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Comparative study of intestine length, weight and digestibility on different body weight chickens

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This experiment was conducted to compare the difference of digestibility on different body weight chickens. Twenty-seven (27) 58-week-old New Yangzhou Chickens of three grade sizes (small 2.0 kg, medium 2.5 kg, and large 3.0 kg) were selected and distributed into three groups (Groups 1 to 3) of nine birds/group, and each group was represented by three replicates. Nutrient retention ratio was determined by adopting whole gather excretion method. In the end of metabolism experiment, all the birds were killed, and the intestine length and intestine weight were measured. Results show that, the amount of feed intake and excretion increased along with body weight gain; the feed intake and excretion in group 3 were significantly higher than that in group 1 (*P* < 0.05). The sidelong lengths in the three groups were evidently different. Although, the intestinal length as well as the length of the jejunum, ileum and rectum appeared to be gradually improved with the body weight increase, there were no significant differences among the three groups (*P* > 0.05). The weightier the intestines, the more was body weight of the birds. The retention ratio of energy, crude fiber and neutral detergent fiber increased with body weight gain, but the differences were not significant (*P* > 0.05). It was concluded that there was no correlation between body weight and digestibility.

Key words: Digestibility, body weight, cock.

INTRODUCTION

Digestion is essentially a process in which proteins, fats, and carbohydrates combine with water and are then split into simpler compounds which may be absorbed. It has been generally accepted that the digestibility of poultry is affected by factors such as breed, feedstuff, bird health, feed manner, and so on. There are distinct differences in digestibility of dietary fibre and amino acids in different groups of poultries (Jamroz et al., 2001). For example, amino acid digestibility in broilers and Pekin ducks are different (Kluth and Rodehutscord, 2006). Varying dietary protein levels can influence amino acid digestibility at different sites of fistulized chicken intestines (Kamisoyama et al., 2010). Even the same wheat, one with waxy wheat and another with non-waxy, has different feed conversion ratio in chickens (Pirgozliev et al., 2002). In addition, some grain crops including sorghum and cottonseeds depress protein digestibility and intestinal uptakes of dietary (Selle et al., 2010). Feeding slowly digestible starch can improve protein and energy utilization in broiler chickens (Weurding et al., 2003).

Many researchers have indicated correlation of body weight (BW) with other parameters (Watanabe, 1975; Van Wambeke et al., 1979). All the stomach parameters including the proven triculus length, width and weight, gizzard length, width and weight are highly correlated with body weight (Mobini, 2010). The co-localization of

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Table 1. Comparison of feed intake and amount of excreta among different groups.

Group	Body weight (kg)	Feed intake (g)	Amount of excreta (g)
1	2.05±0.05[a]	415.47±91.12[a]	155.28±35.98[a]
2	2.57±0.03[b]	507.84±77.75[ab]	187.76±23.71[ab]
3	3.09±0.06[c]	577.40±93.60[b]	207.82±14.06[b]

[a,b,c]Means within a row lacking a common superscript differ significantly (P < 0.05).

quantitative trait loci (QTL) for body weight, growth and sexual maturity suggests that body weight is closely related to the attainment of sexual maturity (Podisi et al., 2011). At the same time, BW is related to the number of normal yellow follicles at the onset of lay in a curvilinear (quadratic) manner (Hocking, 2004). In addition, body weight and egg weight show a positive genetic correlation (Siegel, 1962; Festing and Nordskog, 1967). Furthermore, a research conducted shows abdominal fat deposit in relation to body weight (Deaton et al., 1983). However, the relation between body weight and digestibility has not been reported. The objective of this study, therefore, was to assess the association between body weight and digestibility in New Yangzhou Chickens so as to provide reference material for studying the nutrition demands of poultry.

