# Associations between Feed Efficiency, Body Growth and Serum Insulin-like Growth Factor-I Level for Korean Native Ogol Chickens

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**ABSTRACT :** Increasing of body weight has been one of the important economic factors in the poultry industry. Insulin-like growth factor (IGF)-I is a polypeptide that serves to regulate muscle development and body growth. Moreover, IGF-I is related to feed efficiency. However, there are few studies regarding the regulatory roles of chicken IGF-I/-II compared with that of mammals. Especially, the Korean Native Ogol Chicken (KNOC) has a lean body growth and its body weight is generally lighter than the broiler chicken. Therefore, this study was conducted to investigate associations among serum IGF-I/-II concentration, feed efficiency, and body growth in KNOC. The body weight and feed intake of KNOC were recorded from 20 to 36 weeks at 2 weeks intervals, and blood was taken every 2 weeks. Serum IGF-I/-II were measured by RIA. Chickens were divided into two groups, high and low serum IGF-I concentration. Generally, feed efficiency and growth performance (body weight and weight gain) in the high serum IGF-I group were higher than those of the low group during the experimental period. In particular, the body weight of the IGF-I high group were significantly different from those of the IGF-I low group at 34 and 36 weeks, respectively ($p<0.05$). Moreover, body weight, weight gain, and feed efficiency had a significant correlation with serum IGF-I at several weeks ($p<0.05$ and $p<0.01$). These results show that IGF-I plays an important role in body growth and suggests a possibility that serum IGF-I could be used as a selection marker for body growth in KNOC. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 4 : 532-537)***

**Key Words :** IGF-I, IGF-II, Body Growth, Feed Efficiency, Korean Native Ogol Chicken

## INTRODUCTION

Korean Native Ogol Chicken (KNOC) is a protected species by the Korean government (Protected Species Act No. 265), which is a dual purpose (egg and meat) chicken with lean body growth. The body weight of KNOC is generally lighter than that of broiler chicken.

Body growth has been one of the most important economic traits in the domestic animal industry and is regulated by many factors including endocrine factors. Consequently, many endocrinological studies have been conducted to improve body growth in many species (Oudin et al., 1998; Auchtung et al., 2001; Seo et al., 2001; Yoon et al., 2001; Lee et al., 2002; Yun et al., 2003a). In particular, growth factors, such as insulin-like growth factor (IGF)-I have been shown to stimulate body growth in mammals (Bass et al., 1999; Ohlsson et al., 2000). However, there are few studies regarding the regulatory roles of chicken IGFs in body growth.

Chicken IGF-I is a 7 kDa nonglycoprotein composed of 70 amino acids. Although there is a structural similarity between mammalian and avian IGF-I (Ballard et al., 1990), some unique differences have been reported. For example, free form of IGF-I is more present in chickens and biological responses to IGFs are different in several metabolic pathways (McMurtry et al., 1997; Duclos et al., 1999). Moreover, several reports suggested that IGF-I expression in the chicken muscle could be largely independent of growth hormone, contrary to mammals (Rosselot et al., 1995; Tanaka et al., 1996). Generally, mammalian IGF-I mediates growth hormone action (Rotwein, 1991) and regulates cellular proliferation and differentiation by endocrine as well as auto/paracrine manners in many species (Jones and Clemmons, 1995; Simmen et al., 1998; Liu and LeRoith, 1999).

Similarly, avian IGFs play important roles in the uptake of amino acid and glucose, muscle protein synthesis, feed efficiency, and posthatch development (Kocamis et al., 1998; Buyse and Decuypere, 1999; Colon and Kita, 2002). There were reports regarding a negative correlation between chicken IGF-I and body growth (Pym et al., 1991; Bacon et al., 1993). In addition, Huybrechts et al. (1992) reported that IGF-I did not appear to stimulate growth rate. However, recent studies have shown that circulating IGF-I concentrations have a positive correlation with muscle growth rate and decreased fatness (Guernec et al., 2003; Tesseraud et al., 2003; Yun et al., 2003b)

Collectively, due to such contradictory findings, studies are required to clarify regulatory roles of IGF-I in avian growth physiology. Therefore, this study was conducted to elucidate the association among serum IGF-I/-II concentration, body growth, and feed efficiency, and to investigate the possibility of improving both body weight and feed efficiency by serum IGF-I concentration in KNOC.

