FLAVOR-RELATED COMPOUND LEVELS IN DEFATTED FREEZE-DRIED CHICKEN SOUP MADE FROM KOREAN NATIVE CHICKEN MEAT AT DIFFERENT AGES

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Abstract – The aim of the present study was to compare the availability and content of flavor-related compounds in defatted freeze-dried chicken soup (DFDS) made from Korean native chicken (KNC) meat from different ages. The nucleotide and free amino acid contents, and fatty acid composition were analyzed in ten DFDS samples made from each age group (10, 11, 12, 13, 14 wk). Inosine-5'-monophosphate content fluctuated but hypoxanthine content decreased in DFDS with the increasing age of KNC. In addition, linoleic acid content increased whereas oleic acid content decreased in DFDS when the age of KNC increased. However, age had no effect on arachidonic acid content of DFDS. The content of all free amino acids decreased with the increasing age of KNC, except lysine. Our findings suggest that the levels of flavor-related compounds in DFDS made from KNC meat was significantly affected by the age of KNC.

Key Words – Arachidonic Acid, Inosine-5'-monophosphate, Umami Taste

I. INTRODUCTION

Different cooking methods including grilling, steaming, and stewing have been well developed since the 13th century when the Mongolians invaded Korea [1]. Meats from cattle, pig, and chicken dominate the Korean meat cuisines, in which they are consumed either roasted or as soups or stews [1]. In Korean culture, chicken is frequently served roasted or braised with vegetables or in soups of different types.

Soup is a heterogeneous food category with high satiety value, and reduces hunger as well as quenches thirst as a beverage [2]. Soups have been shown to possess vital characteristics such as the nutritional value, taste properties, physiological effects, and cultural characteristics [3]. Chicken soup is usually popular as the most ubiquitous medicinal soup in the world [4]. Of many meat-based soups found in Korea, *samgyetang* and *baeksuk* are well-known traditional soups prepared using young and mature Korean native chickens (KNC), respectively.

One of the most important quality traits that promote the extensive consumption of soup is the flavor. The distinctive flavor of soup is facilitated by the presence of non-volatile taste components including nucleotides, free amino acids, and soluble sugars other than the volatile compounds [5]. Recent findings have shown that the content of nucleotides and free amino acids, and the fatty acid composition in meat are significantly different between different age groups of KNC [6], hence this difference might influence the availability and the content of similar compounds in the soups made with these meats. However, scientific information regarding the quality traits and the molecules responsible for the flavor of meat-based soups, particularly in those prepared with native chickens such as KNC is limited. Therefore, this study was designed to compare the availability and quantity of flavor-related compounds in the defatted freeze-dried chicken soups (DFDS) made with KNC meat at different ages.

II. MATERIALS AND METHODS

All the experimental procedures conducted during this study followed the recommendations described in The Guide for the Care and Use of Laboratory Animals, published by the Institutional Animal Care and Use Committee of the National Institute of Animal Science [7] in Korea.

Birds and Processing

During the present study, KNC of a certified meat-type commercial strain (*Woorimatdag*) were raised under similar standard commercial conditions at a commercial chicken farm (Gimcheon, Korea). A total of 160 one-day-old male chicks (*Woorimatdag*) obtained from a local hatchery were allotted to five floor pens (32 chicks/pen) within a single house. Chicks were fed commercial starter (3,100 kcal of ME/kg, 23% crude protein [CP] during the first week), grower (3,200 kcal of ME/kg, 20% CP from the second to third weeks), and finisher (3,200 kcal of ME/kg, 18% CP from the fourth week to respective age) diets ad libitum, and had free access to water during the whole experiment period.

At each of the five ages investigated in this experiment (10, 11, 12, 13, and 14 wk), two KNC were randomly selected from each of the five pens (a total of 10 KNC from each age). After a 10-hr feed-withdrawal period, KNC were exsanguinated by a conventional neck cut and were bled for 2 min. The carcasses were then manually defeathered and eviscerated, during which time the sex of each bird was confirmed to avoid any sex effect on the parameters tested in this study. The carcasses were chilled at 4°C for 24 hrs and used to prepare the DFDS samples.

Preparation of DFDS Samples

For the preparation of the DFDS samples, carcasses from each age group were first portioned in to two halves. After trimming the visible skin and fat, the thawed meat was boiled separately in water (1:1.5 wt/vol) for 40 min. After removing the cooked meat from the boiling water, the remaining soup samples were further boiled for 2 h and concentrated. The concentrated soup samples were subsequently filtered through a testing sieve (wire diameter of 100 μm, aperture of 150 μm; Chunggye Sanggongsa, Seoul, Korea) in order to remove the solid particles. The filtrates were mixed with hexane (1:1 vol/vol), stirred using a magnetic stirrer (C-MAG HS 7, Ika Korea Co. Ltd., Seoul, Korea) for 1 h, and allowed to settle. The resulting supernatant layers that mainly consisted of fat were carefully removed to separate containers and used for the analysis of fatty acid composition. The remaining solutions were finally lyophilized at -53°C under pressurized vacuum at 7 mTorr. The DFDS samples were then stored in a freezer (-80°C) until further analysis.