MATERIALS AND METHODS

Birds and management

In this experiment, twenty-seven (27) 58-week-old New Yangzhou cocks of three grade body weights (small, 2.0 kg; medium, 2.5 kg; and large 3.0 kg) were collected from the chicken breeding of New Yangzhou Chicken farm. Then these birds were divided into three groups (Group 1, Group 2, Group 3), with nine birds for each size group, and each group was represented by three replicates. The cocks were kept in a metabolizable cage (75 × 65 × 35 cm) with wire floors, equipped with individual feeders and self-drinking systems, and the datas were recorded singly. The nutrient level of the corn-soybean based diet used to feed the birds was: 11.30 MJ /kg metabolizable energy, 15% crude protein, 1.0% calcium, 0.45% available phosphorus, 0.32% methionine, 0.60% methionine + cystine, and 0.90% lysine. Water was freely available throughout the trial. The average air temperature and relative humidity were 25°C and 60% during the experimental period.

Experimental design

This experiment involved 5-day adaptation and 5-day collection period, and adopted whole gather excretion method. During the collection period, the feathers, dander, and scattered material were removed, then a small amount of 3% sulfuric acid was sprayed on the excreta so as to reserve nitrogen, and the excreta were collected into a bottle per day, dried to a constant weight at 60°C, allowed to reach equilibrium with the atmospheric moisture for 24 h, weighed, and ground to pass through a 40-mesh sieve, then stored at -20°C for further analysis. After that, all birds were killed by manual exsanguination, then the intermixture of intestine tract was squeezed, and the intestine length and intestine weight were measured. All animal handling protocols were approved by Yangzhou University Animal Care and Use Committee.

Chemical analyses

The gross energy contents of the experimental diets and the excretion were determined in duplicate using an adiabatic bomb calorimeter. Samples were analyzed for total N using the micro-Kjeldahl method (990.03, AOAC, 2000). Crude protein was calculated as N × 6.25. The crude fat contents were determined by the Suo' extraction (920.39, AOAC, 2000). Ashing of samples was performed at 550°C for 12 h. Crude fiber was measured by sequential extraction with diluted acid and alkali (962.09, AOAC, 2000). Acid-insoluble ash was analyzed using the technique described by Van Keulen and Young (1977) with modifications. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined sequentially as described by Van Soest et al. (1991) and expressed on an ash-free basis. The nutrient retention ratio was calculated using the following formula:

$$\text{Nutrient retention ratio} = \frac{(\text{feed intake} \times \text{nutrient diet} - \text{excreta output} \times \text{nutrient excreta})}{(\text{feed intake} \times \text{nutrient diet})} \times 100$$

Statistical analyses

All data were analyzed using a one-factor ANOVA (SPSS Inc., 2007). Differences among treatment means were compared by Duncan's multiple-range test. Statements of significance were based on P < 0.05 unless otherwise stated.

RESULTS

Feed intake and amount of excreta of different body weight cocks

The body weight was bigger, the feed intake and amount of excreta were more (Table 1). As a result, the amount of the feed intake and excreta in group 3 were the largest, and they were significantly higher than those in group1 (P < 0.05), furthermore the amount of feed intake and excreta in group 3 were more than those in group1 and group2, 38.98 and 33.84%, respectively.

The intestine length of different body weight cocks

The sidelong length and intestine length as well as the length of the jejunum, ileum and rectum appeared a gradually

Table 2. Comparison of the intestine length among different groups.

Group	Sidelong length of body (cm)	Intestine length (cm)	Duodenum length (cm)	Jejunum length (cm)	Ileum length (cm)	Rectum length (cm)
1	23.0±0.1[a]	133.76±17.58	28.05±5.30	50.90±6.25	49.03±6.57	5.78±0.84
2	25.2±0.2[b]	146.93±25.02	26.83±5.73	58.20±11.19	55.40±8.93	6.50±1.73
3	27.3±0.3[c]	155.76±18.54	28.08±3.06	61.00±6.21	59.55±10.33	7.13±1.34

[a,b]Means within a row lacking a common superscript differ significantly ($P < 0.05$).

Table 3. Comparison of the intestine weight among different groups.

