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Mixed and separate gender feeding influenced the growth performance for two lines of Korean native chickens when compared to a white semi-broiler and a commercial broiler from day 1 to 35 post-hatch

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Abstract

A comparative study was conducted to examine the effects of mixed and separate gender feeding on growth performance of Korean native chickens (KNC) against a white semi-broiler (WSB) and a commercial broiler (CB) over five weeks. 576 chicks were used with eight birds per cage in a randomized complete block design with 18 replicates per breed. For the KNC lines, three groups of male (M), female (F) and mixed-gender (FM) were used. Fresh water and feed were supplied on an ad-libitum basis. Birds were fed a standard starter (d 1 - 22) and grower diet (d 23 - 35). Body weight (BW), feed intake, and shank length (SL) were measured weekly. From the BW and feed consumed data, the average daily feed intake (ADFI), average daily gain (ADG), and feed conversion ratio (FCR) were calculated. The commercial broiler showed higher performance ($p < 0.05$) for all the indices measured for the entire period. The CB group consumed more feed and were more feed-efficient thus grew faster. This group was followed by the white semi-broiler and the KNC, in order. An intra-breed comparison for KNCs revealed that the males showed better growth performance with longer SL ($p < 0.05$) compared to the female and mixed-gender groups. The results showed that other than the breed type, mixed and separate gender feeding impacted on the growth performance of the two lines of Korean native chickens. Males for both lines of KNC generally performed better for the parameters measured, as determined by a greater BW and reduced FCR.

Keywords: growth performance, Korean native chicken, mixed and separate gender feeding

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Introduction

The consumption of meat on a global scale has grown exponentially. In Korea, a typical diet that was originally comprised of grains and vegetables with the oceanic regions having fish and seaweed (Kim et al., 2016) now has more meat than ever. According to the Organization for Economic Cooperation and Development (OECD, 2020), Korea consumed around 62 kg of meat in 2019, an upwards of 51.3 kg in 2014. Within the poultry sub-sector, Korean ate 18.7 kg of poultry meat in 2019, up from 15.4 kg in 2014. In line with the recent boost in healthy living and dieting concerns, the consumption of native chicken and chicken cuts especially chicken breast has also been on the rise (Park et al., 2019). The Korean industry is largely dominated by imported commercial broilers at around 90% that are reared in intensive fattening systems (Kong et al., 2006). Their desirability could be due to faster growth rates and lean muscle accretion ability in addition to relatively lower production costs especially on a large-scale production process (Ahn and Park, 2002). This has disadvantaged the native breeds that are reported to have lower rates of growth, reduced muscle build-up ability and unreasonable pricing that has affected its popularity and threatened its existence (Lee et al., 2017). Thus, there have been intensive efforts by the National Institute of Animal Science (NIAS) to preserve 5 lines of Korean native chickens (KNC) that are distinguishable by plumage colors namely black, grey, red, yellow, and white lines. They have since been registered by the domestic animal diversity information system (DAD-IS) (Jin et al., 2014). In a recent coordinated effort by Korean governmental agencies to improve food self-sufficiency and conserve KNCs, crossbred native chicken breeds have been developed. The crossbreds from this project were used in this experiment.

Korean native chickens have been the subject of recent studies that have detailed their unique taste and flavor with high levels of amino acids and low fat thus it is preferred by older consumers who have been shown more preference for traditional foods (Jung et al., 2011; Park et al., 2019). Besides, it has a firmer texture with more cohesiveness, gumminess, and chewiness (Choe et al., 2010; Lui et al., 2012) thus it is relatively more costly than commercial broilers. It has even shown the capacity for use in the making of retorted Samgyetang (Jeong et al., 2020). White semi-broiler is a crossbreed of male broiler breeder (i.e., Ross 308) and commercial layer (i.e., Hy-Line). It is known to have white feathers, a smaller size compared to commercial broilers, low-fat meat. It is largely produced by private industries to cater for the summer season increase in demand for Samgyetang which is a young chicken carcass soup packed with glutinous rice, ginseng, and garlic as stated by Jeong et al. (2020). Therefore, due to the increased focus on Korean native chicken and the development of new crossbred lines, there is a need to determine and compare their growth performance, consumer response, economic value, and carcass characteristics with other breeds. In this light, the current study was conducted to determine and compare the effects of mixed and separate gender feeding for two lines of Korean native chickens (KNC) to a white semi-broiler (WSB) and a commercial broiler (CB) under the same environmental conditions for 5-weeks.

Materials and Methods

All experimental procedures were revised and endorsed by the Animal Care and Use Committee of Chungnam National University, Daejeon South Korea (Protocol No. 202006-CNU-080).

