한국가금학회지 제 39권 제 2호, 105~112 (2012)
Korean J. Poult. Sci. Vol.39, No.2, 105~112 (2012)
http://dx.doi.org/10.5536/KJPS.2012.39.2.105

Comparative Study on Various Growth Performances of Korean Oge and White Leghorn Chickens

Kyung Soo Kang[1], Hyun-Jun Jang[1], Hyung Chul Lee[1], Sung Kyu Kim[1], Jae-Hwan Kim[2], Seong-Bok Choi[2], Deivendran Rengaraj[1] and Jae Yong Han[1,†]

[1]*WCU Biomodulation Major, Department of Agricultural Biotechnology, Seoul National University, Seoul 151-921, Korea*
[2]*National Institute of Animal Science, R.D.A., Namwon 590-830, Korea*

ABSTRACT Genetic resource conservation of indigenous species is important to conserve terrestrial, aquatic and avian species throughout the world. The native Korean Oge (KO) chickens are important and protected indigenous avian species in Korea. This KO breed is very popular in Korea because of its external appearances of blackish color. The characterization of morphology and growth performances of KO were performed since 1980s, however the information is still not sufficient for breed selection. In this study, we compared various growth performances including body growth, tibia length, shank length, chest width, chest grith and length of tail feather between male and female chickens of KO and widely known White Leghorn (WL) breeds at 1 week, 2 weeks, 5 weeks, 10 weeks, and 24 weeks. We observed differences on various growth performances at different aged groups between KO and WL chickens. This study may help for the selection of chicken breeds based on age, body growth and meat production.

(Key words : Korean Oge (KO), White Leghorn (WL), growth performances)

INTRODUCTION

The Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization was made in connection with the Conference of the Parties to the Convention on Biological Diversity at its 10th meeting on October 2010 in Nagoya, Japan. The Nagoya protocol is an international agreement which aims at sharing appropriate access to genetic resources, appropriate transfer of relevant technologies, and appropriate funding thereby contributing to the conservation of biodiversity (Protocol: Booklets http://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf). There are few indigenous species being very popular in Korea, particularly Hanwoo cattle, Jindo dogs and Korean Oge (KO) chickens have plentiful genetic resources. These indigenous species are widely used by Korean researchers for the research works on improvement of meat quality, milk production and egg production. KO chickens are the indigenous avian species in Korea, and important genetic resources in poultry industry and avian biotechnology. KO chickens have been recognized as a natural monument since 1980 for its genetic important and characteristic appearances.

KO chickens were previously characterized to investigate its hereditary characters and some economical traits (Han et al., 1988). However it has not been registered as new breed because of fewer studies on characteristic feature. The genetic background of KO was biased on breeding. General description of KO chickens are: short rectangular shaped body with six to eight pointed stands up straight reddish black color comb on the head; black colored with a white tip medium length of beak; round and black eyes; reddish black and featherless face; small and varied colors of ear lobes; medium size and elongated reddish black wattles; greyish black tongue; shank of medium length with four greyish black toes; the body covered by dark black feathers; greyish black skin; and greyish black bone cortex (Nahm, 1997). The genetic characteristics of KO chickens are a highly inbred line and closely related to the Korean native yellow fowl by DNA fingerprinting study (Lee et al., 1995). The native KO chickens share the features of Japanese, Chinese and Indian chicken populations which represent the high genetic variability (Lee et al., 2007). White Leghorn (WL) chickens are the most commonly known avian breed for egg laying. WL chickens were first reported in Tuscany in Italy and exported to North America. WL chickens have single comb, legs are yellow in color, and ear-lobes are white in color. It was tested for environ-

† To whom correspondence should be addressed : jaehan@snu.ac.kr

mental stress effect for their body weight growth (Gross and Siegel, 1980). WL chickens are also very good resource for genetic studies such as quantitative trait locus (QTL) (Tsudzuki et al., 2007; Ankra- Badu et al., 2010; Podisi et al., 2011), genetic differentiation (Tadano et al., 2011), and gene polymorphism (Cao et al., 2007).