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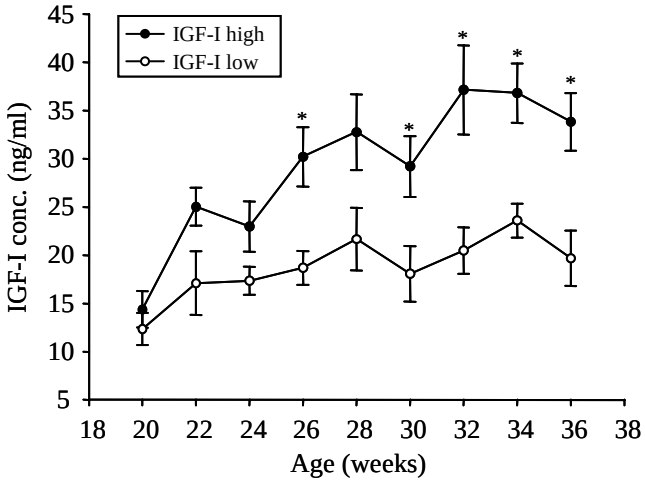


**Figure 1.** Comparison of serum IGF-I concentrations between high and low IGF-I expression groups. Values are the mean±SE. Means with different superscripts differ significantly ($p<0.05$).

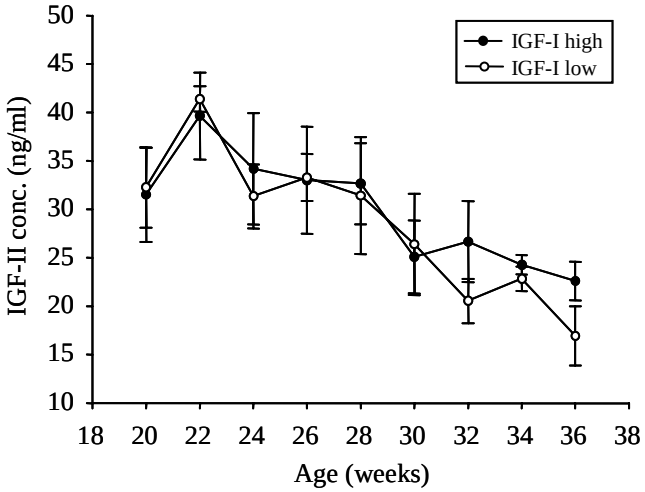


**Figure 2.** Comparison of serum IGF-II concentrations between high and low IGF-I expression groups. Values are the mean±SE.

## MATERIALS AND METHODS

### Animals

KNOCs were purchased from Korean Native Ogol Chicken Breeding Farms (Yeonsan, Korea). After acclimation, they were raised at the Sahmyook University Animal Breeding Center. A total of 50 female KNOC were kept in individual cages (40 cm high, 25 cm wide and 35 cm deep), and fed a commercial boiler diet (Kang et al., 2003). The body weight and feed intake of KNOC were recorded biweekly and blood was taken from the wing vein from 20 to 36 wks every 2 wks. Serum was made according to the standardized procedure.

### Selection for experimental groups

KNOCs were divided into high and low groups based on serum IGF-I concentrations at the age of 36 weeks. Selection between high (>28.3 ng/ml, n=10) and low (<17.9 ng/ml, n=10) groups was made as 20% in both the upper and lower classes, respectively.

### IGF Radioimmunoassay (RIA)

Recombinant human IGF-I/-II (GroPep, Pty Ltd., North Adelaide, Australia) were iodinated by the chloramine-T method (Lee and Henricks, 1990). The concentrations of serum chicken IGF-I/-II were measured by heterologous RIA (Radecki et al., 1997) with minor modifications, using anti-human IGF-I and anti-mouse IGF-II antiserum (GroPep, Pty Ltd.). The intra and inter assay variations of IGF-I were 7.6 and 13.2%, and IGF-II assay had an intra assay variation of 8.3% and inter assay variation of 14.8%.