Birds and housing

A total of 576 birds were housed in 72 raised wire-floor cages with 18 replicates per breed used, and with 8 birds per

cage in a randomized complete block design and subjected to similar conditions for 5 weeks. A total of 144 White Semi broilers, 144 Ross broilers and 288 KNC (A and B) were used. Within the lines of KNC, the birds were separated by gender and housed in three groups of 1) males only, 2) females only, and 3) mixed groups of males and females. The temperature and humidity of the experimental environment were regulated and adjusted if necessary. The birds were exposed to light throughout the experiment.

Diets and experimental design

A completely randomized block design was used. A basal diet of corn-soybean was formulated as per the NIAS (2018) standards for broiler chicken in a two-phase feeding program of a starter diet from day 1 - 21; (crude protein [CP] at 20.3%, metabolizable energy [ME] at 3,059 kcal·kg^{-1}) and a grower diet from day 22 - 35; (CP at 18.6%, ME at 3,123 kcal·kg^{-1}) as demonstrated in Table 1. The experimental diet and clean water were provided at all times for the entire trial period.

Table 1. Ingredients and the nutrient composition in % of the basal diet.

Ingredients	Day 1 - 21	Day 22 - 35
Soybean meal	32.50	26.90
Wheat bran	1.00	1.50
Corn gluten meal	1.00	1.50
Soybean oil	1.50	1.50
Di-calcium phosphate	1.50	1.30
Limestone	1.10	1.05
Salt	0.25	0.25
L-lysine	0.05	0.05
DL-methionine	0.20	0.15
Vitamin-mineral premix[z]	0.50	0.50
Calculated composition		
ME (kcal·kg^{-1})	3,059	3,123
CP (%)	20.3	18.6
Lysine (%)	1.11	0.98
Methionine + cysteine (%)	0.79	0.71

ME, metabolizable energy; CP, crude protein.
[z] Premix supplied the following per kg of diet: Vitamin A, 24,000 IU; vitamin D3, 6,000 IU; vitamin E, 30 IU; vitamin K, 4 mg; thiamine, 4 mg; riboflavin, 12 mg; pyridoxine, 4 mg; folate, 2 mg; biotin, 0.03 mg; vitamin B8, 0.06 mg; niacin, 90 mg; pantothenic acid, 30 mg; Fe, 80 mg (as $FeSO_4 \cdot H_2O$); Zn, 80 mg (as $ZnSO_4 \cdot H_2O$); Mn, 80 mg (as $MnSO_4 \cdot H_2O$); Co, 0.5 mg (as $CoSO_4 \cdot H_2O$); Cu, 10 mg (as $CuSO_4 \cdot H_2O$); Se, 0.2 mg (as Na_2SeO_3); I, 0.9 mg (as $Ca(IO_3) \cdot 2H_2O$).

Growth performance, assessment, and analyses

The body weight (BW), feed consumed, and shank lengths (SL) were measured weekly. Using the body weight and feed consumed data, the average daily feed intake (ADFI), average daily gain (ADG), and feed conversion ratio (FCR) were calculated. The growth performance data were analyzed using the General Linear Model procedures in the SPSS software package (Version 26, IBM SPSS, Chicago, USA). Tukey's multiple range test was used to compare the significant differences between different pairs of means at ($p < 0.05$).

Results

All the birds exhibited normal behavior and remained healthy throughout the experimental period. The commercial Ross broiler 308 (CB) showed a superior ($p < 0.05$) body weight of around 1.75 kg as at week 5. This was found to be 64.3% more than the BW of the white semi-broiler (WSB) at approximately 1.06 kg. The males of KA (KA-M) had an improved ($p < 0.05$) BW of around 979 g compared to the female and mixed groups at 810 g and 904 g respectively. Similarly, KB males (KB-M) had higher ($p < 0.05$) BW of approximately 963 g compared to the female and mixed groups at 862 g and 914 g respectively. Considering the ADG, higher ($p < 0.05$) values were recorded for CB and WSB at roughly 50.0 and 30.0 $g \cdot day^{-1}$ respectively. The ADG for the native chicken varied accordingly at around 25.4 ± 2.0 for KA and 25.6 ± 1.4 for KB. The KNC groups ate about 51.3 ± 3.4 $g \cdot day^{-1}$ which was approximately 49% and 10% less than the figures obtained for CB and WSB that recorded elevated ($p < 0.05$) ADFI of about 76.8 and 56.6 $g \cdot day^{-1}$ respectively. Within the KNC, the males (KA-M and KB-M) had higher ($p < 0.05$) ADFI values of around 54.7 and 54.1 while that of the females (KA-F and KB-F) was the lowest at 47.7 $g \cdot day^{-1}$ and 49.8 $g \cdot day^{-1}$ respectively. For the FCR, the lowest ($p < 0.05$) values were similarly observed for the CB and WSB at around 1.5 and 1.9. Within the KNC, FCR values of around 2.0 were recorded with no significant differences across all the test groups for the KA and KB crossbreeds. Longer ($p < 0.05$) shank lengths (SL) of around 80.7, 80.6 and 80.5 were recorded for the KA-M, CB and KB-M respectively. Shorter ($p < 0.05$) SL of around 75.3 were recorded for KA females when compared to all the other test groups.