Group	Duodenum weight (g)	Jejunum weight (g)	Ileum weight (g)	Cecum weight (g)	Rectum weight (g)
1	5.14±0.53[a]	8.35±0.82[a]	6.69±0.50[a]	4.24±0.10[a]	1.79±0.20[a]
2	5.94±1.13[a]	10.36±1.00[b]	8.46±1.93[ab]	4.82±0.19[b]	1.98±0.73[ab]
3	6.41±0.44[b]	11.72±1.00[b]	10.64±1.38[b]	5.33±0.57[b]	2.72±0.48[b]

[a,b]Means within a row lacking a common superscript differ significantly ($P < 0.05$).

Table 4. The nutrient retention ratio of feedstuff in different groups.

Project	Group 1	Group 2	Group 3
Energy (%)	72.48±1.44	73.22±1.69	74.21±0.70
Crude protein (%)	63.17±3.69	62.89±4.29	64.30±3.32
Crude fat (%)	75.53±7.45	77.48±6.65	72.84±8.27
Crude fiber (%)	2.38±0.46	3.12±2.07	4.14±2.20
Acid detergent fiber (%)	30.63±9.49	24.17±6.99	30.65±8.13
Neutral detergent fiber (%)	10.58±2.12	13.26±2.60	15.12±3.08

improving with the body weight increasing (Table 2). The sidelong length in group 3 was significantly more than that in group 2 ($P < 0.05$), and group 2 was evidently more than group 1 ($P < 0.05$). However, the length of intestine and there into every segment from different groups expressed no significant difference ($P > 0.05$).

The intestine weight of different body weight cocks

The weight of the intestine increased with body weight growing (Table 3). The duodenum weight in group 3 was significantly more than those in group 1 and group 2 ($P < 0.05$). The jejunum weight and cecum weight in groups 2 and 3 were significantly more than those in group 1 ($P < 0.05$). The weights of ileum and rectum in group 1 were significantly less than those in group 3 ($P < 0.05$).

Feedstuff digestibility of different body weight cocks

The nutrient retention ratio of energy, crude fiber and neutral detergent fiber increased with body weight increase, but there were no significant difference among the three groups ($P > 0.05$) (Table 4). At the same time, the nutrient retention ratio of crude protein, crude fat and acid detergent fiber were not significantly different too ($P > 0.05$).

DISCUSSION

The tests showed that the retention ratio of energy, crude fiber and neutral detergent fiber was not significant different among the three body weight groups (Table 3). That is to say, the digestibility was not related with BW of the grown chicken; therefore, the thought that the more the BW, the better the digestibility was not right. We all knew that most of the absorption of the products of digestion took place in the small intestine.

Moreover, the small intestine was structurally adapted for absorption; its lumen was literally lined with small fingerlike projections called villi. Each villus had a lymph capillary and a close network of blood capillaries. The large intestine was very short and mainly absorbed partial water. So it was easy to find that most of the feedstuff was digested and absorbed in the small intestine. On the other hand, digestibility was influenced by many factors such as grain size, hardness, solubility, enzyme activity, and so on. The enzyme activity per mass of intestine was closely correlated with the number of enterocytes per villus in all regions of the intestine (Uni et al., 1999). These highly significant correlations suggested that mucosal enzyme activity played a rate determining role. In addition, chime was determined by the kinds of feedstuff and intestine length. In this experiment, all the testing birds were fed the same feedstuff, the enzyme activities were the same too, and the intestine length was equal (Table 2). As a result, there was no significant difference in nutrient retention ratio among the different body weight birds. The villi had the function of providing a vastly increased surface area for the more efficient absorption of the nutrients. The efficiency of the absorption was influenced by the surface area available for the nutrients to move through; the more villi the better the absorption.

In a general way, the enzyme activities increasing with age were very highly correlated with BW (Uni et al., 1999). In other words, small intestinal mass increased parallel to nutrient intakes in early life in chicks, then a progressive increase both in absorptive area and in the mucosal capacity for hydrolysis in the poultry in early life. After that, in the grown period, the regional activity no longer exhibited the apparent increased and decreased in activity indicated by the determinations per unit mass and was related to the digestive capacity in the specific intestinal region. In the experiment, the intestinal length was equal by and large, and the digestibility was unanimous on the whole. So it was easy to find that the reason of the bigger BW was that the feed intake was more (Table 1).