### Feed efficiency

Feed intake and feed efficiency were measured by standardized methods from 20 to 36 wks every 2 wks.

### Statistical analysis

Data were statistically analyzed using the Duncan method of one-way ANOVA and the Pearson's correlation coefficients procedure in SAS (SAS Inst. Inc., Cary, North Carolina, USA)

## RESULTS

### Serum IGF-I/-II concentrations

The changes in serum IGF-I/-II concentrations of the selected group during 20-36 wk are shown in Figure 1 and 2. In general, serum IGF-I concentrations progressively increased with age in both high and low IGF-I groups, and maximum serum IGF-I concentrations were observed at 32 wks and 34 wks, respectively. The concentrations of serum IGF-I in the high group were higher than those in the low group during the experimental period. Especially, serum IGF-I concentrations were significantly different between high and low groups at 26, 30, 32, 34 and 36 wks (Figure 1).

Compared to the IGF-I profile, a much different profile of serum IGF-II expression was obtained in KNOC (Figure 2). Generally, IGF-II concentrations progressively decreased with age of KNOC, and maximal serum IGF-II concentrations were detected at 22 wk in both groups. However, any significant differences between two groups were not observed.

### Comparison of growth performance

A possible effect of serum IGF-I concentration on body weight was investigated by comparing body weights and weight gain between the high and low IGF-I expression groups (Figures 3 and 4).

Body weight increased with age both the high and low groups, showing a higher body weight in the IGF-I high group than that in IGF-I low group. In particular, significant differences between two groups was found at 34 and 36 wks,

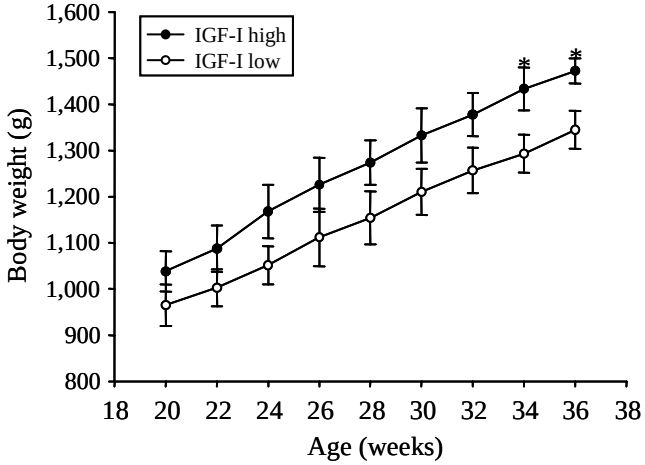


**Figure 3.** Comparison of body weight between high and low IGF-I expression groups. Values are the mean±SE. Means with different superscripts differ significantly ($p<0.05$).

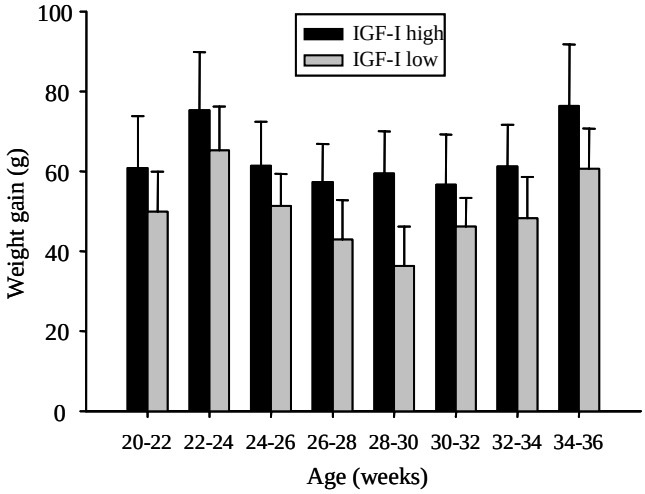


**Figure 4.** Comparison of weight gain between high and low IGF-I expression groups. Values are the mean±SE.

respectively ($p<0.05$, Figure 3).

