Voluntary Intake of Insoluble Granite-grit Offered in Free Choice by Broilers: Its Effect on Their Digestive Tract Traits and Performances

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ABSTRACT : In this study, the effects of granite-grit offered free-choice on voluntary intakes of grit and subsequently on some morphologic traits of the digestive tract and performance of broilers were investigated. A total of 240 7d-old male broiler chicks (Ross 308) were allotted randomly to 10 floor pens supplied with wood shavings. The experiment lasted for 42 days. There were 2 dietary treatments, each consisting of 5 replicates. Each replicate consisted of 24 birds kept in an experimental unit with a floor size of 2×2 m. Dietary treatments consisted of control (C) in which broilers were fed standard broiler rations, and acid insoluble granite-grit choice (AIGG) in which broilers were fed standard broiler rations and grit in separate troughs. Mean amounts consumed varied quite widely from week to week, but on average broilers ate 3.41 g per d per bird during the experimental period. Birds had a higher voluntary intake of granite-grit at an early age (7 to 21 d of age) than later (22 to 42 d of age). The voluntary intake of granite-grit of AIGG broilers increased ($p<0.05$) from 2.7 g/day at 7-14 d to 4.4 g at 15-21 d of age, and then it decreased to 3.4, 3.2 and 3.4 g/day between 22-28, 29-35 and 36-42 d of age, respectively. This level of grit intake increased ($p<0.05$) weights of empty gizzard (0.97 vs. 1.30 g), edible inner organs (3.51 vs. 3.69 g), and length of gut (8.86 vs. 9.01 cm) as a proportion of body weight and the content of insoluble ash (8.4 vs. 42.2 g/kg) in the faeces compared to the control group. Feeding free-choice grit had little or no effect on final live weights (2,542 vs. 2,543 g), daily gains (69 vs. 69 g), carcass weights (1,924 vs. 1,911), dressing percentages (75.6% vs. 75.1%) and feed efficiencies (1.69 vs. 1.66). Birds given grit did not gain more weight than those not given grit but they tended to have ($p<0.07$) lower feed intake (116.7 vs. 114.5 g), and consequently lower protein and energy intake. In conclusion, the granite-grit consumed voluntarily by broilers increased gut length and empty gizzard weight without affecting growth performance of broilers. Thus, it can be assumed that the voluntary consumption of granite-grit was too low to affect performance. ***(Asian-Aust. J. Anim. Sci. 2006. Vol 19, No. 4 : 549-553)***

Key Words : Poultry, Choice Feeding, Grit Preference, Gizzard Development

INTRODUCTION

Grit, a kind of angular and hard crushed rock preferentially derived from granite, is used by the birds in place of "teeth" and hence enhances the mechanical digestion by gizzard. For this reason, it is important in poultry nutrition when higher fibre diets were used. Today, poultry are generally fed a easily digestible mash or pelleted diet. These diets improve performance of birds but also cause their digestive systems to grow lazy. Moreover, Hill (1971) reported that when birds fed mash diet, the transports of ingested nutrients through the gizzard to the intestine, which is translocation place rather than mill, were faster. The utilisation of the nutrients may adversely affect because feeds were not well mechanically digested and not mixed adequately with enzymes, and reached to intestine with higher pH (Rutrowski and Wiaz, 2001). Such a situation may cause stressful conditions for birds and thus allow locating unwanted microorganism population, such as E.coli (Cumming, 1994) and Coccidia (Cumming, 1992) in intestine causing some illnesses.

Long-term stress conditions, such as feed and feeding system in poultry (Lohakare et al., 2004) may be diminished by a scratch feed and choice feeding (Forbes, 1995; Plavnik et al., 2002). The effect of choice feeding, especially free choice feeding in terms of the concept of animal welfare is well established (Tauson and Elwinger, 1986; Olver and Jonker, 1997; Banfield and Forbes, 2001; Sahin et al., 2001; Plavnik et al., 2002; Erener et al., 2003). On the other hand, the grit is necessary if a scratch feed is used (Kermanshahi and Classen, 2001; Bennett et al., 2002b), since it is expected that the grit will help to grind the whole grains and will result in better utilization of the feedstuff by the bird.