Discussion

Due to the increased focus on Korean native chicken based on their tastier and healthier meat, thus reported higher quality (Jayasena et al., 2013; Choo et al., 2014a; Choi et al., 2015) and the development of new crossbred lines, there is a need to determine and compare their growth performance, consumer response, economic value, and carcass characteristics with other breeds. Therefore, the present study was conducted to determine and analyze the effects of mixed and separate gender feeding on the growth performance of Korean native chickens when compared to a white semi-broiler and a commercial broiler. Generally, the growth performance was significantly affected by the breed type and sex. This effect has been thoroughly documented in the literature (Brewer et al., 2012; Fernandes et al., 2013). Table 2 shows that the commercial broilers consumed more feed and were more feed- efficient thus they grew faster during the entire experimental period. This was expected since the Ross breed has been selected for higher feed intake, high feed efficiency and faster growth rates over generations with similarly higher performance being recorded in other studies (Livingston et al., 2020). On average performance, the commercial broiler was followed by the white semi-broiler and lastly, the KNC. This is in line with previous studies that showed the relatively lower growth performance of local native breeds when compared to commercial breeds (Jaturasitha et al., 2008; Choo et al., 2014b; Magothe et al., 2012). Gender has been shown to influence the endogenous functional compounds in meat for Korean native chickens (Jayasena et al., 2015). An analysis to elucidate the effects of gender on mixed and separate gender feeding on Korean native chicken was conducted. In line with Oh et al. (2019), the males for KA and KB recorded significantly higher values for the final body weight, ADG, ADFI when compared to the mixed and female groups. The higher ADFI observed for the male test groups is in line with the general agreement that male birds require greater nutrient quantities than females (NRC, 1994). The effect of age on the difference between the sexes was also noticed as the birds grew from week 1 to week 5. A calculation of the FCR ratios to depict the efficiency of converting

Table 2. Comparison of the growth performance indices for the Korean native chicken (KA, KB), White semi broiler (WSB) and the commercial broiler (CB) from hatch to week 5[y].

