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Comparison of Production Performance and Egg Quality Characteristics of Five Strains of Korean Native Chickens

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ABSTRACT The production performance and egg quality traits among five strains of Korean native chickens (KNC) were evaluated in conventional cages. A total of 240 KNC were housed in a controlled environment. Each strain had 12 replicates with 4 chickens per cage. Feed intake, body weights, egg production and egg quality were measured at 24, 28 and 32 of weeks. Egg quality parameters were analyzed using 150 eggs. Results indicated significant (P<0.05) difference in average body weights, egg production and egg weight among five strains of KNC. In contrast, KNC strains effect was non-significant (P>0.05) for feed efficiency. The difference among those KNC strains on egg shell color, egg shell strength and egg shell density were not different (P>0.05) at the age of week 24 while it was significant (P<0.05) at the age of week 28 and 32. There was no effect (P>0.05) on egg length and egg shape index from five strains of KNC. The significant difference (P<0.05) was observed in egg width with KNC strains during early ages (week 24 and 28) and it was not significant (P>0.05) at the age of 32 weeks. Regarding internal quality parameters, albumen height and Haugh unit were significantly (P<0.05) affected with KNC strains while the effect on yolk color was not significant (P>0.05). Based on the egg weight and the production performance, GS-10 KNC strain was superior when compared with the other strains.

(Key words: egg production, egg quality, Korean native chickens)

INTRODUCTION

Egg considers as an important food item in human diet due to its versatile nutritive values and functional properties (Ali and Anjuma, 2014). Chicken eggs are occupying most of world egg production, but duck, quail and turkey eggs are also showing slight increases of their products. Egg production mainly aims to produce two types of eggs, which categorized as hatching eggs and table eggs. Consumers' awareness about egg quality has risen in these days, and consequently its quality has controlled the egg price in market. Therefore, egg quality is the most important factor to accomplish the economic success of layer business (Monira et al., 2003; Usman et al., 2014). In general, egg quality is examined aspects of the externals and internals quality by using several standards (Moula et al., 2013). External parameters include weight, shell color, shape index and shell thickness, and meanwhile internal parameters indicate yolk color, yolk index, albumen index and Haugh unit. However, different factors deciding the quality exists such as breed, nutrition, environmental conditions, physiological/physiological stresses and egg storage period (Monira et al., 2003; Moula et al., 2013; Kabir et al., 2014).

Chicken breed and genetic factors had greatly influence on all traits of an egg (Ali and Anjum, 2014). Recent studies reported inter relationship between breed or strain of chicken and its effect on egg quality (Monira et al., 2003; Khawaja et al., 2013; Kabir et al., 2014)

Korean native chicken (KNC), a domestic breed of Korea, have been studied to improve their production previously (Seo et al., 2013; Choi et al., 2015). However, published data on egg quality parameters and genetic effects of strains of Korean native chicken have barely been discussed. Therefore, the objective of the present study was to evaluate and compare

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the egg quality parameters among five strains of Korean native chickens from 24- to 32-week of age.

MATERIALS AND METHODS

All procedures for our experiment were reviewed and approved by the Animal Ethics Committee of the Chungnam National University (CNU-00559).

1. Birds and Managements

Total of 240 (20 weeks of age) birds in five different (GS-08, GS-10, GS-12, GS-17 and GS-21) strains of Korean native chickens (KNC) were used for 12-week experiment. Birds were allocated in to 60 battery cages (4 birds per pen) in a completely randomized design with 12 replications per each strain. Same management practices were subjected to all birds in a controlled environmental condition. Throughout the experiment, 16 hours of light and 8 hours of dark was maintained.

2. Feeding Regimen and Data Collection

Birds were fed manually with commercial feed (Crude protein 16%, Metabolizable energy 2,820 kcal/kg) and fresh water was available at all times. At the end of each four week (i.e., from week 20 through week 32), body weights and feed consumption were measured.

3. Egg Collection

During the experimental period, eggs were collected every morning and recorded the number of egg laid per pen. Egg production was calculated for each KNC strains according to the method describe by Khawaja et al. (2013). Eggs were collected for quality analysis at the age of 24, 28 and 32 weeks. At the time of collection, pen numbers were recorded the on the egg shell for identification.

4. Egg Quality Measurements

Total of 150 eggs (10 eggs from each treatment per week) were randomly selected from the total egg collection.