Numerous studies have been conducted to evaluate the efficacy of both soluble and insoluble grit in avian diets (Takahashi, 1973; Masloboev and Gordienko 1974; Kriz et al., 1981; Lazar et al., 1984; Kriz, 1985; Taylor, 1996). Though previous studies revealed that the feeding insoluble grit in poultry are not critical for good performance in terms of growth rate and feed efficiency, growth and gizzard development was faster for chicks given grit. Recently, Jones and Taylor (1999) and Silva-Junior et al. (2003) have used insoluble granite-grit in broiler diet and found that there was no effect of using grit on the broiler performance, and granite-grit increased gizzard and proventriculus weight. Furthermore, these studies have not yielded any conclusive results. The effect of feeding granite-grit or other objects as digestive helpers rather than nutrients in free choice system on voluntary intake of these objects and subsequently

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Table 1. Ingredients and composition of the basal diet

Ingredients	Starter	Grower	Finisher
Maize (yellow)	355.5	330.4	256.8
Soybean meal (480 g CP/kg)	275.3	204.5	171.5
Sunflower meal (350 g CP/kg)	110.0	150.0	111.5
Wheat	99.0	130.0	330.0
Wheat bran	-	38.0	-
Meat-bone meal	64.4	56.0	49.2
Vegetable oil	73.7	85.0	73.6
Limestone	13.6	-	-
Premix[1]	3.5	3.5	3.1
Sodium chloride	3.0	2.5	2.5
L-lysine	0.4	-	0.1
DL-methionine	1.6	0.1	1.7
Total	1,000.0	1,000.0	1,000.0
Calculated chemical composition (per kg of diet)			
ME (kcal)	3,150.0	3,200.0	3,200.0
Crude protein (g)	231.2	212.0	189.8
Calcium (g)	15.0	9.0	8.0
Available phosphor (g)	5.0	4.7	3.9
Lysine (g)	12.0	10.0	8.5
Methionine (g)	5.6	4.0	5.2
Methionine+cystine (g)	9.3	7.6	8.4
Sodium chloride (g)	3.4	2.9	2.9

[1] Provides per kg of diet: Mn, 80 mg; Zn, 60 mg; Fe, 60 mg; Cu, 5 mg; Co, 0.2 mg; I, 1 mg; Se, 0.15 mg; choline chloride, 200 mg; vitamin A, 12,000 IU; vitamin D3, 2,400 IU; vitamin E, 50 mg; vitamin K3, 4 mg; vitamin B1, 3 mg; vitamin B2, 6 mg; niacin, 25 mg; calcium-D-pantothenate, 10 mg; vitamin B6, 5 mg; vitamin B12, 0.03 mg; D-biotin, 0.05 mg; folic acid, 1 mg.

growth performance in broilers has not been studied. Therefore, this study reported herein aimed to investigate the effect of granite-grit offered in free choice on voluntary intake of acid insoluble granite-grit and some morphologic traits of digestive tract and subsequently performance of broiler chickens.

MATERIALS AND METHODS

A total of 240 1-d-old male broiler chicks (Ross 308) were purchased from a commercial hatchery and fed standard broiler ration (CP: 230 g/kg, ME: 3,150 kcal/kg, as fed basis) for 7 days. All birds were wing-banded on d 7 and allotted randomly to 10 floor pens with wood shavings. The environmental conditions of experimental unit were as 33°C in room temperature declining by 3°C weekly until 21°C, 23 h light+1 h dark illumination and weekly changed dry wooden bedding. There were 2 dietary treatments, each consisting of 5 replicates. Each replicate was consisted of 24 birds kept in the experimental unit sized 2×2 m on floor. Dietary treatments consisted of control (C) in which broilers were fed standard broiler rations, and acid insoluble granite-grit choice (AIGG) in which broilers were fed standard broiler rations and grit in separate troughs. No dilution of nutrients or ingredients occurred, and nutrient specifications for all diets were similar. The standard broiler diets (starter diet from 7 to 21 d of age, grower diet from 21 to 35 d of age and finisher diet from 36 to 42 d of age) were based primarily on corn and soybean meal (Table 1) and formulated to meet nutrient concentrations recommended by the National Research Council (NRC, 1994).

Granite containing 70.5% SiO_2; 14.5% Al_2O_3; 4.1% K_2O; 3.5% Na_2O; 2.0% CaO; 1.8% FeO; 1.6% Fe_2O_3; 0.9% MgO; 0.8% H_2O; 0.4% TiO_2; 2.0% P_2O_5 and 1.0% MnO (DSI, 2003) was obtained from a commercial enterprise and was broken to get 2 mm particle size. All diets were fed in mash form. While diets for the C were supplied *ad libitum* in suspended cylindrical tube feeders (capacity: 15 kg), those for the AIGG were supplied *ad libitum* in suspended cylindrical tubes (capacity: 15 kg), two per pen, one containing the standard broiler diets and the other the granite grit until the end of the experiment at 42 d of age. Feeder space was 2 cm per bird for all of the groups. Water was available all day through experimental period by using one hanging drinker per pen.

