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Determination and comparison of growth performance parameters between two crossbred strains of Korean native chickens with a white semi broiler chicken for 84 days post-hatch

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Abstract

The aim of this study was to investigate the growth performance between two different crossbred strains of Korean native chickens denoted as 1E and 2E with a white semibroiler (LL) from hatch to d-84 post-hatch. A total of 450 one-day-old chicks were randomly distributed into cages which included 15 replicate cages each for 1E and 2E with 9 replicate cages for LL. A three phase feeding program was used as a starter (Day 1 - 35; crude protein [CP] 20.3%; metabolizable energy [ME] 3,059 kcal·kg^{-1}), grower (Day 36 - 56; CP 18.6%; ME 3,123 kcal·kg^{-1}) and finisher (Day 57 - 84; CP 16.7%; ME 3,187 kcal·kg^{-1}). The results revealed that LL had a higher ($p < 0.05$) BW during d-8 to d-84 compared with the other two cross breed groups. A higher ($p < 0.05$) ADG was observed from the LL during the entire period except from d-1 to d-14 and d-71 to d-84 when compared with 1E and 2E. Shank length did not vary ($p > 0.05$) between the strains, despite LL having a SL that was 2.86% higher ($p < 0.05$) when compared with the other strains from d-15 to d-21 post-hatch, and 1E had a SL that was 2.28% ($p < 0.05$) higher when compared with the other strains during the first week of the experiment.

Keywords: cross breed, growth performance, Korean native chickens, shank length, white semi broiler

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Introduction

Chicken meat industry in Korea is one of the major sub-sectors in the livestock industry and per capita consumption of chicken meat showed a rapid increment from 2.4 kg in 1980 to 15.4 kg in 2014 (Shin et al., 2017) which was a 541.67% increment and also with an increase of approximately 89% in 2018 compared to that of 2005 (Park et al., 2019). The reason for increasing chicken consumption was the consumer preference towards healthy white meat compared with red meat (MAFRA, 2014). Even though the per capita consumption of chicken meat increased, data from the MAFRA (2014) concluded that chicken meat self-sufficiency rate in Korea has fallen during the same time period by 24.9%. With compared with past, approximately 90% of the poultry industry in Korea undergo their products based on the imported chicken breeding stocks (Choi et al., 2015) and those data indicate that rearing Korean Native Chicken (KNC) for food purpose became suppressed by imported chicken breeds in now-a-days.

KNC is a well-renowned breed for its superior meat quality, taste and high market price (Choi et al., 2015). Furthermore, KNC meat is characterized by low-fat content and high protein content (Kong et al., 2006) and also it is darker and reddish than broilers, contains more essential fatty acids and collagen (Jeon et al., 2010) with better sensory properties (Choe et al., 2010). However, possessing a low growth rate and poor commercial performances KNC almost became extinct in recent history but Korean government started to practice conservation strategies through the National Institute of Animal Science (NIAS) from 1994 up to date which obtained an ultimate goal of developing five lines of KNC (Seo et al., 2013; Choi et al., 2015) classified mainly by plumage colour representing black, grey, red, yellow, and white lines (Jin et al., 2014; Cahyadi et al., 2015). The cross breeds used in this study (1E and 2E) to evaluate growth performance was developed by the Golden Seed Project, Korea.

White semi broiler is a hybrid species generated by artificial fertilization between male broiler and female hen which characterized by white fur, small build, and low-fat muscle mass. White semi broiler chicks (LL) used in this study was offspring of Hy-Line female and Ross® male chickens (LL; Hy-Line female × Ross® male). This chicken breed is widely known as a main ingredient in Samgyetang (Korean chicken soup) and it has a large industrial presence, especially since Samgyetang ingredients sold on the market account for 60 - 70 % in Korea. Moreover, white semi chicks maintain its unique form of meat despite high temperature heating, and has a chewy, elastic, and suitable advantage for consumers' taste (Cho et al., 2007; Ahn et al., 2009; Lee et al., 2018). Therefore, this study was conducted to compare growth performance between three different strains of commercial KCN including 1E and 2E with the white semi broiler strain from hatch to 84 days of age post-hatch.