Analysis of patterns of growth performances is very important for understanding feed utilization and meat production in poultry. Several studies were previously conducted to compare growth patterns between different breeds of avian species. Some studies have been reported on environmental conditions that influence chicken growth. For example, early hatched chicks grow faster than late hatched chicks (Martin, 1929). Some other considerable factors are also influencing the size of hatchlings, early growth (Martin, 1929), early feathering (Jaap and Morris, 1937), sex difference (Burke and Sharp, 1989), breed difference (Asmundson and Lerner, 1934), and shank length (Jull et al., 1943). However, the available information is not enough to have a clear conclusion on breed specific features. In this study, we compared KO and WL chickens on growth patterns of six different parameters for providing additional information to the characteristic features of KO chickens.

MATERIALS AND METHODS

1. Bird Management

The care and experimental use of chickens were approved by the Institute of Laboratory Animal Resources of Seoul National University (SNU-070823-5). KO and WL chickens were maintained according to a standard management program at the University Animal Farm, Seoul National University. Animal management and reproduction were performed in accordance with standard protocols of Lab of Animal Genetic Engineering, SNU, Korea. Chickens were kept in individual cages and maintained at a photoperiod of 16 hrs light: 8 hrs dark schedule. All birds were allowed to free access food and water throughout the day.

2. Analysis of Growth Performances of KO and WL Chickens

The data of growth performances were collected from indigenous avian breed (KO) with foreign breed (WL) that were reared equally for up to 1 week, 2 weeks, 5 weeks, 10 weeks and 24 weeks of ages. In total hundred KO chickens and 50 WL chickens were used for the measurements of growth performances at 1 week, 2 weeks and 5 weeks. Further, 30 male and female chickens of each KO and WL were used for the measurements of growth performances at 10 weeks, and 24 weeks. Growth performances including body weight, tibia length, shank length, chest width, chest grith, and length of tail feather were measured at appropriate ages. The length of tibia was measured in between the metatarsus (hock joint) and femur (thigh joint). The length of shank was measured between the foot and middle hock joint. The length of tail feather was measured from the pygostyle end in chickens ageing above 2 weeks old. The chest width was measured on the top of keel (breast bone) and chest girth was measured on top of keel though between body and humerus part. All growth performances were compared between KO chickens and WL chickens of same sex and age group. In addition, we compared the growth performances between male and female chickens within KO and WL breeds. Data collection was performed during 1 week to 24 weeks old age chicken.

3. Statistical Analysis

Data was used for statistical analysis and standard deviation (SD) calculation. Statistical analysis was performed to determine significant differences existed in the measured data by using the general linear model (PROC-GLM) of SAS software (SAS Institute, Inc. USA), and the least-significant difference (LSD) method. A P-value of less than 0.05 was considered to be statistically significant. Graphical data on growth performances were prepared using GraphPad (Prism 5) software (GraphPad Software, USA).

RESULTS

1. Comparison of Body Weight between KO and WL Chickens

The average body weight of male and female KO and WL chickens were obtained from 1 week to 24 weeks of ages. These were significantly lower than those of WL males and females

(45.80 g and 44.52 g, respectively) at 1 week. At 2 weeks, the average body weights of WL males and females were 31.09 g and 16.99 g higher, respectively than those of KO male and female chickens. At 5 weeks, the average body weights of WL males and females were 38.32 g and 21.04 g higher, respectively than those of KO male and female chickens. At 10 weeks, the average body weights of WL males and females were 7.03 g and 25.2 g higher, respectively than those of KO male and female chickens. At 24 weeks, the average body weights of WL males and females were 30.13 g and 92.17 g higher, respectively than those of KO male and female chickens (Table 1 and Fig. 1a).

Table 1. Comparative growth performances of Korean Oge and White Leghorn chickens from 1 week to 24 weeks of age

