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Assessment of Breed- and Sex-based Variation in Flavor-related Compounds of Duck Meat in Korea

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ABSTRACT The objective of present research is to evaluate the effect of breed and sex on flavor-related compounds of duck meat in Korea. Breast meat of each different breed [Korean native duck (KND) and commercial duck, Cherry Valley (CD)] and sex (male and female) were analyzed for chemical composition, nucleotide, fatty acid composition, and free amino acid. In comparison within the different breed and sex, CD and female duck were higher in moisture composition compared to KND and male duck. The meat from female duck had higher inosine monophosphate (IMP) contents while the meat from KND had higher inosine contents ($P<0.05$). Mostly, male duck had higher contents of free amino acid, including alanine, aspartic acid, glycine, histidine, leucine, serine, valine, glutamic acid and cysteine ($P<0.05$), even though no significance in the sum of taste-related free amino acid was observed with respect to breed and sex. From the results, it was found that breed has no significant impact while sex has influenced the flavor-related compounds, especially, IMP and most of the free amino acids. In order to get breed-specific advantages, KND should be developed based on flavor aspect and further studies using KND with known genetic confirmation should be conducted for the extrinsic and intrinsic flavor influencing factors.

(Key words : breed, sex, duck meat, flavor-related compounds)

INTRODUCTION

The consumers' purchasing decision in meat market can be influenced with a lot of factors, such as appearance, texture, and flavor. The term 'flavor' defines the two sensations between taste and aroma and it is considered to be one of the decision making factors for purchasing meat (Jayasena et al., 2013b). It is now well known that raw meat has blood-, metallic- and salt-like taste and no aroma without cooking steps. As meat is cooked, flavor precursors in meat determine the meat flavor through lipid oxidation, Maillard reaction, and interaction of Maillard reaction and lipid oxidation (Jayasena et al., 2013a; Jayasena et al., 2013b). As flavor precursors, nucleotide, fatty acid composition, and free amino acid are suggested so that researchers have studied in these products extensively in order to enhance the meat flavor. Inosine monophosphate (IMP) is capable for enhancing the meat flavor itself or as combination with glutamic acid or cysteine (Aliani and Farer, 2005; Jayasena et al., 2014b). The products from lipid oxidation, interaction of Maillard reaction and lipid oxidation, and the changes in IMP and free amino acid during aging or storage have impact on the meat flavor development. In addition, these compounds are varied with breed, sex, age, meat portion and cooking state, etc (Joo et al., 2013; Jung et al., 2013; Karasawa et al., 1989; Vani et al., 2006).

Duck meat is getting attention from the consumers, in particular, in Asia. It contains less fat and cholesterol compared to the other common meat sources, including cattle, pig, and lamb so that it is considered as healthier meat source (Lee et al., 2015). In contrast to chicken which is composed of more white muscle than red muscle, duck meat is composed of 70 to 90% oxidative red muscle (Ali et al., 2007; Smith and Fletcher, 1992) so that its flavor is closer to the other red meats (Heo et al., 2013b). Since 1990's, the National Institute of Animal Science (NIAS) has been developing Korean native duck (KND), which is a crossbred between Mallard duck (*Anas platyrhynchos*) and meat-type duck (Kim et al., 2010a; Kim et al., 2010b). However, most of the researches have

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more focused on growth performance and carcass yield (Kim et al., 2010a; Kim et al., 2010b; Kim et al., 2012a; Kim et al., 2012b; Heo et al., 2013b; Hong et al., 2012). Since the factors affecting the flavor precursors in chicken meat have been studied extensively (Choi et al., 2010; Jayasena et al., 2013c; Jayasena et al., 2014; Jeon et al., 2010; Jung et al., 2011; Lee et al., 2012), it is worth to investigate the flavor-related compounds in duck meat to develop a high quality meat-type duck breed. However, duck meat is different from chicken meat due to its muscle composition and it has been reported that different species have different flavor development mechanism (Ali et al., 2007; Mottram, 1998), and still, limited information is available regarding flavor-related compounds in duck meat.

Therefore, present research was designed to evaluate breed and sex effect on flavor-related compounds of duck meat in Korea, which are considered to be strong factors influencing the meat flavor development.