The weight of each egg was measured using analytical balance (OHAUS explorer E12140, Ohaus Corp., USA) while the egg length and width were measured using a Vernier caliper (MITUTOYO 530-312, Mitutoyo, Japan). Egg shell color (ESC) was measured using shell color reflectometer (TSS QCR, Technical Services and Supplies, York, UK). Thick albumen height and the Haugh unit of each egg was measured according to the methods of Jayasena et al. (2012) with the use of an automated Haugh unit system (TSS QCD, Technical Services and Supplies, York, UK). Yolk color was measured by utilizing yolk colorimeter (TSS QCC, Technical Services and Supplies, York, UK) that initially calibrated with DSM® color fan. Egg shell strength (ESS) was measured as static compression shell strength as described by Jones et al. (2012) with the aid of a texture analyzer stable micro system (TA. XT *Plus* Texture Analyzer, Texture Technologies Corp., Scarsdale, NY).

Egg shells were gently washed in water and dried before measuring shell weight and shell thickness. The weight of egg shells was measured using analytical balance (OHAUS explorer E12140, Ohaus Corp., USA). Measurements of the shell thickness were taken from the blunt end area (without air sac membrane) with a digital micrometer (Mitutoyo, Japan).

5. Calculations

Feed efficiency was calculated based on the method reported by Khawaja et al. (2013). Further calculations were performed with the collected measurements data, to analyze the respective quality parameters. Egg shape index (ESI) was calculated by the method described by Monira et al. (2003) and Jayasena et al. (2012). Egg shell density (ESD) was calculated based on egg weight and dry egg shell weight according to the Riley et al. (2014).

$$\text{Egg shape index} = \frac{\text{Width of egg}}{\text{Length of egg}} \times 100$$

$$\text{Shell density} = \frac{\text{Shell weight}}{4.68\left(\text{egg weight} \times \frac{2}{3}\right)} \times 100$$

6. Statistical Analysis

Data were analyzed using SPSS software version 21 (IBM Corp., 2012). One-way ANOVA was performed along with the strain effect as a single factor. When significant (P<0.05) differences were observed, means were separated using turkey's test procedure of SPSS software (Version 21, IBM SPSS, 2012).

RESULTS AND DISCUSSION

1. Production Performance

Average daily feed intake, average body weight, egg production performance and feed efficiency of five strains of KNC are presented in the Table 1. In the present study, average daily feed intake and feed efficiency were non-significant ($P>0.05$) among five KNC strains during the experiment period. Nevertheless, a significant deference ($P<0.05$) was observed in average body weights among five strains of KNC. KNC strain GS-21 had the lowest body weight while highest body weight was observed in GS-17 KNC strain. In this experiment, feed intake was generally higher than the reported values (88.7～105.0 g/bird/day) for young layers by Singh et al. (2009) at the same age. This is probably results of breed and body weight differences exist in these studies. However, similar to our results Afolayan et al. (2013) reported higher feed intake values for young Shika brown layers during the 23～35 weeks of age.

Feed efficiency was calculated for layers as the amount of feed consumed per weight of egg produced. Poor feed efficiency results were observed in this study with compared observed value (2.32 g/g) for 30-week layers by Singh et al. (2009). Higher values (3.95～7.50) in this study results, as substantial amounts of feeds were utilized for growth purposes in young layers. Likewise, Afolayan et al. (2013) and Khawaja et al. (2013) reported higher values for feed efficiency in their studies with young layers.

Egg production percentage was calculated in this study to get the precise measurement by using daily egg collection data. Significant ($P<0.05$) effect of KNC strain on egg production was observed at the age of 28 and 32 weeks. Similar to our result, Scheideler et al., (1998) observed significant strain effect on egg production percentages in their experiment with three strains (Babcock B300, DeKalb Delta and Hy-Line W-36) of chicken. Further, Singh et al. (2009) observed significant strain effect on hen-day egg production percentage in their experiment with four strains (Lohmann White, H & N White, Lohmann Brown and a noncommercial cross between Rhode Island Red and Barred Plymouth Rock) of laying hen.

2. External Parameters

The effect of KNC strains on the tested external quality parameters are presented in Table 2.