	Weeks	Korean Oge male		Korean Oge female		White Leghorn male		White Leghorn female	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Body weight (g)	1	39.96^{a}	3.32	37.80^{a}	4.18	45.80^{b}	3.60	44.52^{a}	5.16
	2	64.04^{a}	12.12	74.32^{a}	14.71	95.13^{b}	12.00	91.31^{a}	11.35
	5	279.20^{a}	41.41	269.24^{b}	37.60	317.52^{ab}	43.93	290.28^{bc}	30.55
	10	821.47^{a}	92.20	706.27^{ab}	86.34	828.50^{bc}	91.16	731.47^{ac}	78.84
	24	1,544.0^{a}	1,28.25	1,134.13^{a}	99.91	1,574.13^{b}	143.53	1,226.30^{a}	135.08
Tibia length (cm)	1	3.12^{a}	0.42	3.10^{bc}	0.35	3.40^{ab}	0.39	3.41^{ac}	0.36
	2	4.33^{a}	0.37	3.37^{b}	0.47	4.64^{a}	0.43	4.63^{ac}	0.35
	5	6.39^{a}	0.84	6.87^{ab}	0.61	6.90^{cd}	0.58	6.43^{bcd}	0.51
	10	11.19^{a}	0.97	10.55^{a}	0.68	10.92^{b}	1.01	10.12^{ab}	0.67
	24	13.08^{a}	1.01	12.17^{ab}	1.18	15.07^{ab}	1.65	13.73^{b}	1.28
Shank length (cm)	1	2.00^{a}	0.24	1.91^{b}	0.28	2.26^{abc}	0.23	2.22^{ab}	0.35
	2	2.99^{a}	0.95	2.61^{ab}	0.56	2.73^{abc}	0.32	3.19^{bc}	0.32
	5	3.83^{a}	0.62	4.47^{ab}	0.52	4.27^{ab}	0.42	3.89^{b}	0.43
	10	6.74^{a}	0.97	5.72^{a}	0.58	7.47^{ab}	0.49	7.32^{a}	1.04
	24	11.27^{a}	1.82	8.67^{a}	0.58	9.27^{a}	0.99	8.05^{a}	0.82
Chest width (cm)	1	2.27^{a}	0.73	3.03^{a}	0.70	2.48^{ab}	0.30	2.42^{a}	0.29
	2	3.59^{a}	0.48	4.08^{a}	0.52	4.75^{ab}	0.41	4.74^{a}	0.43
	5	5.90^{a}	0.67	6.04^{b}	1.04	6.37^{abc}	0.51	6.46^{ab}	0.41
	10	9.99^{a}	1.11	8.90^{a}	0.83	10.57^{a}	0.87	9.48^{a}	0.97
	24	16.43^{a}	1.85	15.63^{b}	1.70	15.8^{c}	1.69	14.23^{abc}	0.94
Chest grith (cm)	1	8.05^{a}	0.65	8.43^{ac}	0.69	8.22^{b}	0.55	8.05^{c}	0.53
	2	9.62^{a}	0.89	10.24^{a}	1.01	11.63^{ab}	0.86	11.36^{ac}	0.93
	5	14.69^{a}	1.13	15.16^{ab}	1.11	14.53^{b}	1.17	14.79^{c}	1.06
	10	23.33^{a}	2.24	20.88^{ab}	1.19	24.97^{ab}	2.02	24.03^{b}	1.46
	24	28.00^{a}	1.86	27.35^{b}	1.04	26.87^{a}	1.04	25.00^{ab}	1.53
Tail feather (cm)	1	–	–	–	–	–	–	–	–
	2	1.26^{a}	0.37	1.41^{a}	0.63	3.27^{a}	0.47	3.16^{b}	0.47
	5	3.33^{a}	1.82	5.18^{a}	1.63	7.47^{a}	1.77	7.43^{b}	0.97
	10	11.30^{a}	1.92	11.15^{b}	1.66	15.03^{abc}	3.41	14.1^{ab}	2.36
	24	23.23^{a}	3.60	17.69^{ab}	2.51	18.90^{ac}	4.66	18.47^{ad}	1.80

SD, standard deviation.

$^{a\sim d}$There is a significantly difference between the different superscripts ($P<0.05$).

2. Comparison of Tibia Length between KO and WL Chickens

The lengths of tibia in male and female chickens of KO and WL were observed from 1 week to 24 weeks of ages. At 1 week and 2 weeks, the tibia length was higher in male than that of female chickens in both KO and WL. At 1 week, the lengths of tibia were measured 0.28 cm and 0.31 cm higher in WL male and female, respectively than those of KO male and female chickens. At 2 weeks, the length of tibia showed 0.31 cm and 1.26 cm higher in WL males and female, respectively compare to KO male and female. At 5 weeks and 10 weeks, the growth of tibia showed different patterns in male and female chickens of KO and WL. The lengths of male tibia were longer in WL chickens at these ages but the length of female tibia was longer than that of male chickens in KO at 5 weeks. At 24 weeks, the growth of tibia was higher in both male and female chickens of WL than those of KO chickens. In addition, the average growth pattern of tibia was

