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Original Research Article

Comparison of the amounts of endogenous bioactive compounds in raw and cooked meats from commercial broilers and indigenous chickens

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ABSTRACT

A study was conducted to compare carnosine, anserine, betaine and carnitine contents of breast and leg (combined thigh and drumstick) meat from Korean native chickens (KNCs) and commercial broilers (CBs) at their market ages (100 and 32 d, respectively) and to determine the changes in these compounds during moist heat cooking. In general, KNCs showed significantly higher histidyl dipeptide and carnitine contents and a lower betaine content than CBs ($p < 0.05$). Significantly higher histidyl dipeptide contents were observed in breast meat, while leg meat had more betaine and carnitine contents ($p < 0.05$). Significant decreases in the content of all compounds analysed in this study occurred during cooking ($p < 0.05$). Meat from KNCs is a good source of carnosine, anserine, and carnitine compared to that from CBs, which has a higher content of betaine. In addition, the contents of these endogenous compounds are significantly affected by the meat portion and the cooking process ($p < 0.05$).

1. Introduction

With rapid economic growth and globalisation of the food industry in Asian countries, including South Korea, meat production and consumption have increased remarkably in recent years. Accordingly, an approximate five-fold increase in *per capita* chicken meat consumption was reported during the last four decades in Korea (Jayasena et al., 2013). This increasing demand for chicken meat is mainly fulfilled by a few fast-growing commercial broiler (CB) strains (Choe et al., 2010), with little contribution from the slow-growing indigenous chicken breed known as the Korean native chicken (KNC). Because of their unique flavour and texture, KNCs are highly preferred to CBs by Korean consumers (Jayasena et al., 2013). In addition to these unique characteristics, these indigenous chickens contain considerable amounts of certain endogenous bioactive compounds such as carnosine and anserine (Jung et al., 2013); these can be considered additional nutritional quality factors.

Potential health-promoting and bioactive characteristics of carnosine, anserine, betaine, and carnitine have been revealed in recent studies. Both carnosine and anserine are histidyl dipeptides with strong buffering roles and antioxidant properties (Peiretti et al., 2012). In addition, carnosine possesses good anti-ageing properties (Purchas et al., 2004) and promotes defence mechanisms against glycation and oxidation (Peiretti et al., 2011). In addition to its ability to improve growth performance

Abbreviations: KNC, Korean native chicken; CB, commercial broiler; HPLC, high performance liquid chromatography.

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and fat distribution, betaine has osmoregulatory properties and can act as a methyl donor in tissue (de Zwart et al., 2003). Carnitine is a lysine-derived molecule that plays a vital role in fatty acid metabolism (Arslan et al., 2003). Carnitine is biosynthesised in the kidneys, liver, and brain, and can also be found in different food sources (Rigault et al., 2008).

Recently, Jung et al. (2013) quantified the contents of carnosine and anserine in KNC meat. They showed that the contents of these compounds in raw meat were affected by the line and sex of KNCs. No scientific literature was found regarding the factors affecting the availability of these bioactive compounds in KNCs and CBs, except that of Jung et al. (2013). Although meat quality characteristics of KNCs and CBs were compared previously (Choe et al., 2010; Jayasena et al., 2013), comparisons of these bioactive compounds in these two breeds are still unavailable. Therefore, the present study was primarily designed to compare the carnosine, anserine, betaine and carnitine contents of breast and leg meat from KNCs and CBs at their respective market ages and to determine the changes in these compounds during the cooking process.

2. Materials and methods

2.1. Animals and processing

Eighty one-day old male chicks each from a commercial KNC strain (Woorimatdag™) and a CB strain (Ross) were allotted to 10 floor pens (16 chicks of same strain per separate pen) within a single house with similar standard commercial conditions to a chicken farm (Gimcheon, Korea). Chicks were fed commercial starter (3100 kcal ME/kg, 23% CP during first 7 days), grower (3200 kcal ME/kg, 20% CP from 8th to 21st day) and finisher (3200 kcal ME/kg, 18% CP from 22nd day to respective age) diets *ad libitum*, and they had free access to water. Two birds each from CBs and KNCs were randomly selected from each replication pen at 32 and 100 d of age and subjected to a 10-h feed withdrawal period. Subsequently, birds were exsanguinated by a conventional neck cut and were bled for 2 min. The carcasses were then defeathered and eviscerated manually. After chilling (4 °C) for 24 h, each carcass was split into two halves.

2.2. Preparation of raw and cooked meat samples

Raw meat samples were obtained by dissecting both breast and a combination of thigh and drumstick (hereinafter referred to as "leg") meat from the left half of each carcass. After trimming the visible skin, fat, and connective tissues from each of the dissected raw meat samples, they were minced (CH180; Kenwood, Shenzhen, China) separately and used for subsequent analysis.

