Effects of Granite Grit Supplementation to Broiler Diets on Performance and Carcass Characteristics

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***Abstract*—The purpose of this experiment was to determine the effects of granite grit supplementation to broiler diets on performance and carcass characteristics. For this purpose a total of 160 Ross 308 male broiler chicks aged seven day were used. One control group and one treatment group were designed for 5 weeks of experimental period. Each group was divided into 4 replicates of 20 chicks each in pens. Granite grit (Ankara-Turkey) was added at the level of 0 and 0.8% to the basal diets for control and treatment groups, respectively. Granite grit supplementation had no significant effect on final weight, weight gain and feed conversion ratio. However grit improved feed conversion ratio during the experiment at 2.19% (P>0.05). Feed intake during the first period and during the experiment was significantly reduced by grit supplementation (P<0.05). The relative weight of gizzard was increased (P<0.001) and the relative weight of abdominal fat was decreased (P<0.05) with granite grit supplementation to the diets of broilers. Dietary treatments did not affect blood serum total cholesterol and triglyceride. As a conclusion granite grit may be useful supplement in broilers in the field due to having some improvements in performance and in the relative weight of gizzard and reduction in relative weight of abdominal fat.**

***Index Terms*—granite grit, broiler, performance, carcass characteristics**

I. Introduction

Grit is explained as stones and rock fragments ingested by birds excluding very fine particles [1]. Grit used by the birds stimulates the gizzard and enhances the mechanical digestion in the gizzard. The gizzard is the main organ to grind coarser particles and control feed passage rate and therefore it is thought to be the feed-flow regulator or pace-maker in birds [2], [3]. Digestibility of crude protein, crude fibre and nitrogen free extract were improved with granite grit supplementation [4].

Jones and Taylor [5] and Silva-Junior *et al.* [6] found that granite grit usage in broilers had no effect on performance but increased proventriculus and gizzard weight. Garipoğlu *et al.* [7] concluded that voluntary intake of insoluble granite-grit offered in broilers increased gut length and empty gizzard weight without affecting growth performance. However Moghaddam *et al.* [8] reported that weight gain and feed conversion ratio were significantly improved in broilers fed grit having particle size of 2 mm whereas, carcass traits were not significantly altered. Moghaddam *et al.* [8] concluded that grit having the size of 2 mm improved growth performance in broilers. Fuerjiafu [9] also stated that feeding grit to broiler chickens didn't decrease the passage rate and didn't improve the gizzard weight and the performance. There are controversial results about grit usage. Therefore the purpose of this experiment was to determine the effects of granite grit supplementation to broiler diets on performance and carcass characteristics.

II. Materials and Methods

This study was approved by Ankara University Animal Care and Use Committee.

Materials: A total of 160 Ross 308 seven day old male broiler chicks were allocated into one control group and one treatment group with 80 chicks in each. Each group was divided into four pens with 20 chicks per pen. Each pen had wood shavings litter, 4 nipple drinker and one hanging suspended feeder. Feed as a mash form and water were provided ad libitum during the 5 week of experimental period. Continuous lighting was supplied during the experiment. Average room temperature was 32 ± 2^{o}C on the first week and then gradually lowered to average 24 to 26^{o}C, and this temperature was maintained

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up to slaughter age. Broilers were fed on starter diets during 7-21 days and fed on grower diets during 21-42 days. Granite grit having a particle size of 1-2 mm was obtained from a commercial company in Ankara-Turkey and it was used at the level of 0 and 0.8% for the diets of control group and treatment group, respectively. The ingredients and chemical composition of the basal diets for starter and grower periods were shown in Table I. The diets were mainly consisted of maize and soya.

TABLE I. THE INGREDIENTS AND CHEMICAL COMPOSITION OF THE BASAL DIETS FOR STARTER AND GROWER PERIODS

kg/ton	Starter (7-21 days)	Grower (22-42 days)
Maize	510.0	550.0
Fullfat soya	60.0	65.0
Soyabean meal	323.0	286.0
Fish meal	40.0	20.0
Soya oil	38.0	50.0
Dicalcium phosphate	10.0	10.0
Limestone	10.0	10.0
Methionine	1.5	1.5
Lysine	1.0	1.0
Vitamin premix[1]	2.0	2.0
Mineral premix[2]	1.0	1.0
Salt	2.5	2.5
Choline chloride	1.0	1.0
Chemical composition, analyzed		
Crude protein, g/kg	235.0	210.4
Metabolisable energy, MJ/kg	12.97	13.42
Calcium, g/kg	9.20	8.90
Total phosphorus, g/kg	7.40	6.80

1: Contained per 2 kg: 11.000.000 IU vitamin A, 3.500.000 vitamin D3, 100 g vitamin E, 3 g vitamin K3, 3 g vitamin B1, 6 g vitamin B2, 15 g calcium D-pantothenate, 1 g vitamin B6, 20 mg vitamin B12, 35 g niacin, 1.5 g folic acid and 200 mg biotin.
2: Contained per 1 kg: 30 g Cu, 120 g Mn, 110 g Zn, 2 g I, 300 mg Se and 50 g Fe.

