Meat Science 119 (2016) 16–21

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Chemical compositions, free amino acid contents and antioxidant activities of Hanwoo (*Bos taurus coreanae*) beef by cut

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ARTICLE INFO

Article history:
Received 27 August 2015
Received in revised form 15 March 2016
Accepted 7 April 2016
Available online 18 April 2016

Keywords:
Hanwoo beef
Chemical composition
Free amino acid
Antioxidant activity
QUENCHER procedure

ABSTRACT

The objective of this study was to evaluate chemical compositions, free amino acid contents, and antioxidant activities of different cuts of Hanwoo (*Bos taurus coreanae*) beef. Beef preferences and prices in the Korean market depend on cut. Therefore, comparisons were made between high-preference cuts (group 1 [G1], including loin, tenderloin, and rib) and low-preference cuts (group 2 [G2], including brisket, topside, and shank). Meat samples were collected from 10 fattened cows. Crude fat content was significantly higher in G1 than in G2 ($p < 0.05$). The amounts of crude protein and total free amino acid were negatively correlated with crude fat content ($p < 0.05$). Overall G2 contained higher levels of free amino acids with antioxidant activity than G1. Antioxidant activities were also significantly higher in G2 compared with G1 ($p < 0.05$). In conclusion, providing consumers with positive information about G2 as found in this study could help health-conscious consumers choosing among beef products and further promote increased consumption of low-preference beef cuts.

1. Introduction

Beef is one of the main animal food resources providing high-quality protein and essential nutrients, including essential amino acids, unsaturated fatty acids, minerals, and vitamins, for human consumption. The annual per capita consumption of beef has more than tripled during the last 2 decades in Korea, rising to approximately 9.7 kg in 2012 from 2.6 kg in 1980 (Korea Meat Trade Association, 2013).

Cattle carcasses are generally divided into 10 cuts (loin, tenderloin, rib, brisket, topside, shank, striploin, neck, blade, and rump) for distribution in Korea (Korea Institute for Animal Products Quality Evaluation, 2008). The nutritional composition and physico-chemical properties of beef differ by cut (Cho et al., 2007; Lee et al., 2010), which affects flavor characteristics. Consequently, consumer preferences vary for each cut of beef. Loin, tenderloin, and rib cuts have a higher fat content and are preferred over other cuts such as brisket, topside, and shank in the Korean meat market. The auction price of highly preferred cuts such as loin and tenderloin is roughly triple that of low-preference cuts such as topside and shank, and the price variance between the cuts is continuously increasing (Korea Institute for Animal Products Quality Evaluation, 2014). Nevertheless, it is responsible for disproportion of beef market because the demand of beef is higher in high-preference cuts than low-preference cuts. Therefore, it is required to promote consumption of low-preference cuts meats for stabilization of beef market.

Consumers have become increasingly focused on the healthfulness, freshness, safety, and functionality of food, in addition to its taste, and there is an increasing demand for foods with healthful characteristics (Gökmen, Serpen, & Fogliano, 2009; Han, 1999; Shahidi, 2009). Antioxidant compounds in food enhance the health potential, and their presence is one of the most heavily weighted features in defining food nutritional quality (Rice-Evans, Miller, & Paganga, 1997). Antioxidants perform an important role in defending the body against reactive oxygen species (Gutteridge & Halliwell, 2000). Therefore, antioxidant content and activity can serve as criteria for the health potential of food, and several methods have been developed to measure the antioxidant activity present in foods (Gökmen et al., 2009). The antioxidant activity of meat can be affected by the feed consumed by the animal (Cheong et al., 2012; Descalzo & Sancho, 2008; Qwele et al., 2013) and by animal species (Serpen, Gökmen, & Fogliano, 2012a). However, little information exists on the functionalities of different cuts of beef with the same meat quality grade.

The QUENCHER (QUick, Easy, New, CHEap and Reproducible) procedure proposed by Serpen, Capuano, Fogliano, and Gökmen (2007) is a method for evaluating the total antioxidant activity of solid foods. It is based on an interaction that occurs at the interface between the solid matrix and a liquid chromophore-containing probe for radicals. This extraction-independent procedure permits robust determination of antioxidant activity (Gökmen et al., 2009).