Materials and Methods

All procedures were approved, and birds were cared for according to the guidelines of the Animal Care and Use Committee Chungnam National University, South Korea (Protocol No. CNU-00613).

Birds and housing

A total of 450 one-day-old 1E, 2E and LL chicks with the similar initial body weight were randomly allotted to 39 cages which include 15 replicate cages each for 1E and 2E with 9 replicate cages for LL. Each pen of 1E and 2E contained 12 birds and LL contained 10 birds. Raised wire floor cages (76 × 61 × 46 cm^3) were provided as housing for birds and same environment condition was provided to each group. Furthermore, continuous lighting regime of 25 lux was practiced during the experimental period. The temperature of the cages was maintained at 32 ± 2℃ during the week one post-hatch, then it was gradually lowered to 20 ± 2℃ until the birds were 5 weeks old, then after the same temperature was maintained for the entire experimental period. Moreover, relative humidity was maintained at 70 ± 5% at 1 week, 65 ± 5% at 2 weeks, and 60 ± 5% thereafter.

Experimental design and diet

The experiment was conducted using completely randomized design (CRD) with general linear model (GLM). Corn-soybean meal basal diet was provided to birds which formulated according to the Korean Feeding Standard for Poultry of NIAS (2012) that included starter phase (Day 1 - 35; crude protein [CP] 20.3%, metabolizable energy [ME] 3,059 kcal·kg^{-1}), grower phase (Day 36 - 56; CP 18.6%, ME 3,123 kcal·kg^{-1}) and finisher phase (Day 57 - 84; CP 16.7%, ME 3,187 kcal·kg^{-1}) (Table 1). Diets were provided in *ad-libitum* basis using metal feed troughs and birds had free access to fresh clean drinking water via nipple drinkers throughout the experiment.

Table 1. Composition of the experimental diets (%, as-fed basis).

Ingredient (%)	Diets		
	Day 1 - 35	Day 36 - 56	Day 57 - 84
Corn	60.40	65.30	70.40
Soybean meal	32.50	26.90	21.10
Wheat bran	1.00	1.50	2.00
Corn gluten meal	1.00	1.50	2.00
Soybean oil	1.50	1.50	1.50
Di-calcium phosphate	1.50	1.30	1.10
Limestone	1.10	1.05	1.00
Salt	0.25	0.25	0.25
L-lysine	0.05	0.05	0.05
DL-methionine	0.20	0.15	0.10
Vitamin-mineral premix[z]	0.50	0.50	0.50
Calculated composition			
ME[y] (kcal·kg^{-1})	3,059	3,123	3,187
CP[z] (%)	20.3	18.6	16.7
Lysine (%)	1.11	0.98	0.84
Methionine + Cysteine (%)	0.79	0.71	0.63

ME, metabolizable energy; CP, crude protein.
[z] Vitamin and mineral pre-mixture provided the following nutrients 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; folacine, 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 evaluation

Body weight (BW), feed intake and shank length (SL) were recorded as weekly basis from d-1 to d-42 and bi-weekly basis after d-42 to end of the experiment. With using the BW and feed intake data, average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR) for chickens were calculated. Moreover, daily mortality of birds in each replicate was recorded when a death occurred.

Statistical analysis

Data were analyzed using one-way ANOVA technique, CRD by using SPSS software package (Version 21, IBM SPSS, Chicago, USA). Tukey multiple range test was used to determine the significant differences between experimental groups at 95% significant level.