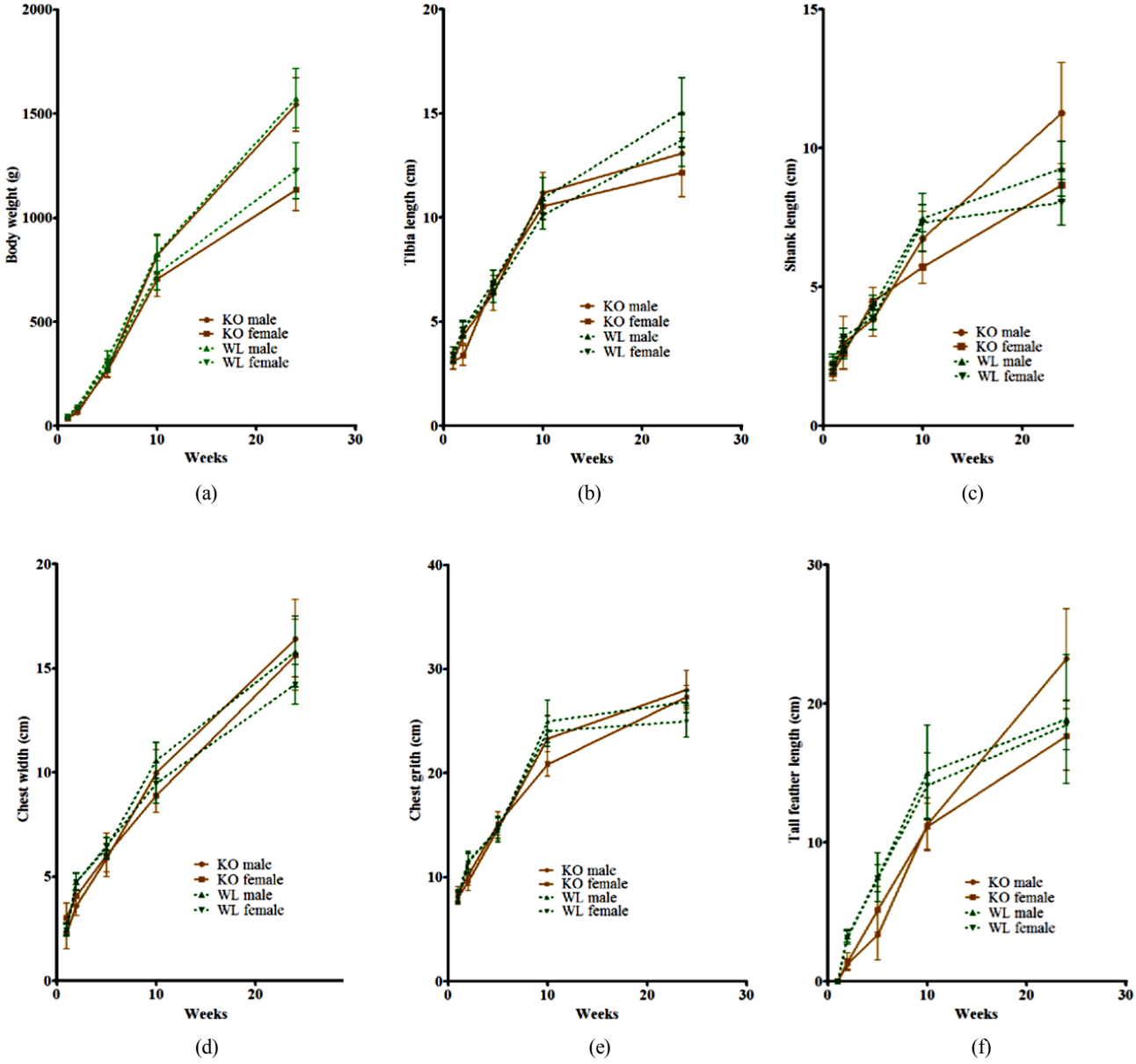

Fig. 1. Comparative growth pattern on (a) body weight, (b) tibia length, (c) shank length, (d) chest width, (e) chest grith, (f) tail feather length of KO and WL chickens at 1 week, 2 weeks, 5 weeks, 10 weeks, and 24 weeks. Bar, standard deviation (SD).

observed higher in KO and WL males when compared to their female partners at all age groups (Table 1 and Fig. 1b).