The present study investigated chemical compositions, free amino acid contents, and antioxidant activities using the direct QUENCHER procedure in high-preference and low-preference cuts (loin, tenderloin,

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http://dx.doi.org/10.1016/j.meatsci.2016.04.016
0309-1740/

rib, brisket, topside, and shank) of Hanwoo (*Bos taurus coreanae*) beef in order to promote consumption of various low-preference cuts of beef.

2. Materials and methods

2.1. Meat sample preparation

Comparative studies were conducted for high-preference cuts of beef (group 1 [G1], loin, tenderloin, and rib) and low-preference cuts of beef (group 2 [G2], brisket, topside, and shank). Fresh meat samples from 10 fattened Hanwoo cows (quality grade 1) were purchased from Sungjin Co., Ltd. (Seoul, South Korea). The cows were slaughtered at the same time in a local municipal slaughterhouse (Eumseong, South Korea) and were evaluated by the Hanwoo beef carcass grading system of Korea Institute for Animal Products Quality Evaluation (2008) 24 h post mortem. After grading, the carcasses were divided into various cuts and were transported within 24 h. Immediately after purchase, the meat samples were dried with a freeze dryer (Programmable freeze dryer, Ilshin Lab Co., Ltd., Seoul, South Korea) at −45 °C (10 mTorr for 72 h) and ground into powder form using a sample grinder (HMF-3100S, Hanil Co., South Korea).

2.2. Chemical compositions analysis

The chemical compositions of the meat samples were analyzed by the standard method of the Association of Official Analytical Chemists (1995) to determine moisture, crude protein, crude fat, and ash content.

2.3. Free amino acids analysis

Free amino acids analysis was performed as indicated by Cordoba et al. (1994). Briefly, five grams of each sample were homogenized with 20 mL of ultrapure water. 20 mL of 10% 5-sulfosalicylic acid was then added into the homogenate for deproteinization, which was maintained at 4 °C for 17 h. After deproteinization, the homogenate was centrifuged at 15,000 *g* for 10 min at 4 °C, and filtered through a 0.2 μm filter. The free amino acid contents of the filtrate were determined using an amino acid analyzer (Amino Acid Analyzer ARACUS, Membrapure, Hennigsdorf, Germany) with postcolumn derivatization with ninhydrin. The amino acid analyzer conditions were as follows: pre-column, narrow bore, stainless steel, 30 mm; column, narrow bore, stainless steel, 125 mm, ID 3 mm; injection volume, 20 μL; excitation, 440 nm; emission, 570 nm; and program time, 87.50 min. The amino acid standard solution (AA-S-18, Sigma, St. Louis, MO, USA) was used for identification and quantification of free amino acids. The free amino acids were expressed as milligrams per 100 g of meat (mg/100 g meat).

2.4. Antioxidant activities by the QUENCHER procedure

Antioxidant activities measurement by the QUENCHER method was done using the method of Serpen et al. (2012a) with slight modification as below.

2.4.1. Preparation of meat samples for the QUENCHER procedure

In the direct QUENCHER procedure, the particles of solid sample having a mesh size in the range of 140–60 mesh are suitable to perform a reaction with an acceptable rate during the antioxidant activity evaluation (Gökmen et al., 2009; Serpen, Gökmen, Pellegrini, & Fogliano, 2008). Freeze dried meat samples were mixed with cellulose at a ratio of 1:1 (*w*/*w*) for the next step, because the meat samples included lipid, and became sticky after the freeze drying. After dilution, the samples consecutively passed through a 50-mesh size sieve (testing sieve, Chung Gye Sang Gong Sa, Seoul, South Korea).