Multi-factorial effects (Age, genetics, feed, environment condition and etc.) would be influencing the egg quality para-

Table 1. Comparison of production performance of five strains of KNC during experiment period[1]

Item		GS-8	GS-10	GS-12	GS-17	GS-21	SEM[2]	*P*-Value
Average Daily feed intake (g/hen/day)	Week 24	140.52	143.22	135.12	138.32	153.06	3.980	0.706
	Week 28	152.21	158.43	141.60	150.43	167.96	4.830	0.544
	Week 32	155.66	157.92	158.34	150.24	185.70	5.280	0.243
Average body weight (g/hen)	Week 24	3,468.50	2,683.20	3,299.50	3,500.90	2,628.10	110.400	0.006
	Week 28	3,630.70	2,836.70	3,392.70	3,687.30	2,722.20	114.100	0.004
	Week 32	3,717.20	2,908.50	3,500.40	3,763.00	2,800.70	115.400	0.004
Egg production rate (%)	Week 24	51.60	59.40	55.90	52.80	60.90	6.610	0.099
	Week 28	62.30	72.40	65.80	63.00	75.40	8.490	0.034
	Week 32	55.00	72.30	62.50	63.20	71.70	1.820	0.004
Feed efficiency (g feed: g egg mass)	Week 24	7.00	7.50	7.36	6.83	6.48	0.329	0.893
	Week 28	4.43	4.10	4.02	4.33	4.12	0.117	0.812
	Week 32	4.96	3.95	4.61	4.14	4.73	0.132	0.069

1 Results are mean with 12 replicates per strain.
2 Standard error of mean.

Table 2. The effect of KNC strain on the tested external quality parameters[1]

	Parameter	Age/week[2]	Strain					SEM[3]	*P* value
			GS-08	GS-12	GS-17	GS-21	GS-10		
External parameters	Egg weight (g)	24	50.83	51.81	47.16	50.83	53.68	0.320	0.001
		28	55.63	56.30	53.34	54.39	56.91	0.280	0.005
		32	53.32	55.50	54.55	55.29	57.60	0.290	0.003
	Egg shell color (%)	24	36.40	31.40	36.60	36.00	32.20	0.830	0.165
		28	45.00	31.00	49.80	33.80	39.00	1.050	0.001
		32	52.60	35.80	47.00	40.20	36.20	0.740	0.001
	Egg length (cm)	24	5.28	5.42	5.28	5.30	5.40	0.030	0.405
		28	5.52	5.52	5.60	5.58	5.54	0.030	0.896
		32	5.46	5.58	5.48	5.16	5.50	0.060	0.248
	Egg width (cm)	24	4.12	4.20	4.02	4.14	4.16	0.010	0.019
		28	4.24	4.24	4.18	4.12	4.26	0.010	0.045
		32	4.12	4.22	4.18	4.22	4.16	0.010	0.113
	Egg shape index	24	78.07	77.51	76.18	78.16	77.16	0.560	0.802
		28	76.85	76.98	74.74	73.85	76.89	0.600	0.359
		32	75.49	75.67	76.37	82.70	75.64	0.990	0.139
	Egg shell strength (g)	24	3,842.27	4,083.96	3,694.00	4,149.95	3,574.23	91.150	0.250
		28	4,177.86	3,461.61	3,514.44	3,189.02	3,722.85	93.270	0.038
		32	3,634.97	3,510.20	2,799.49	3,364.03	2,505.41	114.160	0.022
	Egg shell thickness (mm)	24	0.34	0.34	0.35	0.35	0.33	0.004	0.517
		28	0.39	0.34	0.37	0.33	0.36	0.005	0.005
		32	0.35	0.33	0.31	0.35	0.33	0.004	0.097
	Egg shell density (g/cm^2)	24	2.80	2.95	2.93	2.86	2.59	0.039	0.051
		28	2.89	2.66	2.84	2.55	2.59	0.029	0.004
		32	2.78	2.62	2.34	2.83	2.27	0.028	0.000
Internal parameters	Albumen height (mm)	24	7.34	6.44	5.94	5.58	5.92	0.110	0.001
		28	6.06	6.78	5.82	5.50	7.10	0.100	0.001
		32	5.44	5.62	6.18	6.06	5.10	0.080	0.002
	Haugh unit	24	88.12	82.30	80.72	76.78	78.12	0.770	0.002
		28	78.56	83.06	77.30	75.68	84.96	0.740	0.003
		32	74.76	75.14	79.78	78.68	70.32	0.560	0.001
	Yolk color	24	10.00	9.80	9.60	9.60	10.00	0.100	0.558
		28	10.00	9.40	10.00	9.20	9.80	0.100	0.057
		32	7.80	8.00	8.60	8.40	8.00	0.150	0.449