MATERIALS AND METHODS

1. Sample Preparation

Frozen carcasses from three birds of each sex from different breeds, KND and CD (commercial duck, Cherry Valley), were raised under the same condition, purchased at 6 wk of age from a local farm (Jeollanamdo, Korea) and transported in ice condition to a laboratory. The KND was certified by the farm owner but was different from Woorimotori™, the KND breed developed by NIAS. Then, the carcasses were thawed at 4℃ for 48 h, skin-removed, and deboned manually. After collecting breast meat from each carcass, they were minced separately using a mini chopper (CH180, Kenwood, Shanghai, China) for 30 sec and used for the analysis.

2. Chemical Composition

The chemical composition of duck meat was determined by slightly modified methods of AOAC (1995). Briefly, the moisture content was obtained by drying sample (3 g) placed in an aluminum dish at 104℃ for 15 hr. The crude protein contents were measured by the Kjeldahl method (VAPO45, Gerhardt Ltd., Idar-Oberstein, Germany). The crude fat contents were measured using the Soxhlet extraction system (TT 12/A, Gerhardt Ltd., Idar-Oberstein, Germany). The crude ash content was measured by igniting 2 g of each sample in a furnace at 600℃ overnight.

3. Nucleotide Contents

Nucleotide contents were determined by the method of Jung et al. (2013) with a few modifications. The meat samples (5 g) were mixed with 20 mL of 0.7 M perchloric acid and homogenized to extract nucleic acids. The homogenized samples were then centrifuged at 3,000 rpm for 15 min (Continent 512R, Hanil Co., Ltd., Incheon, Korea) and filtered through a filter paper (Whatman No. 4, Whatman PLC., Kent, UK). The supernatant was then adjusted to pH 5 with 7 N KOH and transferred into a volumetric flask and made up to a volume of 50 mL with 0.7 M perchloric acid (pH 5). After 30 min of cooling, the samples were centrifuged at 3,000 rpm for 15 min and the supernatants were filtered through a membrane filter (0.2 μm) into a glass vial. The samples were injected into a high performance liquid chromatography (HPLC; Ultimate 3000, Thermo Fisher Scientific Inc., Waltham, MA, USA) system. The analytical conditions for HPLC included a Synergi™ Hydro-RP 80 Å (250×4.6 mm, 4 μm particles; Phenomenex Inc., Seoul, Korea), with a 20 mM potassuim phosphate, monobasic (pH 5) with a flow rate at 1.0 mL/min. The injection volume was 10 μL and elution time was 25 min. The column temperature was maintained at 30℃ and detection was monitored at a wavelength of 254 nm. Each content was calculated through a standard curve obtained using a standard adenosine monophosphate (AMP), inosine monophosphate (IMP), inosine, and hypoxanthine (Sigma-Aldrich, St. Louis, MO, USA) and calculated using the area for each peak.

4. Fatty Acid Composition

Lipids were extracted from meat samples according to the method of Folch et al. (1957) and Jo et al. (2013). BF_3-methanol (1 mL, Sigma-Aldrich) was added to 100 μL of lipid extract and incubated at 90℃ for 1 hr. After cooling, 2 mL of hexane and 5 mL of distilled water were added, mixed thoroughly and left overnight for phase separation. The top (hexane) layer containing methylated fatty acids was analyzed using a gas chromatograph (HP 7890, Agilent Technologies, Santa Clara, CA, USA). A split inlet (split ratio, 50:1) was used to inject the samples into a capillary column (SP™ 2,560 Capillary column; 100 m × 0.25 mm × 0.20 μm film thickness), and ramped oven temperature was used (100℃ for 5 min, increased to 240℃ at 4℃/min and maintained for 20 min). The inlet temperature was 210℃. N_2 was used as the carrier gas at a constant flow rate of 1 mL/min. The data was integrated within ChemStation software (Agilent Technologies, Santa Clara, CA, USA).