3. Comparison of Shank Length between KO and WL Chickens

The lengths of shank in male and female chickens of KO and WL were observed from 1 week to 24 weeks of ages. The shank growth showed interestingly different patterns at all age groups of KO and WL chickens. At 1 week, the lengths of shank were 0.26 cm and 0.31 cm longer in male and female chickens of WL, respectively than those in KO male and female chickens. At 2 weeks, the length of shank was longer in KO males than that of WL males but WL females were longer than KO females. Reversely, at 5 weeks, the length of shank was longer in WL males than that of KO males and KO females were longer than WL females. At 10 weeks, the lengths of shank were 0.73 cm and 1.6 cm longer in male and female WL chickens, respectively compared to those in KO male and female. The lengths of shank showed longer in KO chickens compared to WL chickens in both male and female at 24 weeks. The lengths of shank were observed 2.0 cm and 0.62 cm longer in male and female KO chickens when compared to WL chickens but the difference in shank length was not statistically significant (Table 1 and Fig. 1c).

4. Comparison of Chest Width in KO and WL Chickens

The width of chest in male and female chickens of KO and WL were observed from 1 week to 24 weeks of ages. At 1 week, the width of chest was 0.21 cm higher in WL males compared to KO males and 0.61 cm higher in KO females compared to WL females. From 2 weeks to 10 weeks, the widths of chest were continuously observed higher in male and female chickens of WL breed compared with their counterparts in KO breed. However, there was not much significantly different at 10 weeks. In contrast, the chest width of KO chickens was observed remarkably higher in males and females when compared with their counterparts in WL breed at 24 weeks of age (Table 1 and Fig. 1d). Compared between male and female in KO breed, the width was shown higher in females from 1 week to 5 weeks, thereafter the width was shown higher in males. At the other hand, the width of male WL chickens was shown higher at 1 week, 2 weeks, 10 weeks, and 24 weeks.

5. Comparison of Chest Grith in KO and WL Chickens

The grith of chest in male and female chickens of KO and WL were observed from 1 week to 24 weeks of ages. At 1 week, the grith of chest was 0.17 cm higher in WL males compared to KO males and 0.38 cm higher in KO females compared to WL females. Thereafter, the growth performance of chest grith was different between KO and WL chickens. Particularly, the growth of chest grith was shown higher in male and female WL chickens at 2 weeks and 10 weeks compared to male and female KO chickens. In contrast, the growth of chest grith was shown higher in male and female KO chickens at 5 weeks and 24 weeks compared to male and female WL chickens (Table 1 and Fig. 1e). In addition, the length of chest grith grew more rapidly in KO females than KO males at 1 week to 5 weeks. From 10 weeks, the length of chest grith was longer in KO males than that of KO females.

6. Comparison of Tail Feather Length in KO and WL Chickens

The tail feather was not obviously grown enough for the measurement at first week of age in KO and WL chicks. Thus, we measured the tail feather length in male and female chickens of KO and WL from 2 weeks to 24 weeks of ages. The tail feathers continuously grew in KO and WL chickens from 2 weeks to 24 weeks. However, the tail feather length was shown longer in male and female WL chickens at 2 weeks, 5 weeks, and 10 weeks when compared with the male and female KO chickens of the same age. At 24 weeks, the length of tail feather was 4.33 cm longer in KO males compared to WL males and 0.78 cm longer in WL females compared to KO females (Table 1 and Fig. 1f). Furthermore, the tail feather length was observed longer in KO females than KO males at 2 weeks and 5 weeks. From 10 weeks, the tail feather length was observed longer in KO males than KO females. In WL chickens, the tail feather length was continuously longer in males than females at 2 weeks to 24 weeks.

DISCUSSION

Korean Oge (KO) is one of the important indigenous avian species in Korea. KO was announced as a protected avian species under the Korean government (Protected Species Act No. 265) (Nahm, 1997). The general characteristics, morphology, anatomy and breeding behaviors of KO chickens were briefly reported early. The native KO chickens are commonly known as black chickens because of its external appearances including blackish color of the beak, eyes, face, earlobes, wattle, tongue, shank, toes, feathers, skin and bones (Nahm, 1997). The egg color is brown, and the average egg production rate is about 100 eggs annually (Ohh, 1989; Nahm, 1997). KO chickens shares some of the characteristic features with the native chickens from neighboring countries of Korea (Lee et al., 2007). KO chickens are nervous and easily frightened by mankind disturbances. During the brooding period, KO chickens are very sensitive to inappropriate environmental conditions, inadequate ventilation and poor protection from diseases, but their ability to adjust to environmental changes increases with age (Ohh, 1989). There were few studies on the growth performances of KO chickens in 1980s, particularly they concentrated on the body weight, meat and egg production (Han et al., 1988). However, studies on the characteristic and morphological features of KO chickens after 1980s remain to be investigated. Therefore, in this study, we concentrated on several growth performances such as body weight, tibia length, shank length, chest width, chest grith, and tail feather length of male and female KO chickens aged from 1 week to 24 weeks. We compared all these growth performances with the male and female chickens of WL chickens at the same age groups. We found many differences between our results and earlier publications on body weight and other growth performances and this discrepancy was caused from environmental changes and differences in the experimental trails.