[1]Results are mean with 5 replicates per strain.
[2]Age at the egg sample collection.
[3]Standard error of mean.

ters. Among those factors, breed or strain or the combination of both effects on egg quality (Usman et al., 2014). According to our observed results GS-10 KNC strain was the highest weight egg producers throughout the study period and it was followed by GS-12 KNC strain ($P<0.1$). Moreover, effect of the KNC strain on egg weight was significant ($P<0.05$) at all ages. These findings are in agreement with the outcomes of several previous experiments (Scheideler et al., 1998; Scott and Silversides, 2000; Anderson et al., 2004; Singh et al., 2009) which observed significant effect of strain on egg weight.

The strain effect on ESC was not significant ($P>0.05$) at the age of 24-week. However, strain effect on ESC was significant ($P<0.05$) after at the age of week 28 and 32. Similarly, Joseph et al. (1999) observed significant influenced from chicken strain on ESC in their study with broiler breeder eggs. In reflectometer method egg shell color measures and expresses as a percentage of black and pure white, where black refers 0% and the pure white as 100% (Roberts et al., 2013). According to above mentioned, lowest percentage values refers the darkest in color and the higher values refer to lighter colored eggs. The lowest ESC percentages were observed in GS-12 KNC strain at all ages of the experiment period and therefore darkest (brown) eggs were produced in GS-12 KNC strain over the other four strains. Egg shell color is an important factor which makes an effect on consumer buying behavior in many countries (Scott and Silversides, 2000; Romanowska, 2009).

Effect from KNC strain on egg length was not significant throughout in the current study. Similarly, there was no effect ($P>0.05$) on the ESI from KNC strain. Nevertheless, significant effect ($P<0.05$) was observed in egg width with KNC strain in the early ages (week 24 and 28) and it was not significant ($P>0.05$) at the age of week 32. In contrast, Anderson et al. (2004) reported a significant strain effect on egg shape index which studied with historic strains of single comb white Leghorn chickens. However, our results were supported by Haunshi et al. (2011) which observed non-significant differences in the shape index within the native chicken breeds.

Egg shell strength is an important egg quality trait to be considered in the egg production industry, as shell cracking during handling leads to market rejections (Hunton, 2005). Effect of KNC strain on ESS was not significant ($P>0.05$) at the age of week 24 while it was significant ($P<0.05$) in 28 and 32 weeks. Identical trend ($P<0.1$) was observed in the ESD, which was observed a significant effect at the end (week 28 and 32) of the experiment. Similarly, significant strain effect on shell strength was observed by Kocevski et al. (2011) in his experiment with ISA Brown and DeKalb White chicken strains.

3. Internal Parameters

Table 2 shows the effect of KNC strain on the tested internal quality parameters. The significant ($P<0.05$) interactions were observed in both albumen height and Haugh unit with KNC strain. Many studies (Scott and Silversides, 2000; Silversides and Budgell, 2004) observed different albumen heights with the effect of strain. Further, Hagan et al. (2013) reported Haugh unit were significantly affected by the strain, which is in agreement with our current results. According to Jayasena et al. (2012), eggs having Haugh unit value of 70 or above are considered as good quality eggs. Moreover, it was reported (Stadelman, 2002) higher Hugh unit values indicate better albumen quality. In order to aforementioned, all KNC strains produced high quality eggs which showed Haugh unit value higher than 70 in this study.

Egg yolk color which is a result of egg pigmentation is an important parameter that consider in egg industry (Lokaewmanee et al., 2011). Yolk color was considered as an egg quality parameter which is use for egg grading. Effect of KNC strain on yolk color was not significant ($P>0.05$) and the egg yolk color was ranged from 7.8 to 10.0 in the current study, suggesting KNC have bright golden colored egg yolk. Hagan et al. (2013) observed non-significant difference in yolk color among different chicken strains. Similarly, Haunshi et al. (2011) observed non-significant difference among chicken breeds and this was in an agreement with our results.

In conclusion, together with outcomes from the current study indicated that many internal and external egg quality parameters are significantly influenced by the KNC strain. Based on the egg production, feed efficiency and the egg weight, GS-10 group was the superior, with compared to other groups.

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