Digestibility of different nutrient component was dissimilar, the digestibility of energy and crude fat were the most, followed by crude protein, acid detergent fiber, and neutral detergent fiber, but the digestibility of crude fiber was the least. Previous studies in chicks indicated that protein digestion was lower than fatty acid and carbohydrate digestion at 4 days of age (Noy and Sklan, 1995). Both the experiment results were consilient.

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REFERENCES

AOAC (2000). Official Methods of Analysis. 15th ed. Association of Official Analytical Chemists. Arlington, USA.
Deaton JW, McNaughton JL, Lott BD (1983). The effect of dietary energy level and broiler body weight on abdominal fat. Poult. Sci. 62:2394-2397.
Festing MF, Nordskog AW (1967). Response to selection for body weight and egg weight in chickens. Genetics. 55:219-231.
Hocking PM (2004). Roles of body weight and feed intake in ovarian follicular dynamic in broiler breeders at the onset of lay and after a forced molt. Poult. Sci. 83:2044-2050.
Jamroz D, Jakobsen K, Orda J, Skorupinska J, Wiliczkiewicz A (2001). Development of the gastrointestinal tract and digestibility of dietary fibre and amino acids in young chickens, ducks and geese fed diets with high amounts of barley. Comp. Biochem. Phys. A. 130A:643-652.
Kamisoyama H, Honda K, Kubo S, Hasegawa S (2010). Effects of dietary protein levels on amino acid digestibility at different sites of male adult chicken intestines. J. Poult. Sci. 47: 220-226.
Kluth H, Rodehutscord M (2006). Comparison of amino acid digestibility in broiler chickens, turkeys, and Pekin ducks, Poult. Sci. 85:1953-1960.
Mobini B (2010). Relationship of characteristics of the proventriculus and gizzard with body weight in the Ross broiler chicken. J. Appl. Anim. Res. 38:271-272.
Noy Y, Sklan D (1995). Digestion and absorption in the young chick. Poult. Sci. 74:366-373.
Pirgozliev VR, Rose SP, Graybosch RA (2002). Energy and amino acid availability to chickens of waxy wheat. Archiv fuer Gefluegelkunde. 66:108-113.
Podisi BK, Knott SA, Dunn, IC, Law AS, Burt DW, Hocking, PM (2011). Overlap of quantitative trait loci for early growth rate, and for body weight and age at onset of sexual maturity in chickens. Reproduction. 3:381-389.
Selle PH, Cadogan DJ , Li X , Bryden WL (2010). Implications of sorghum in broiler chicken nutrition. Anim. Feed. Sci. Tech. 156:57-74
Siegel PB (1962). Selection for body weight at eight weeks of age. 1. Short term responses and heritabilities. Poult. Sci. 41:954-962.
Uni Z, Noy Y, Sklan D (1999). Posthatch development of small intestinal function in the poult. Poult. Sci. 78:215-222.
Van Keulen J, Young BA (1977). Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. J. Anim. Sci. 44:282-287.
Van Soest PJ, Robertson JB, Lewis A (1991). Methods for dietary fiber, neutral detergent fiber, and nonstarch poly-saccharides in relation to animal nutrition. J. Dairy. Sci. 74:3583-3597.
Van Wambeke F, Moermans R, De Groote G (1979). Early body-weight selection of broiler breeder males in relation to reproductive and growth performance of their offspring. Bri. Poult. Sci. 20:565-570.
Watanabe IS (1975). Comparative logarithmic studies on the relation between body weight and brain mass in birds. Rev. Bras. Pes medic. Biol. 8:29-31.
Weurding RE, Enting H, Verstegen MW (2003). The relation between starch digestion rate and amino acid level for broiler chickens. Poult. Sci. 82:279-284.