5. Free Amino Acid Contents

The free amino acid composition was determined by the method of Hughes et al. (1984) and Jo et al. (2013). Defatted meat sample (5 g) was mixed with 20 mL of 2% trichloroacetic acid solution and homogenized at 13,500 rpm for 1 min. The homogenate was then centrifuged and filtered through 0.45 μm membrane filter. The filtrate was derivatized by the method of Waters AccQ-Tag™ (1993, Millipore Co-Operative, Milford, MA, USA) and 5 μL was injected in to a RP-HPLC (AccQ · Tag™ column, 3.9×150 mm, Waters). The column temperature was set at 37℃ and a fluorescent detector (Waters™ 2475, Millipore, Billerica, MA, USA) was used with 250 nm excitation and 395 nm emission wavelengths. The separation was done by using buffers: A (Waters AccQ · Tag eluent) and B (60%, v/v, acetonitrile). Accuracy and repeatability of this analysis are ensured by the inclusion of a control sample of known amino acid composition with the samples prior to hydrolysis.

6. Statistical Analysis

The data was pooled for statistical analysis (n=12). Multifactorial analysis of variance (ANOVA) was used to estimate the effect of the breed and sex on chemical composition and flavor-related compounds of duck meat, and the significant differences between the mean values were identified with Tukey's multiple range test using SAS software at a confidence level of $P<0.05$ (SAS 9.3, SAS Institute Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

1. Chemical Composition

Moisture and fat contents are not in direct relation with flavor, however, still important factors as related to texture properties, including tenderness and juiciness, in meat (Park et al., 2010). The results regarding chemical composition i.e. moisture, crude fat, crude protein, and crude ash, was assessed in Table 1. Breed and sex had significant impacts on moisture with *P*-values at <0.0001 and 0.0006, respectively. In comparison within the different breed and sex, CD (79.22%) and female duck (78.90%) were higher for their moisture composition as compared to KND (78.12%) and male duck (78.43%). On the other hand, no significances were observed in fat, protein, and ash compositions of duck meat. Heo et al. (2013b) evaluated large-type KND at different ages and the chemical composition of 6-wk-old KND was moisture (78.2±0.09%), fat (0.82±0.13%), protein (19.0±0.11%), and ash (1.06±0.01%) in comparison to 78.67±0.49% moisture, 1.04±0.12% fat, 18.20±0.23% protein, and 1.11±0.08% ash of 45-d-old CD (Chae et al., 2006). As assessed 6-wk-old ducks in the present research, our results were similar to previous ones.

2. Nucleotide Contents

A comparison of the nucleotide contents (mg/100 g) with

Table 1. Comparison of the chemical composition (%) on Korean native duck and commercial duck in Korea

	Breed		Sex		SEM[1]	*P*-value	
	KND	CD	Male	Female		Breed	Sex
Moisture	78.12[b]	79.22[a]	78.43[b]	78.90[a]	0.061	<.0001	0.0006
Crude fat	1.55	1.38	1.43	1.50	0.057	0.1436	0.3669
Crude protein	19.31	18.52	19.15	18.69	0.344	0.7772	0.8926
Crude ash	1.02	0.88	0.99	0.92	0.338	0.0712	0.4522

[1] Standard error of the means (n=12).
[a,b] Means within the same row with different letters within the same effect differ significantly ($P<0.05$).

Table 2. Comparison of the nucleotide contents (mg/100 g) of Korean native duck and commercial duck in Korea

	Breed		Sex		SEM[1]	*P*-value	
	KND	CD	Male	Female		Breed	Sex
AMP	1.86	1.69	1.69	1.86	0.117	0.3164	0.3429
IMP	103.13	107.08	98.68[b]	111.54[a]	3.252	0.4154	0.0233
Inosine	74.62[a]	60.56[b]	65.94	69.24	1.845	0.0007	0.2417
Hypoxanthine	13.31	13.94	14.11	13.13	0.466	0.3634	0.1759

[1] Standard error of the means (n=12).
[a,b] Means within the same row with different letters within the same effect differ significantly ($P<0.05$).