Results

All birds remained healthy and performed well; sudden death syndrome (SDS), death from stress and disease were not found. Results of growth performance between three different strains of chicken from d-1 to d-84 post-hatch summarized in Table 2. White semi broiler chickens showed improved ($p < 0.05$) BW by 22.35% during d-8 to d-84 compared with other two cross breed groups and meanwhile BW was not different ($p > 0.05$) between 1E and 2E during the same period. Furthermore, higher ($p < 0.05$) ADG was observed from the LL strain during the experimental period by 27.32% except d-1 to d-14 and during the last week (d-71 to d-84) rather than to 1E and 2E. Besides, all three strain showed an increasing trend in ADG from d-1 to d-42 then after declining was observed. Moreover, similarly LL reported higher ($p < 0.05$) ADFI during the test period except d-1 to d-7. Birds belong to LL strain fed averagely 17.21% more than the 1E and 2E regard on daily basis. When considering feed conversion ratio, FCR of the birds did not differ ($p > 0.05$) among the strain during the period except from d-1 to d-7, d-15 to d-21 and d-57 to d-70. Throughout those three periods, LL birds showed improved FCR (1.54, 1.97 and 3.97 during d-1 to d-7, d-15 to d-21 and d-57 to d-70 respectively) with compared to 1E and 2E birds. Shank length was not varied ($p > 0.05$) between the strains during the d-84 period, except during d-15 to d-21 post-hatch LL birds showed 2.86% higher ($p < 0.05$) SL with compared with other two cross breed strains and 1E birds obtained 2.28% higher ($p < 0.05$) SL with compared with 2E and LL during d-1 to d-7.

Table 2. Comparison of growth performance between 1E, 2E and White semi broiler chicks (LL) chicken strains from hatch to week 12 post-hatchy.

Items	Strain			SEM[z]	p-value
	1E	2E	LL		
Body weight (g)					
Day 1 - 7	128.7	129.5	135.5	2.24	0.256
Day 8 - 14	258.0a	250.2a	273.0b	2.54	0.013
Day 15 - 21	408.5a	409.4a	491.4b	6.38	0.001
Day 22 - 28	622.4a	628.5a	749.2b	9.37	0.001
Day 29 - 35	812.8a	816.1a	986.4b	12.99	0.001
Day 36 - 42	1091.5a	1068.8a	1326.1b	18.26	0.001
Day 43 - 56	1547.9a	1517.6a	1888.7b	26.65	0.001
Day 57 - 70	1866.7a	1851.9a	2315.2b	34.42	0.001
Day 71 - 84	2207.3a	2149.8a	2697.7b	40.22	0.001
Average daily gain ($g \cdot day^{-1}$)					
Day 1 - 7	11.5	11.5	13.1	0.33	0.080
Day 8 - 14	18.5	17.2	19.6	0.47	0.340
Day 15 - 21	21.5a	22.7a	31.2b	0.74	0.001
Day 22 - 28	30.6a	31.3a	36.8b	0.52	0.001
Day 29 - 35	27.2a	26.8a	33.9b	0.65	0.001
Day 36 - 42	39.8a	36.1a	48.5b	0.99	0.001
Day 43 - 56	32.6a	32.1a	40.2b	0.71	0.001
Day 57 - 70	22.8a	23.9a	30.5b	0.74	0.001
Day 71 - 84	24.3	21.3	27.3	0.71	0.074
Average daily feed intake ($g \cdot day^{-1}$)					
Day 1 - 7	20.8	20.4	19.4	0.29	0.069
Day 8 - 14	51.3a	50.1a	62.3b	1.02	0.001
Day 15 - 21	52.8a	52.7a	61.3b	1.10	0.020
Day 22 - 28	68.9a	68.9a	81.1b	1.07	0.001
Day 29 - 35	81.0a	77.7a	91.2b	1.22	0.001
Day 36 - 42	107.9a	103.5a	123.6b	1.89	0.001
Day 43 - 56	110.3a	108.5a	124.5b	1.81	0.001
Day 57 - 70	103.8a	102.2a	119.9b	1.59	0.001
Day 71 - 84	112.1a	109.3a	133.8b	2.53	0.001
Feed conversion ratio ($g \cdot g^{-1}$)					
Day 1 - 7	1.8b	1.8b	1.5a	0.03	0.001
Day 8 - 14	2.8	2.9	3.6	0.16	0.049
Day 15 - 21	2.5b	2.3b	2.0a	0.05	0.001
Day 22 - 28	2.3	2.2	2.2	0.02	0.412
Day 29 - 35	2.9	2.8	2.7	0.05	0.124
Day 36 - 42	4.0	3.9	3.7	0.07	0.050
Day 43 - 56	3.1	3.2	2.8	0.06	0.057
Day 57 - 70	4.6b	4.4ab	4.0a	0.10	0.009
Day 71 - 84	4.7	5.3	4.9	0.11	0.330
Shank length (mm)					
Day 1 - 7	37.2b	36.7a	36.0a	0.13	0.001
Day 8 - 14	47.4	47.4	47.0	0.19	0.440
Day 15 - 21	55.5a	55.2a	56.9b	0.28	0.049
Day 22 - 28	64.2	64.7	65.3	0.44	0.354
Day 29 - 35	73.5	74.5	75.8	0.51	0.094
Day 36 - 42	89.3	88.4	89.7	0.48	0.760
Day 43 - 56	95.9	96.3	97.3	0.64	0.418
Day 57 - 70	106.8	107.3	106.1	0.65	0.679
Day 71 - 84	117.6	120.9	113.8	2.76	0.613

