochemical and microbiological analysis.

**Physicochemical analysis**

Water activity, pH, 2-thiobarbituric acid reactive substances (TBARS), CIE L* a* b* color and texture profile were performed during storage (3-d intervals) at 4, 10 and 20°C. The products stored at 4°C and 10°C were analyzed after 1, 3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33 and 36 d, and those at 20°C were analyzed after 1, 3, 6, 9, 12 and 15 d.

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TBARS was determined by a modification of the previous methods (Choi et al., 2002; Witte et al., 1970). The