respect to breed and sex was shown in Table 2. The adenosine triphosphate (ATP) degraded to AMP, IMP, inosine, hypoxanthine, and ribose after slaughtering and these compounds are related to meat flavor (Jayasena et al., 2013a; Kim et al., 2012c). IMP has a role as an umami taste enhancer and also generates 2-methyl-3-furanthiol, mercaptoketones and other sulfur compounds when reacted with cysteine and H_2S (Aliani & Farmer, 2005; Jayasena et al., 2013a). Jung et al. (2013) reported that IMP contents were affected with breed and sex differences (P=0.0001) and female Korean native chicken (KNC) contained higher IMP contents compared to those in male KNC in agreement with present results. No significant differences were found in AMP contents with respect to breed and sex of ducks while IMP contents in ducks were 103.13, 107.08, 98.68 and 111.54 mg/100 g for KND, CD, male, and female, respectively, and significant sex effect was shown. IMP contents can be varied with different muscle fiber as it is deaminized from AMP through a reaction of AMP deaminase and their activities are predominant in type IIB muscle fiber compared to type I muscle fiber (Wang et al., 2008). Abundant AMP deaminase in type IIB muscle fiber leads it for high accumulation in IMP contents (Arabadjis et al., 1993). Jayasena et al. (2014) evaluated IMP contents between KNC and commercial broiler (CB) at their respective market age, 100 d and 32 d. KNC had higher IMP contents since increased age has positive relationship with IMP contents, and also, meat portion was suggested as a factor influencing IMP contents. Jung et al. (2013) and Jayasena et al. (2014) reported that chicken breast meat contained higher IMP contents than thigh meat. It can be supportive evidence for the relationship between IMP contents and muscle composition since chicken breast meat is composed with 90% type IIB muscle fiber compared to thigh meat composed of type I muscle fiber (Jayasena et al., 2014) in accordance with Jaturasitha et al. (2008). In the present study, the ducks at the same age (6-wk-old) were used for assessment of breed- and sex-based variation in flavor-related compounds. However, the market age for KND is usually longer than 7 wks compared with 6wks for CD (Chae et al., 2005; Heo et al., 2013b). Therefore, KND may contain more IMP contents than CD in commercial market.

Breed effect had a strong influence in inosine contents while interaction effect between breed and sex was shown in hypoxanthine contents (P=0.0011, data not shown). Muscle composition is still an important factor for inosine contents as 5’-nucleotidase, which converts IMP to inosine, is predominant in type I muscle fiber (Tullson and Terjung, 1999). Identification for muscle composition within breeds and sexes was not conducted in the present study, however, it is reported that muscle composition is contributed to different breed, sex, and other factors (Joo et al., 2013). pH value also has an influence in degradation rate for nucleotide contents as acidic pH inhibits the activities of AMP deaminase and promotes degradation rate of IMP to inosine (Jung et al., 2013; Vani et al., 2006), however, no significant differences were observed for both breeds and sexes in pH of 5.90～5.93 (data not shown).

3. Fatty Acid Composition

The predominant fatty acid in the composition was palmitic (C16:0), stearic (C18:0), oleic (C18:1), linoleic (C18:2) and arachidonic acid (C20:4) for both skin and meat of ducks (Tables 3 and 4) and these findings are in agreement with

Table 3. Comparison of the fatty acid composition (%) on the skin of Korean native duck and commercial duck in Korea

	Breed		Sex		SEM[1]	*P*-value	
	KND	CD	Male	Female		Breed	Sex
C10:0	0.03[b]	0.04[a]	0.03	0.04	0.001	0.0398	0.0595
C12:0	0.09[b]	0.10[a]	0.09	0.10	0.001	0.0052	0.1960
C14:0	0.83[b]	0.93[a]	0.87	0.89	0.012	0.0003	0.2358
C14:1	0.17[b]	0.19[a]	0.18	0.18	0.005	0.0297	0.7696
C15:0	0.07[b]	0.09[a]	0.08	0.08	0.002	0.0005	0.1387
C16:0	22.28	22.82	22.52	22.58	0.207	0.0973	0.8240
C16:1	4.14	3.97	4.12	3.99	0.109	0.3118	0.4013
C17:0	0.11[b]	0.13[a]	0.12	0.12	0.004	0.0122	0.7205
C17:1	0.17[b]	0.18[a]	0.17	0.18	0.004	0.0377	0.6702
C18:0	5.29	5.40	5.41	5.28	0.127	0.5645	0.4805
C18:1	52.64[a]	50.37[b]	51.38	51.62	0.286	0.0005	0.5689
C18:2	12.32[b]	13.69[a]	13.01	13.00	0.168	0.0004	0.9474
C20:0	0.06[b]	0.07[a]	0.06	0.06	0.002	0.0113	0.8949
C18:3	0.66[b]	0.72[a]	0.70	0.68	0.015	0.0336	0.4653
C20:1	0.46	0.49	0.47	0.47	0.010	0.0740	0.7766
C21:0	0.11	0.11	0.11	0.11	0.005	0.6705	0.2761
C20:2	0.10[b]	0.12[a]	0.10	0.11	0.004	0.0149	0.1049
C20:3	0.10[b]	0.12[a]	0.11	0.11	0.004	0.0081	0.9036
C20:4	0.22[b]	0.26[a]	0.25	0.23	0.011	0.0164	0.2017
C20:5	0.05[b]	0.06[a]	0.06[a]	0.05[b]	0.002	0.0162	0.0106
C24:1	0.11[b]	0.16[a]	0.14	0.13	0.007	0.0020	0.3029
C22:6	0.01	0.01	0.01	0.01	0.001	0.0533	0.3915
SFA	28.87[b]	29.68[a]	29.30	29.25	0.174	0.0110	0.8345
UFA	71.13[a]	70.33[b]	70.70	70.76	0.174	0.0110	0.8345