Individual body weight (BW) was recorded each week. Prior to feeding, feed and granite-grit leftovers were removed and weighed. Feed and granite-grit intakes per pen were calculated for periods of one week and used to calculate feed:gain ratio. Mortality was recorded as it occurred. During the last three days of experiment, faeces were collected for determination its acid insoluble ash content. Four birds from each replicate were slaughtered at day 42 to determine carcass weight, dressing percentage, abdominal fat pad, empty gizzard and edible inner organs (heart+liver+gizzard) weights, and length and weight of gut. Dressing percentage, weights or length of organs as a proportion of BW (g/100 g BW) were calculated.

The main effect of feeding styles (C and AIGG) was compared in this experiment. The data concerning final live weight, daily feed intake, feed conversion ratio, protein and energy intake, daily granite-grit intake, carcass weight, dressing out percentage, abdominal fat pad, edible inner organs and empty gizzard weights and gut length were analysed using One-Way ANOVA (SPSS, 1999). Results obtained in this study are presented as means per experimental group with standard errors of the mean (SEM).

RESULTS AND DISCUSSION

There was no difference between groups in terms of mortality during the experiment (0.83% for AIGG vs. 0% for C). Birds had a higher voluntary intake of granite-grit at early age (7 to 21 d of age) than at late age (22 to 42 d of age). The voluntary intake of granite-grit of broilers in the AIGG increased ($p<0.05$) from 2.7 g at 7-14 d to 4.4 g at 15-21 d of age per day, and then it decreased 3.4, 3.2 and

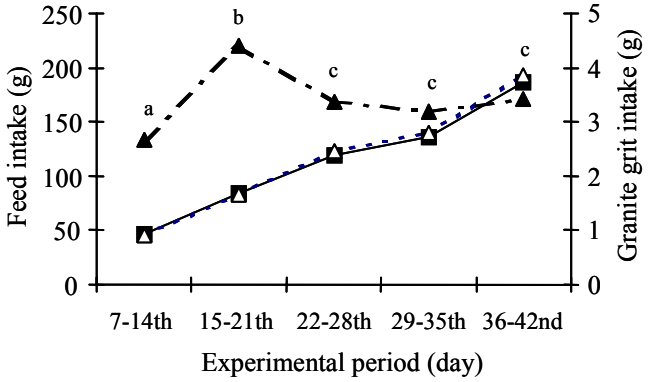

Figure 1. Daily feed intake in the C (Δ) and AIGG (■) groups, and voluntary granite grit intake (▲). Means with different letters (a, b and c) are significantly differ ($p<0.05$).

3.4 g per day between 22-28, 29-35 and 36-42 d of age, respectively (Figure 1). The results reported here are in agreement with the observation of Lazar et al. (1984) who reported that it is commercially advisable to provide silica grit with feed until 21 days of fattening. However, Kriz et al. (1981) and Kriz (1985) suggested that grit be given only up to 15 d old. Differences in granite consumption between the periods of 7-14 days and 15-21 days might be attributed to the development rate of digestive organs and therefore physical development of gizzard. Dror et al. (1977) reported that relative gizzard weight decreased steadily from day 0 to day 15 in the male parent line broilers. Decreasing of granite-grit consumption during 22-42 days can be explained by increase in gizzard development and by the fact that the birds did not need excess intake of granite-grit during this period. As a matter of fact, granite-grit consumptions did not vary during 22-42 days (Figure 1).