Analytical procedures

Nucleotide and free amino acid contents of each DFDS sample were analyzed using the methods described by Jung *et al*. [8] and Hughes *et al*. [9] with some modifications, respectively. Total lipid content of the supernatant layer separated from each soup sample was extracted according to the method of Folch *et al*. [10] with some modifications. Then, fatty acid methyl esters were prepared from the extracted lipids using boron trifluoride-methanol (Sigma-Aldrich), followed by separation in a gas chromatograph (HP-7890, Agilent Technologies, Santa Clara, CA) according to the method of Jung et al. [11] with some modifications.

Statistical Analysis

The experimental data were subjected to an analysis of variance for a completely randomized design using the procedure of General Linear Model using SAS software system [12]. Comparisons of means were performed by Duncan's multiple range tests at $P<0.05$.

III. RESULTS AND DISCUSSION

In the present study the influence of age of KNC on the flavor-related compounds of DFDS was examined. However, scientific literatures regarding the flavor-related compounds of soups prepared from poultry or other species are rare to compare the findings of the present study.

Inosine-5'-monophosphate (IMP) is the major nucleotide found in muscle and it is considered one of the major precursors responsible for flavor [13]. Degradation of IMP to inosine takes place during aging and cooking and inosine can further be degraded to hypoxanthine and ribose [14]. The umami taste is attributed to the synergistic effect of inosinic acid and glutamic acid [15]. Additionally, IMP possesses the characteristics of umami flavor [13, 14]. In contrast, hypoxanthine might contribute to bitter flavor characteristics [14]. The age of KNC significantly influenced the content of all ATP breakdown products in the DFDS samples (Table 1). It has been well documented that the nucleotides content in muscles varied with the species, breed, age, and sex [16].

Table 1 Nucleotide content (g/100 g) of defatted freeze-dried soup made from Korean native chicken (*Woorimotdag*) of different age groups

Age group (wk)	AMP	IMP	Inosine	Hypoxanthine
10	0.29^{a}	1.53^{a}	1.17^{c}	0.55^{a}
11	0.28^{a}	1.29^{c}	1.31^{b}	0.53^{ab}
12	0.28^{a}	1.50^{ab}	1.32^{b}	0.48^{c}
13	0.25^{c}	1.48^{b}	1.35^{b}	0.51^{b}
14	0.26^{b}	1.24^{c}	1.52^{a}	0.47^{c}
SEM[1]	0.00	0.01	0.01	0.01

[a–c]Mean values in the same column with different superscripts differ significantly ($P<0.05$).
[1]Standard error of the means (n = 50)

The content of IMP in meat was previously reported to increase with increasing bird age [17]. However, the IMP contents of raw leg meat and cooked meat from KNC fluctuated ($P<0.05$) with increasing bird age [6]. Similarly, the IMP content of DFDS significantly fluctuated with the increasing age of KNC (Table 1). However, AMP and hypoxanthine contents were decreased whereas inosine content was increased ($P<0.05$) when the age of birds increased. Similar AMP and hypoxanthine contents were recently reported in DFDS [3]. In contrast, the same study revealed higher IMP and lower inosine contents in DFDS compared to the results of the present study [3].

Oleic acid content of DFDS decreased whereas linoleic acid content of DFDS increased significantly with the increasing age of KNC. However, age of KNC had no effect on the arachidonic acid content of DFDS (data not shown). In addition, docosahexaenoic acid (DHA) content was significantly lower in DFDS samples made from 12-wk old KNC (0.06%) compared to other samples which had the same DHA contents (0.08%). Recently, Jayasena et al. [6] found that age of the bird had a significant effect on oleic acid, arachidonic acid, and DHA content of KNC meat. In addition, similar arachidonic acid contents had been recently reported in DFDS made from 14-wk old KNC [3]. The same DFDS samples had a higher oleic acid content and lower linoleic acid and DHA contents compared to DFDS made from 14-wk old KNC in the present study.

The age of KNC significantly influenced the free amino acid content of DFDS samples (data not shown). In this regards, the content of free amino acids responsible for umami taste (glutamic and aspartic acids), sweet taste (alanine, serine and glycine), and bitter taste (valine, isoleucine, leucine, phenyalanine, methionine, arginine, and histidine) decreased significantly with the increasing age of KNC. In contrast, the age of KNC showed a positive effect ($P<0.05$) on the content of lysine which is also responsible for sweet taste. Scientific literatures regarding the free amino acid content of meat-based soups were scarce, which prevented a comparison of the data of the present study with previous reports.

IV. CONCLUSION

The results of this study demonstrated that the age of KNC significantly influences the content of nucleotides and free amino acids in the DFDS samples and the fatty acid composition of lipid layers separated during the preparation of DFDS. With the increasing age of KNC, inosine, linoleic acid and lysine contents of DFDS increased whereas AMP, hypoxanthine, oleic acid and all the other amino acid contents decreased.

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