[1] Standard error of the means (n=12).
[a,b] Means within the same row with different letters within the same effect differ significantly ($P<0.05$).

Cobos et al. (2003). Different patterns were observed between skin and meat of ducks as the composition on the skin resulted in breed effect for stearic acid and sex effect for palmitic, linoleic, and arachidonic acid. The stearic and oleic acid of meat had significant effect with breed and sex differences on the meat, in order of effectiveness. The fatty acid composition of skin influenced more by breed and sex of ducks compared to fatty acid composition of meat ($P<0.05$).

The fatty acid composition has a strong relation with meat flavor as lipid breakdown products give an important contribution through their oxidation and cooking (Calkins and Hodgen, 2007; Jayasena et al., 2013a). Jayasena et al. (2013b) suggested that lipid oxidation lead itself to desirable as well as undesirable flavor in meat and meat products. Flavor development is more related to unsaturated fatty acid (USFA) than saturated fatty acid (SFA) as USFA can be resulted in unsaturated volatile compounds (Noleau and Toulemonde, 1987; Wood et al., 2003). Linoleic and arachidonic acid are oxidized to form volatile compounds such as hexanal, 2,4-decadienal, 2,4-nonadienal, 2-nonenal, 2-octenal and 1-octen-3-

Table 4. Comparison of the fatty acid composition (%) on the meat of Korean native duck and commercial duck in Korea

	Breed		Sex		SEM[1]	*P*-value	
	KND	CD	Male	Female		Breed	Sex
C10:0	-	-	-	-	-	-	-
C12:0	-	-	-	-	-	-	-
C14:0	0.29	0.27	0.28	0.28	0.029	0.6583	0.9138
C14:1	-	-	-	-	-	-	-
C15:0	0.15	0.17	0.15	0.16	0.022	0.5709	0.7002
C16:0	21.06	20.59	20.96	20.69	0.143	0.0508	0.2230
C16:1	1.56	1.15	1.27	1.44	0.152	0.0935	0.4546
C17:0	0.11	0.13	0.12	0.12	0.011	0.1101	0.9584
C17:1	-	-	-	-	-	-	-
C18:0	14.49	15.03	15.03	14.48	0.249	0.1647	0.1575
C18:1	30.33[a]	28.96[b]	28.75[b]	30.54[a]	0.412	0.0466	0.0150
C18:2	15.84[b]	16.87[a]	16.07[b]	16.64[a]	0.158	0.0017	0.0346
C20:0	0.12	0.15	0.11	0.16	0.018	0.2620	0.0974
C18:3	0.31	0.29	0.32	0.28	0.028	0.4024	0.3605
C20:1	0.38	0.36	0.37	0.37	0.020	0.3970	0.7791
C21:0	-	-	-	-	-	-	-
C20:2	0.38	0.40	0.40	0.38	0.029	0.6931	0.5824
C20:3	1.30[b]	1.39[a]	1.33	1.36	0.029	0.0456	0.4442
C20:4	11.28	11.51	12.16[a]	10.62[b]	0.212	0.4690	0.0009
C20:5	-	-	-	-	-	-	-
C24:1	1.76[b]	2.10[a]	2.03	1.83	0.099	0.0438	0.2015
C22:6	0.65	0.65	0.65	0.64	0.021	0.9824	0.7012
SFA	36.21	36.34	36.65	35.90	0.354	0.7986	0.1701
UFA	63.79	63.66	63.35	64.10	0.354	0.7986	0.1701