A comparison study on weight gain in both groups revealed no significant difference, but the serum IGF-I high group tended to show higher weight gain than the low group (Figure 4).

**Comparison of feed efficiency**

In order to investigate whether a link between IGF-I concentration and feed efficiency exists, two groups were compared with respect to serum IGF-I and feed efficiency.

Similarly to a weight gain pattern, a significant difference was not found and the IGF-I high group tended to show higher feed efficiency than the IGF-I low group (Figure 5).

**Correlation coefficient of serum IGF-I/-II with feed efficiency, weight gain, and body weight**

Table 1 shows the correlation coefficients of serum IGF-I with feed efficiency, weight gain, and body weight. The both body weight and feed efficiency generally showed positive correlation with serum IGF-I, particularly at 24 and 34 wks ($p<0.05$). Moreover, a highly significant correlation between serum IGF-I and feed efficiency, including weight gain, was observed at 30 wks ($p<0.01$). In addition, weight gain and body weight also showed positive correlation with serum IGF-I at 22, 24 and 32 wks, respectively ($p<0.05$).

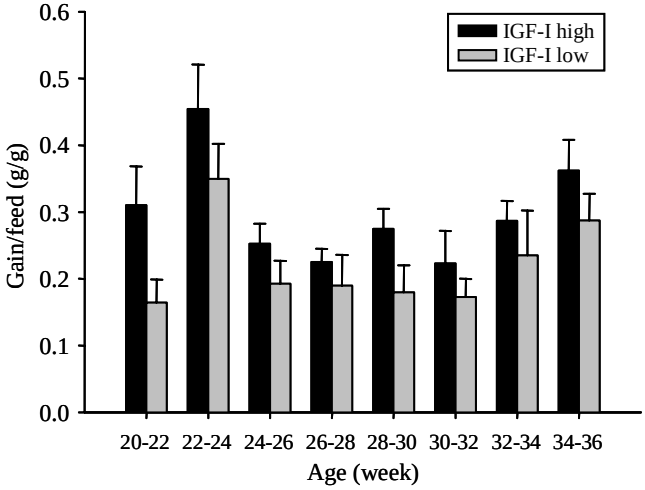


**Figure 5.** Comparison of feed efficiency between high and low IGF-I expression groups. Values are the mean±SE.

On the contrary, serum IGF-II did not show any significant correlation with body growth parameters except at 22 wk (Table 2).

## DISCUSSION

Body growth of domestic animals is regulated by the coordinated actions of nutritional, genetic, environmental and endocrine factors (Etherton and Kensinger, 1984). Among the several endocrine factors, IGF-I in particular is generally known to be an important regulator of muscle development in a number of species (Bass et al., 1999; Yun et al., 2003a). For unclear reason in chickens, IGF-I is not always accompanied by enhanced body growth. For instance, administration of IGF-I has been reported to have no apparent effect on growth rate (McGuinness and Cogburn, 1991; Huybrchts et al., 1992; Czerwinski et al., 1998). Similarly, Mitchell and Burke (1995) reported no clear relationships between growth and plasma IGF-I concentrations. However, different results have also been claimed, reporting that IGF-I treatment consistently has been associated with an increased growth rate (Kocamis et al., 1998; Tomas et al., 1998; Colon and Kita, 2002). These indicate that the relationships between IGF-I and body growth is not apparent in poultry. Therefore, the present study analyzed the concentrations of IGF-I/-II, feed efficiency, and body growth to clarify the roles of IGF-I in

**Table 1.** Correlation coefficients of serum IGF-I concentration with feed efficiency and body weight in KNOC

| | IGF-I concentration | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 20 w | 22 w | 24 w | 26 w | 28 w | 30 w | 32 w | 34 w | 36 w |
| Feed efficiency | - | 0.393 | 0.601** | -0.049 | 0.507* | 0.624** | 0.083 | 0.561* | 0.383 |
| Weight gain | - | 0.428* | 0.142 | -0.034 | 0.473* | 0.535** | 0.099 | 0.227 | 0.306 |
| Body weight | 0.267 | 0.295 | 0.418* | 0.136 | 0.242 | 0.101 | 0.463* | 0.441* | 0.256 |

* p<0.05, **<0.01.