Comparative analysis on the growth performances between KO and WL chickens performed in this investigation shows many significant differences on body weight, tibia and shank lengths, chest width and girth, and tail feather length. All analyzed parameters were continuously increased in KO and WL chickens according to their ages and growth, however they also showed different patterns; KO males vs. WL males, KO females vs. WL females, KO males vs. KO females, and WL males vs. WL females. Many quantitative trait loci (QTL), growth hormones or factors were closely associated with various growth performances in chickens. In the body weight, significant difference was shown in WL males at 1 week, 2 weeks, and 24 weeks, and in both WL males and females at 5 weeks to 10 weeks compared with corresponding KO chickens. QTL on chromosome 2 and 4 are very strong candidate for body growth (Rowe et al., 2006; Ankra-Badu et al., 2010). However, in a recent study, Insulin-like growth factor 1 is an essential growth factor required for rapid postnatal growth. Insulin-like growth factor 1 associated genes such as *SPOT14* homolog also plays an important role on body weight (Cao et al., 2007; Marquez et al., 2010). Chickens feed with carbohydrate or insulin injections greatly increase *SPOT14* mRNA expression. Additionally, POU domain, class 1, transcription factor 1 (*PIT1*, growth hormone factor 1) gene polymorphisms was found related to chicken body growth (Nie et al., 2008). Thus, molecular and endocrine focus is needed to predict which factor is inducing the significant growth in WL chickens.

Examination of growth performances on tibia length and shank length helps for the selection of breeds and studies on bone development in chickens (Gao et al., 2011). The overall length of tibia was measured longer in WL females at 1 week, WL males at 2 weeks, 5 weeks and 24 weeks, and KO males at 10 weeks. Similarly, the overall length of shank was measured longer in WL males at 1 week and 10 weeks, WL females at 2 weeks, KO females at 5 weeks, and KO males at 24 weeks. Different QTL which located on chicken chromosomes 1, 4 and 24 were responsible for shank growth at different ages (Tsudzuki et al., 2007; Gao et al., 2010). Particularly, In total, 14 single nucleotide polymorphism (SNP) were found on chromosome 1 for 12 on bone traits, and the retinoblastoma 1 (*RB1*) gene has strong relation with bone traits (Zhang et al., 2011). Examination of growth performances on chest width and chest grith helps for the understanding and selection of breeds for the meat production and weight. The overall look on chest width and grith suggest similar growth pattern rendered in KO and WL at the observed ages. The QTL for breast muscle were identified in chicken

chromosome 1 (Park et al., 2006). At last, we examined the comparative length of tail feather in KO and WL chickens. The length of tail feather was significantly longer in WL chickens up to 10 weeks, but the feather length became longer in KO male chickens at 24 weeks. The feather development is one of the secondary sexual characteristics influenced by steroid hormones and thyroxin hormone (Harenberg, 2003). Nutrient supply further add as necessary factor for feather growth (Zhang et al., 2002).

In conclusion, we compared various growth performances between the native KO chickens and widely known WL chickens. The overall findings of our study suggest that 1) body weight was higher in WL chickens, 2) tibia length was longer in WL chickens, 3) chest width and grith were longer in KO chickens and 4) tail feather was longer in KO chickens. Our study will largely help for the selection of breeds at different age groups in accordance with growth and meat production.

ACKNOWLEDGEMENTS

This research was supported by a grant from World Class University program (WCU, R31-10056) through the National Research Foundation of Korea funded by the Ministry of Education, Science and Technology, and also supported by a grant from Regional Subgenebank Support Program of Rural Development Administration, Republic of Korea.

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(received: 2012. 3. 7, revised: 2012. 6. 1, accepted: 2012. 6. 7)