[1] Standard error of the means (n=12).
[a,b] Means within the same row with different letters within the same effect differ significantly (P<0.05).

one improving aroma of meat (Calkins and Hodgen, 2007). Arachidonic acid is one of the major components in poultry products. Rikimaru and Takahashi (2010) suggested arachidonic acid as a representative factor responsible for palatable flavor of Hinai-jidori (Japanese native chicken) by comparing Hinai-jidori and Heo et al. (2013a) stated that increased arachidonic acid with increasing age of large-type KND meaning that KND at market age (8 wk old) should have higher composition for arachidonic acid. A 6-wk-old KND resulted in 1.57±0.09% arachidonic acid whereas a 8-wk-old KND had 2.24±0.09% composition in thigh meat.

Beside from meat flavor, USFA is related to meat firmness as it has a lower melting point compared to SFA. Wood et al. (2003) noted that stearic acid melted at 69.6℃ while oleic and linoleic acid had about 13.4℃ and −5℃ as their melting points. An increase in USFA resulted in a decrease in the melting point making meat structure more changeable even at low temperature. Oleic acid has a positive relationship with favorable flavor intensities and softness as it had a low melting point (Smith et al., 1998; Chung et al., 2006). In present research, our results did not have significant differences within breeds [36.21% (KND) and 36.34% (CD)] and sexes [36.65% (male) and 35.90% (female)].

The ratio of USFA to SFA (USFA/SFA) is an important nutritional indicator as well as omega-3 fatty acid in meat and meat products. USFA/SFA of KND (1.76) had no significant differences compared to that of CD (1.75) based on results of fatty acid composition. Omega-3 fatty acid, which are α-linolenic (C18:3), eicosapentaenoic (EPA, C20:5), and docosahexaenoic acid (DHA, C22:6), is responsible for normal growth and development (Zhang et al, 2014). Zhang et al. (2014) stated that omega-3 fatty acid can improve functional value of meat and meat products. In present research, a strong breed effect on DHA and sex effect on EPA and DHA were observed in the fatty acid composition of the skin, however, no significant differences in breed and sex effect were spotted in the meat of ducks. The EPA was not detected in the meat and these results are in accordance with Heo et al. (2013a).

4. Free Amino Acid Contents

As flavor precursors in meat, free amino acid takes a vital role for flavor enhancement during storage (Rikimaru and Takahashi, 2010) and alanine, aspartic acid, glutamic acid, glycine, serine, and threonine are known as taste-related free amino acid (Jung et al., 2011; Lee et al., 2012). In this section, taste-related free amino acid and cysteine will be discussed at the aspect in flavor development in meat. The results regarding free amino acids of duck meat are explicated in Table 5. It is

Table 5. Comparison of the free amino acid contents (mg/100 g) on the meat of Korean native duck and commercial duck in Korea

	Breed		Sex		SEM[1]	*P*-value	
	KND	CD	Male	Female		Breed	Sex
Ala	33.86[b]	36.55[a]	36.29[a]	34.11[b]	0.631	0.0165	0.0400
Arg	144.13	141.05	135.77	149.41	7.813	0.7879	0.2523
Asp	9.34[a]	7.89[b]	9.21[a]	8.02[b]	0.285	0.0071	0.0188
Cys	40.96	40.27	42.19[a]	39.04[b]	0.954	0.6212	0.0482
Glu	28.65	28.72	31.20[a]	26.17[b]	0.764	0.9452	0.0016
Gly	16.65	17.79	18.61[a]	15.83[b]	0.472	0.1262	0.0032
His	34.37[b]	48.73[a]	47.55[a]	35.56[b]	1.773	0.0004	0.0014
Leu	7.91[a]	7.50[b]	7.84[a]	7.57[b]	0.064	0.0020	0.0158
Lys	14.38[a]	12.14[b]	13.88	12.63	0.675	0.0472	0.2260
Phe	13.28[a]	12.59[b]	13.18	12.69	0.205	0.0449	0.1260
Pro	19.44	21.61	22.23	18.82	1.082	0.1947	0.0567
Ser	24.17	25.08	26.60[a]	22.65[b]	0.637	0.3401	0.0023
Thr	93.06	84.01	82.24[b]	94.83[a]	3.833	0.1333	0.0488
Tyr	25.67[a]	23.71[b]	25.08	24.29	0.593	0.0475	0.3729
Val	5.22	5.28	5.39[a]	5.11[b]	0.070	0.6024	0.0227
Taste-related[2]	205.72	200.04	204.15	201.61	3.497	0.2844	0.6208