**Table 2.** Correlation coefficients of serum IGF-II concentration with feed efficiency and body weight in KNOC

| | IGF-II concentration | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 20 w | 22 w | 24 w | 26 w | 28 w | 30 w | 32 w | 34 w | 36 w |
| Feed efficiency | - | -0.550 | 0.398 | 0.258 | 0.181 | .371 | 0.286 | 0.159 | 0.062 |
| Weight gain | - | -0.174 | 0.360 | 0.318 | 0.082 | .278 | -0.038 | 0.044 | -0.043 |
| Body weight | -0.099 | 0.548* | 0.293 | 0.427 | 0.204 | .067 | 0.375 | 0.056 | 0.149 |

* p<0.05.

body growth of KNOC as a model and to furthermore investigate the possibility that serum IGF-I concentration could be used as a selection marker for body growth in chicken.

The concentrations of serum IGF-I in the IGF-I high group were higher than those in the low group, especially at 26, 30, 32, 34 and 36 wks (p<0.05, Figure 1). Similar profiles on feed efficiency (Figure 4), body weight, and weight gain (Table 1) were also obtained.

Although IGF-I treatment did not affect chicken growth rate and feed consumption (McGuinness and Cogburn, 1991; Czerwinski et al., 1998), the results in the present study are consistent with other reports that IGF-I stimulates posthatching muscle development in chickens (Colon and Kita, 2002; Guernec et al., 2003) and that IGF-I treatment promotes lean growth and feed utilization efficiency in broiler chickens (Kocamis et al., 1998; Tomas et al., 1998). Moreover, serum concentration of IGF-I in chickens selected for high growth rate was higher than that in chickens selected for low growth rate (Beccavin et al., 2001). These reports indicate that serum IGF-I controls the body growth, suggesting that they may stimulate chicken feed efficiency and body weight. In pigs, a positive correlation between serum IGF-I concentrations and body growth has been demonstrated (Yun et al., 2003a).

Contradictory arguments on the roles of IGF-I in weight gain were also published. Infusion of IGF-I and growth hormone did not produce differences in weight gain and feed intake (Huybrechts et al., 1992; Vasilatos-Younken et al., 1999) but, others (Kita et al., 2002; Tesseraud et al., 2003) along with the present study (Figure 4, Table 1) pointed toward a positive relationship between IGF-I expression and weight gain.

Spencer et al. (1996) and Tomas et al. (1998) have observed that administration of IGF-II did not affect feed efficiency and body growth in chickens, implying no involvement of IGF-II in feed efficiency and body growth. The present study also shows that serum IGF-II is not correlated with feed efficiency, weight gain, or body weight (Table 2). Moreover, serum IGF-II concentration between the IGF-I high and low groups were not significantly different (Figure 2). However, serum IGF-II concentration at 22 wk was positively correlated to body weight (0.548, p<0.05, Table 2). Similarly, maximal concentration of serum IGF-II was also detected at 22 wk. Like these results, Beccavin et al. (2001) have reported that IGF-II mRNA level showed a similar trend with nutritional state. Moreover, Decuypere et al. (1993) suggested that the plasma IGF-II level was related with body weight in chickens, indicating that the serum IGF-II concentration may not directly affect feed efficiency but rather indirectly affect body weight in KNOC.

In conclusion, the body weight, weight gain, and feed efficiency in the serum IGF-I high group were higher than those in the serum IGF-I low group during the experimental period. Moreover, significantly positive correlations of serum IGF-I concentration with body weight, weight gain, and feed efficiency were observed, suggesting that IGF-I directly promotes not only feed efficiency but also weight gain, resulting in increased body growth of KNOC. Collectively, this study shows that serum IGF-I plays an important role in the improvement of body growth and suggests a possibility that serum IGF-I could be used as a selection marker for body growth in KNOC.

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