The right half of each carcass was separately boiled in stainless steel containers with water (1:1.5, w/v). When a core temperature of 72 °C was reached in breast and leg meat as checked using a digital thermometer (YF-160A Type-K; YFE, Hsinchu City, Taiwan), carcasses were removed from boiling water and vacuum-packed separately. After cooling the vacuum-packed carcasses under running water, cooked breast and leg meat samples from each half of the carcasses were dissected and deboned separately. Finally, deboned samples were manually chopped into small pieces and used for analysis.

2.3. Determination of carnosine and anserine contents

Amounts of carnosine and anserine were determined according to the modified method described by Jung et al. (2013). Each meat sample (2.5 g) was homogenised with 0.01 N HCl (7.5 mL) at 13,500 rpm for 1 min [T25b; Ika Works (Asia), Sdn. Bhd, Rawang, Malaysia] and centrifuged at 17,030 × *g* for 15 min at 4 °C (HM-150IV, Hanil Co., Ltd., Incheon, Korea). The supernatant (250 μL) was mixed with 750 μL of acetonitrile, and after holding at 4 °C for 20 min, it was centrifuged at 10,000 × *g* for 10 min (4 °C; Hanil). The resulting supernatant was injected into a high-performance liquid chromatography (HPLC) column with a Waters 1525 pump and a Waters 717 plus auto sampler (Millipore Corporation, Milford, MA, USA). An Atlantis HILIC silica column (4.6 × 150 mm, 3 μm, Millipore) was used. To determine carnosine and anserine contents, a Waters 2487 diode array detector (Millipore) was used at 214 nm. A standard curve of each compound was used to calculate the content of the particular compound in the samples. Carnosine (≥99.0%) and anserine (≥99.0%) standards were obtained from Sigma Co. (St. Louis, MO, USA).

2.4. Determination of betaine and carnitine contents

Betaine and carnitine contents in raw and cooked meat samples were determined by the method of Li et al. (2007) with some modifications. Each meat sample (3 g) was homogenised at 13,500 rpm for 30 s (Ika Works) with 10 mL of acetonitrile–methanol solution (9:1, v/v) and centrifuged at 2090 × *g* for 5 min (4 °C; Hanil). The supernatant was filtered into a 20-mL volumetric flask through a funnel plugged with glass wool. The remaining filtrate was again mixed with 10 mL of acetonitrile–methanol solution and centrifuged (Hanil) under the same conditions. The resulting supernatant was collected in the same volumetric flask, which was then filled with acetonitrile–methanol solution. Subsequently, 2 mL of this sample were mixed with 810 mg of Na_2HPO_4 and 90 mg of Ag_2O (9:1, w/w) in a 15-mL tube by vigorous shaking and vortexing. Sample tubes were then dried by shaking without their caps in a shaker for 30 min and centrifuged again (Hanil) at 2090 × *g* for 5 min at 4 °C. A 0.5-mL aliquot of each supernatant sample was then mixed with 0.5 mL of derivatising reagent (1.39 g of bromoacetophenone and 0.066 g of 18-crown-6 in 100 mL of acetonitrile) in a 15-mL tube, vortexed, and heated (80 °C) for 60 min in a water bath. After cooling under running water, this mixture was filtered through a 0.2-μm membrane filter and analysed by HPLC to determine betaine and carnitine contents. The HPLC system used was the same as that used to determine the dipeptide contents (Millipore), except that the partitioned fractions were detected at 254 nm. Mobile phase A was 25 mM ammonium acetate in which pH was adjusted to 3.0 using formic acid, and mobile phase B was acetonitrile. The mobile phase was supplied at 1.4 mL/min for 20 min with isocratic elution (90% A:10% B). Betaine and carnitine contents were calculated using the standard curve of each compound. Betaine (≥99.0%) and L-carnitine hydrochloride (≥98.0%) standards were obtained from Sigma Co. (St. Louis, MO, USA).

2.5. Statistical analysis

Data of the birds from the same pen were averaged and five replications from each breed were used for the statistical analysis of each parameter. The effects of cooking, meat portion, and the breed of chicken were estimated using three-way ANOVA and using the GLM procedure. After grouping the data according to each state of meat (raw or cooked) with each meat portion, the data were analysed by one-way ANOVA using the GLM procedure to confirm the associations and effects of the breed, meat portion, and state of meat. Mean separation was conducted using Tukey's multiple range test ($p < 0.05$). All tables indicate the mean values and SEM. The SAS software system was used for all statistical analyses (version 9.3, SAS Institute Inc., Cary, NC, USA).