[y] Values are mean for three chicken strains.

[z] Pooled standard error of mean.

a, b: Values in a row with different superscripts differ significantly ($p < 0.05$).

Discussion

When considering BW results, LL birds showed significant higher BW compared with the 1E and 2E chickens during the entire experimental period except d-1 to d-7. Our results on BW in 1E and 2E between d-1 to d-56 post-hatch was higher and afterword BW was reduced till d-84 post-hatch with comparing with the findings of Hong et al. (2018) on KNC cross breeds. Moreover, Kim et al. (2014) obtained average body weight of 1.10 kg for cross breed chicken at week 12 post-hatch and our results at the same period on BW of cross breed birds was approximately two times higher. That kind of differences in data can be obtained might due to the seasonal changes, breeding site, quality of the parent birds and the hybrid strength (Kang et al., 1997). In addition, a similar type of low growth rate in Korean local chicken was reported by Choo et al. (2014) and also in local chickens in other countries (Raach-Moujahed and Hadaad, 2013). Cross breed birds showed lower ($p < 0.05$) ADG with compared with LL birds in the current study. During the d-1 to d-70 post-hatch period, current study showed improved result on ADG compared to the study by Cho et al. (2017) and vice-versa after d-70 till the end. Furthermore, Shin et al. (2017) reported an increment trend of ADG in cross breed KNC from hatch to week 8 and thereafter a decrement till to the end which was tally with our results on ADG in the present experiment. ADFI was differ ($p < 0.05$) among the trait. During the experimental period ADFI was increased with the age of the birds but during d-57 to d-70 every traits reported low ADFI regard with d-43 to d-56. Current results were in accordance with the findings of Shin et al. (2017) who reported a same manner of decrement in ADFI during week 10 than week 8. Significant effect ($p < 0.05$) in FCR between the strains was received only during the d-1 to d-7, d-15 to d-21 and d-57 to d-70 of the experiment where LL birds showed improved ($p < 0.05$) figures in all three time slots. This kind of uneven results on FCR in KNC cross breeds also received by Hong et al. (2018) and Kim et al. (2014). Normally, shank length affect on the chicken leg health and it is considered as an indicator of proper leg conditions in chicken (Gao et al., 2010). Shank length did not vary ($p < 0.05$) between the strains throughout the experimental period except d-1 to d-7 and during d-15 to d-21.

Conclusion

White semi broiler birds (LL) showed significantly higher growth performance including BW, ADG and ADFI compared with 1E and 2E crossbred birds from hatch to 12 weeks post-hatch while 1E and 2E birds did not show a significant difference in growth performance in between them. Moreover, LL strain obtained significantly lower FCR only in three weeks during the experimental period over 1E and 2E while 1E birds reported significantly higher shank length in the starting week over 2E and LL birds.

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