Items	Experimental Groups								SEM[z]	p-value
	KA-F	KA-FM	KA-M	KB-F	KB-FM	KB-M	WSB	Ross		
Body weight (g)										
Week 0	40.2a	40.5a	40.4a	39.1a	40.2a	39.7a	42.7b	44.5c	0.15	0.001
Week 1	128.9a	133.6b	132.6b	128.6a	131.8b	133.0b	127.1a	136.4c	0.60	0.002
Week 2	253.2b	265.5c	268.0cd	249.2a	265.4c	263.3c	281.3d	353.3e	2.08	0.001
Week 3	442.0a	467.9b	486.9c	450.7ab	456.8ab	482.6bc	514.7c	769.3d	5.45	0.001
Week 4	658.7a	713.0b	760.7c	683.9ab	697.4ab	746.5bc	806.8d	1242.0f	9.28	0.001
Week 5	810.3a	904.7b	979.3cd	862.6ab	914.6bc	963.6c	1064d	1748.9f	14.13	0.001
Average daily gain ($g \cdot day^{-1}$)										
Week 1	12.6b	13.3c	13.1c	12.7ab	13.1c	13.3c	12.0a	13.1c	0.09	0.007
Week 2	17.7a	18.8a	19.3ab	17.2a	19.0 ab	18.5a	22.0b	30.8c	0.64	0.001
Week 3	26.9a	28.9ab	31.2bc	28.7ab	28.1ab	31.24bc	33.3c	59.3d	1.51	0.001
Week 4	30.7a	35.0abc	38.9cd	33.3ab	33.5abc	37.7bcd	41.6d	67.7e	1.71	0.001
Week 5	29.9a	31.9ab	36.4b	29.7a	36.3b	36.1b	42.9c	84.0d	2.49	0.001
Week 1 - 5	23.4a	25.4bc	27.5d	24.2ab	25.7bcd	27.1cd	30.0e	50.0f	1.20	0.001
Average daily feed intake ($g \cdot day^{-1}$)										
Week 1	21.4b	21.6b	21.4b	21.6b	21.7b	21.8b	21.4b	17.8a	0.20	0.001
Week 2	35.1a	37.3ab	40.4b	35.9a	39.0ab	36.7ab	46.9c	46.9c	0.75	0.001
Week 3	50.1a	51.8ab	58.6b	51.9ab	51.8ab	56.3ab	51.7ab	79.6c	1.52	0.001
Week 4	63.6a	73.2b	75.9b	70.8ab	69.7ab	77.4b	78.1b	103.7c	1.88	0.001
Week 5	66.7a	68.7a	77.1b	68.6a	76.1b	78.2bc	85.0c	135.8d	3.17	0.001
Week 1 - 5	47.4a	50.5ab	54.7cd	49.8ab	51.7bc	54.1cd	56.6d	76.8e	1.30	0.001
Feed conversion ratio ($g \cdot g^{-1}$)										
Week 1	1.6b	1.6b	1.6b	1.7b	1.6b	1.6b	1.7b	1.3a	0.02	0.001
Week 2	1.9b	1.9b	2.1b	2.1b	2.0b	1.9b	2.1b	1.5a	0.03	0.001
Week 3	1.8c	1.8bc	1.8c	1.8bc	1.8c	1.8bc	1.5ab	1.3a	0.03	0.001
Week 4	2.0bc	2.1bc	1.9bc	2.1c	2.1bc	2.0bc	1.8b	1.5a	0.03	0.001
Week 5	2.2b	2.1b	2.12b	2.3b	2.1b	2.18b	2.03b	1.6a	0.06	0.001
Week 1 - 5	2.0bc	1.9bc	1.9bc	2.0bc	2.0bc	2.0bc	1.89b	1.5a	0.02	0.001
Shank length (mm)										
Week 1	38.0b	38.7bc	38.9bc	38.2b	38.5bc	39.1c	38.0b	37.0a	0.10	0.001
Week 2	49.4a	50.5ab	51.2bc	49.1a	50.8b	50.9b	49.6ab	50.1ab	0.12	0.001
Week 3	59.0a	61.7bc	62.2c	60.1ab	61.5bc	62.5c	60.9b	63.9d	0.17	0.001
Week 4	68.3a	71.2b	73.8c	68.1a	69.9b	73.2c	70.38b	74.1c	0.22	0.001
Week 5	75.3a	77.7b	80.7c	76.9b	77.7b	80.5c	78.37b	80.6c	0.21	0.001

F, female only; FM, female and male; M, male only.
[y] Results are mean of 18 replicates per treatment.
[z] Pooled standard error of mean.
a - c: Values in the same row with different superscripts differ significantly ($p < 0.05$).

the feed consumed into lean muscle mass was also conducted. Desirably lower values that signify better feed efficiency and low feed wastage were observed for the WSB and the CB with no significant differences among all the test groups for

KA and KB (Table 2). It was also noted that the ADFI increased with the age of the bird. This is akin to previous studies that were conducted by Shin et al. (2017) and Nawarathne et al. (2020). Generally, the FCR figures recorded for this study with KNC (KA and KB) were much lower than those recorded using the same research facilities by Shin et al. (2017) and Nawarathne et al. (2020) and Hong et al. (2018). The differences could be due to seasonal changes, the initial body weight of the birds, and the overall effect of the hybrid vigour from crossbreeding. The lower values could also be in line with the genetic progress that underlies the rapid growth of the poultry industry (Havenstein et al., 2003). Modern commercial broilers are known to be able to reach a market weight of around 2.1 kg within 35 days as of 2009 from 63 days around the 1960s (Ravindran, 2013; Zuidhof et al., 2014). Unfortunately, the rapid weight gain ability has not coincided with a proportional increase in the capacity of the skeleton and internal organs and the vascular system to support the rapidly increasing body mass (Deeb and Lamont, 2002), this has led to animal welfare, fitness and health concerns (Emmerson, 1997), especially among desirable broiler breeds with higher muscle accumulation ability and faster BW gain rates. Therefore, a further assessment was conducted for the shank lengths from the distance between the corner of the hock joint and the first scale of the third toe (Gao et al., 2006) in millimeters. In the present study, longer shank lengths with no significant differences were observed for the CB and the males for both lines of KNC (KA and KB; Table 2).

Conclusions

The present study has established the interaction of gender and the effects of mixed and separate gender feeding on the growth performance of Korean native chickens. Males for both lines of KNC (KA and KB) generally performed better than the mixed and the female groups for indices measured. Further studies on the effect of gender on performance could vary the gender ratios under similar conditions.

Conflict of Interests

No potential conflict of interest relevant to this article was reported.

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