2.4.2. DPPH radical scavenging activity

A 2,2-diphenyl-1-picrylhydrazyl (DPPH) solution was prepared according to the method of Brand-Williams, Cuvelier, and Berset (1995) with some modifications. A stock solution of DPPH was prepared by dissolving 40 mg of DPPH in 100 mL of ethanol. The DPPH solution was then diluted with 100 mL of deionized water to obtain a DPPH stock solution in a water–ethanol (50:50, *v*/*v*) mixture. The DPPH working solution was obtained by mixing 200 mL of stock solution with 800 mL of a water–ethanol (50:50, *v*/*v*) mixture to obtain an absorbance value of 0.80–0.85 units at 540 nm. Ten milligrams of the powdered meat–cellulose samples was transferred to a 15-mL centrifuge tube. The reaction was started by adding 10 mL of the DPPH working solution. The tube was vigorously mixed by vortexing in the dark for 30 s. The mixture was shaken at 200 rpm at room temperature on an orbital shaker in the dark to facilitate the surface reaction between the meat sample particles and the DPPH solution. After 30 min from the first introduction of the radical solution to the meat samples, the tubes were centrifuged at 3000 rpm for 2 min. Supernatants (200 μL) were transferred into 96-well plates and the absorbance values were measured at 540 nm. The DPPH radical scavenging activity was expressed as millimoles of Trolox equivalent per kilogram of dry weight meat (mmol Trolox Eq./kg meat d.w.).

2.4.3. ABTS radical scavenging activity

2,2′-Azino-bis-3-ethylbenzothiazoline-6-sulfonic-acid (ABTS) solution was prepared using the method described by Re et al. (1999). The stock solutions of ABTS included 7.4 mM ABTS solution and 2.45 mM potassium persulfate solution (final concentrations). The ABTS solution was prepared by mixing 5 mL of deionized water with 38.41 mg of ABTS. The potassium persulfate solution was prepared by adding 5 mL of deionized water to 6.62 mg of potassium persulfate. The working solution was then prepared by mixing the two stock solutions in equal quantities and allowing them to react in the dark at room temperature for 12–15 h before use. The working solution of ABTS was diluted by mixing 10 mL of ABTS stock solution with approximately 700 mL of a water–ethanol (50:50, *v*/*v*) mixture to obtain an absorbance value of 0.75–0.80 units at 750 nm. Ten milligrams of powdered meat–cellulose samples was transferred to a 15-mL centrifuge tube. The reaction was started by adding 10 mL of the ABTS working solution. The tube was vigorously mixed by vortexing in the dark for 30 s. The mixture was shaken at 200 rpm at room temperature on an orbital shaker in the dark to facilitate the surface reaction between the meat sample particles and the ABTS solution. After 90 min from the first introduction of the radical solution to each sample, the tubes were centrifuged at 3000 rpm for 2 min. The supernatants (200 μL) were transferred into 96-well plates, and the absorbance values were measured at 750 nm. The ABTS radical scavenging activity was expressed as millimoles of Trolox equivalent per kilogram dry weight meat (mmol Trolox Eq./kg meat d.w.).

2.4.4. DMPD radical scavenging activity

N,*N*-Dimethyl-*p*-phenylendiamine (DMPD) solution was prepared by diluting an aqueous solution of 0.05 M ferric chloride and 100 mM DMPD in 100 mM acetate buffer (pH 5.25) at a ratio of 2:10:1000 (*v*/*v*/*v*) as proposed by Fogliano, Verde, Randazzo, and Ritieni (1999). Ten milligrams of the powdered meat–cellulose samples was transferred to a 15-mL centrifuge tube. The reaction was started by adding 10 mL of the DMPD working solution. The tube was vigorously mixed by vortexing in the dark for 30 s. The mixture was shaken at 200 rpm at room temperature on an orbital shaker in the dark to facilitate the surface reaction between the meat sample particles and the DMPD solution. After 60 min from the first introduction of the radical solution to each sample, mixtures were centrifuged at 3000 rpm for 2 min. The supernatants (200 μL) were transferred into 96-well plates and the absorbance values were measured at 490 nm. The DMPD radical scavenging activity was expressed as millimoles of Trolox equivalent per kilogram dry weight meat (mmol Trolox Eq./kg meat d.w.).