Mean amounts eaten varied quite widely from week to week, but on average broilers ate 3.41 g/d/bird during the experimental period (Table 2). Such a level of grit intake increased ($p<0.05$) weights of empty gizzard, edible inner organs and length of gut as a proportion of body weight and the content of insoluble ash (0.84 vs. 4.22%) in the faeces compared to the control counterpart. Increased gizzard weight might be a result of acceleration of muscle movement as Moore (1998) postulated. Furthermore, Yildiz et al. (2001) reported that supplying insoluble grit to the broilers fed mash, crumble or pellet diets increased the thickness of gizzard muscle. Although gizzard weight and gut length were greater in birds given grit, feeding grit in free choice system had little or no effect on final live weight, daily gain, carcass weight, dressing percentage and feed efficiency. Our results which reported that grit did not growth affect performance of broilers is in line with previous reports (Kriz et al., 1981; Lazar et al., 1984; Kriz, 1985; Taylor, 1996; Jones and Taylor, 1999; Silva-Junior et al., 2003) that growth performance was not affected by inclusion of grit into broiler diet although gizzard weight was greater in birds given grit. Also, influence of whole barley and grit on live performance and health of turkey toms (Bennett et al., 2002a, b) or hens (Bennett and Classen, 2003) has been studied, and feeding grit had no effect on the live performance of birds fed similar levels of whole barley or mash diets. Bennett et al. (2002a, b) also reported that access to insoluble grit did not alter the response to feeding whole barley. Bennett et al. (1995), Schwean et al. (1997) and Svihus et al. (1997) showed that grit supplementation has no effect on performance even though supplied with whole grains. In contrast, Karunajeewa and Tham (1984) showed that pullets fed whole grain may increase their consumption of insoluble grit when it is available free choice.

Birds given grit did not gain more weight than those not given grit but they tended to have ($p<0.07$) lower feed intake and subsequently lower protein and energy intake. Chickens given grit with their feed had slightly but non-significantly higher feed conversion efficiency than birds not given grit (Table 2). It has been hypothesized that feeding whole grain and other feed ingredients that increase

Table 2. Growth and slaughter performances of broilers fed granite grit in free choice system

Parameter	C	AIGG	SEM	P
Final live weight (g)	2,542	2,543	18.1	NS
Daily gain (g)	69	69	0.5	NS
Daily feed intake (g)	116.7	114.5	0.94	**
FCR (g feed:g gain)	1.69	1.66	0.02	NS
Protein intake (g)	24.3	23.8	0.19	**
Energy intake (kcal ME)	372.2	365.5	3.01	**
Granite grit intake (g)	-	3.41	0.151	NS
Carcass weight (g)	1,924	1,911	39.2	NS
Dressing out percentage (%)	75.6	75.1	0.35	NS
Gut length (cm/100 g BW)	8.86	9.01	0.151	*
Abdominal fat (g/00 g BW)	2.13	2.15	0.138	NS
Edible inner organs (g/100 g BW)	3.51	3.69	0.005	*
Empty gizzard weight (g/100 g BW)	0.97	1.30	0.005	*

SEM: standard error of the mean.

* C (control) and AIGG (acid insoluble grit-granite) differ at $p<0.05$. ** C and AIGG differ at $p<0.07$.

the grinding activity of the gizzard will alter gut motility, increase peptic digestion in the gizzard, and improve gut health (Ferket, 2000). Our results with respect to feed and subsequently protein and energy intake show that either the use of granite-grit has no beneficial effect on mechanical digestion or was not such a granite-grit size (2 mm) that would cause a beneficial effect on mechanical digestion. A decrease tendency in the feed intake show that birds may have either a behavioural or a nutritional need for the ingestion of insoluble grit. It is a behavioural need due to the fact that they were not forced to eat grit and it is a nutritional need because broilers had a lower protein and energy intake due to its help to grind the ingredients although experimental feeds were in mash form in the present study. Therefore, these results do not support the idea that the grit is not necessary when an all-mash system is used. In fact, laying hens fed mash diets and free-choice insoluble grit will consume grit far in excess of what their gizzards will retain without any improvement in live performance (Walter and Aitken, 1961). If the gizzard is unable to thoroughly grind the whole barley, adding insoluble grit to the diet does not appear to solve the problem (Bennett, and Classen, 2003).

Analytic chemical findings in the present study showed that granite-grit was insoluble in acid. In such a situation, one of the topics which must be taken into account is the wearing of the equipments used in cleaning of the gizzards due to granite-grit found in gizzards (Bennett et al., 1995). In present study, there was no negative effect of granite-use at slaughtering equipments as the gizzards were cleaned manually.

In conclusion, the granite-grit consumed by broilers voluntarily increased gut length and empty gizzard weight without affecting growth performance of broilers. Thus, it can be assumed that the voluntary consumption of granite-grit was low to affect performance and birds have the ability to balance their consumption not to disturb their digestive physiology. Salt and stone eating is a natural behaviour in broilers, generally associated with animal welfare. For this reason, free choice granite-grit might be regarded as a method, which can be used to alleviate stress conditions and to improve the animal welfare. Furthermore, the possibilities of using granite-grit with pellet, crumble or whole grain feeds at different particulate grit sizes are potential subject titles for further investigation of the mechanism of grit on poultry digestive physiology.

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