[1] Standard error of the means (n=12).
[2] The sum of alanine, aspartic acid, glutamic acid, glycine, serine and threonine.
[a,b] Means within the same row with different letters within the same effect differ significantly ($P<0.05$).

evident from results that there are no significant differences in taste related amino acid with respect to breed [205.72 mg/100 g (KND) and 200.04 mg/100 g (CD)] and sex [204.15 mg/100 g (male) and 201.61 mg/100 g (female)].

Among the taste-related free amino acid, glutamic acid can be the most important flavor precursors because it has a huge impact on flavor development itself or in combination with IMP since the reaction between glutamic acid and IMP increase umami flavor in meat (Jo et al., 2012; Jung et al., 2011). Jayasena et al. (2014) expressed glutamic acid and IMP as umami-related compounds and observed their contents resulting in higher glutamic acid and IMP contents in KNC than CB for both compounds (P=0.0001). Cysteine is a good source for hydrogen sulfide in cooked meat as well as the reaction between cysteine and ribose can generate furanthiols and sulfur containing volatile compounds, which make an important contribution to meat aroma (Alinai and Farmer, 2005; Jayasena et al., 2013a). Jayasena et al. (2014) evaluated cysteine contents between KNC and CB and as the results, cysteine was not related with breed (P<0.05) in agreement with ours. Alinai and Farmer (2005) determined the effect of added IMP, ribose, glucose, glucose-6-phosphate, cysteine, the combination of ribose and cysteine, and thiamin. The addition of cysteine and the combination of ribose and cysteine caused significant increases in chicken, bloody, rancid, and sour aroma and roasted, chicken, savory, and salty aroma, respectively.

In the present research, no breed effect was shown between KND and CD, and significance was found with sex difference as both glutamic acid and cysteine contents were higher in male compared to female. In addition, P-values were 0.0482 (glutamic acid) and 0.0016 (cysteine) for sex effect, and plus, cysteine had an influence with the interaction effect between breed and sex with P-value at 0.0006 (data not shown).

CONCLUSION

The research was taken to assess the effect of breed and sex on flavor-related compounds of duck meat. It can be concluded from our results that breed has no significant impact on flavor related compounds, however, the sex of duck has influenced the flavor-related compounds, especially IMP, cysteine and glutamic acid. In order to get breed-specific advantages, KND should be developed based on flavor aspect and further studies using KND with known genetic confirmation such as Woorimatori™ should be conducted for the extrinsic and intrinsic flavor influencing factors.

적 요

본 연구는 오리의 종 및 성별에 따른 육 내 풍미 관련 물질의 영향을 구명하고자 수행되었다. 동일한 조건에서 사육된 6주령의 한국 토종오리 및 일반오리(Cherry Valley) 총 12수를 공시하여 가슴육의 일반성분, 핵산관련물질, 지방산 조성 및 유리아미노산 등을 분석하였다. 그 결과, 일반오리와 암컷오리가 각각 토종오리와 수컷오리에 비해 수분함량이 유의적으로 높았다. 육 내 IMP 함량은 수컷보다 암컷이 더 높았으며, 일반오리보다 토종오리 내 inosine 함량이 높은 결과를 보였다(P<0.05). 또한, 수컷 오리 가슴육은 암컷오리에 비해 alanine, aspartic acid, glycine, histidine, leucine, serine, valine, glutamic acid, cysteine 등 유리아미노산 함량이 높았다(P<0.05). 연구결과, 종에 따른 토종오리와 일반오리의 풍미 관련 물질의 차이는 미미한 것으로 확인되어, 토종오리 만의 우수성과 차별성을 확보하기 위해 오리육 내 풍미 관련 물질에 영향을 미치는 인자들에 관한 연구와 이를 통한 품종 개량이 필요할 것으로 사료된다.

(색인어 : 종, 성별, 오리, 풍미관련물질)

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