Traits measured: Nutrient composition of the diets were determined according to the AOAC [10]. The samples were ashed in a muffle furnace prior to the analysis of calcium and total phosphorus [11], [12]. Metabolizable energy levels of diets were estimated using the Carpenter and Clegg's equation [13]. Mineralogical composition of granite grit was determined by D8 Advance Diffractometer AXS (Bruker, Germany).

Chicks were weighed individually at the beginning of the experimental period and weekly to determine the body weight and body weight gain. Feed consumption was determined weekly and the feed conversion ratio was calculated as kg feed per kg body weight gain. The birds were observed for evaluating mortality.

At d 41, 8 broilers from each subgroup were randomly selected and bled from the vena brachialis under the wing. Blood samples were taken in the tubes having no anticoagulant for estimating cholesterol and triglyceride levels. Blood samples were centrifuged at 3220 x g for 8 min. Serum was collected and stored at -20^{o}C. Serum cholesterol and triglyceride levels were determined using a Hitachi auto-analyzer (Hitachi, Tokyo) and its accompanying commercial kits.

At 42 d of age, 8 broilers from each subgroup were randomly selected for processing. Feed was removed 5 h prior to slaughtering. Broilers were weighed and slaughtered in a commercial processing plant. Hot carcass, abdominal fat and gizzard were weighed and expressed as percentage of slaughter weight.

Statistical analyses were done by SPSS 23.0 (SPSS Inc., Chicago, IL, USA). The normality of data distribution was checked using the Kolmogorov-Smirnov test. Comparison between groups was examined with independent samples t test. Level of significance was taken as $p<0.05$. Data were given as mean±standard error of mean [14].

III. RESULTS AND DISCUSSION

Granite grit used in this experiment contained 68.22% SiO2, 16.75% Al2O3, 4% K2O, 3.7%Na2O, 1.68% Fe2O3, 0.48% MgO, 0.38% TiO2, 1.40% P2O5, 0.72% MnO and 1.80% CaO. Granite grit supplementation to the diets based on maize and soya did not significantly affect final body weight and body weight gain (Table II). Feed intake during first period and during the experiment was significantly reduced ($P<0.05$) by grit supplementation. Feed conversion ratio during the experimental period was not affected significantly by grit supplementation. However 0.8% granite grit supplementation improved total feed conversion ratio at 2.19% ($P>0.05$). This numerical improvement was seen in feed conversion ratio due to the reduced feed intake. No mortality was seen during the experiment. The relative weight percentage of gizzard was increased ($P<0.001$) and the relative weight percentage of abdominal fat was decreased ($P<0.05$) by grit supplementation (Table III). Granite grit supplementation did not significantly affect carcass yield, blood serum total cholesterol and triglyceride level (Table IV).

TABLE II. EFFECTS OF DIETARY GRIT SUPPLEMENTATION ON PERFORMANCE OF BROILERS

	Granite grit, %		P
	0	0.8	
Initial body weight (at d 7), g	150.10±1.11	148.77±2.19	0.608
Final body weight (at d 42), g	2223.11±70.21	2209.90±78.68	0.904
Body weight gain, g			
7-21 days	581.27±7.83	563.85±1.99	0.074
21-42 days	1491.75±65.51	1497.29±80.57	0.959
7-42 days	2073.02±71.17	2061.13±79.74	0.915
Feed intake, g			
7-21 days	908.55±12.93	858.08±3.81	0.010
21-42 days	2864.59±24.61	2813.29±15.61	0.129
7-42 days	3773.14±28.89	3671.37±14.18	0.020
Feed conversion ratio, kg feed/kg weight gain			
7-21 days	1.56±0.04	1.52±0.01	0.358
21-42 days	1.93±0.09	1.90±0.10	0.798
7-42 days	1.83±0.07	1.79±0.07	0.722

n=4

TABLE III. EFFECTS OF DIETARY GRIT SUPPLEMENTATION ON CARCASS YIELD AND RELATIVE WEIGHT OF GIZZARD AND ABDOMINAL FAT WEIGHTS IN BROILERS

	Granite grit, %		P
	0	0.8	
Carcass yield, %	75.38±0.24	75.05±0.19	0.280
Gizzard, %	1.41±0.02	1.53±0.02	<0.001
Abdominal fat, %	2.12±0.09	1.85±0.09	0.048

n=32

TABLE IV. EFFECTS OF DIETARY GRIT SUPPLEMENTATION ON BLOOD SERUM CHOLESTEROL AND TRIGLYCERIDE LEVELS IN BROILERS

	Granite grit, %		P
	0	0.8	
Total cholesterol, mg/dl	95.09±3.22	94.91±2.98	0.966
Triglyceride, mg/dl	88.84±4.12	84.94±2.61	0.426

n=32

Gionfriddo and Best [15] reported that feeding grit to poultry is generally considered for optimum feed utilization and health which is mainly accomplished by stimulating gizzard and improving functions of the gizzard the developed and well functioned gizzard can also be explained as the gizzard with increased weight [9]. Well-developed gizzard would grind diet more efficiently, increase the fine particles [16] and give a synchronized feed flow [17]. Fuerjiafu [9] reported that increased fine particles would present a greater surface to contact with digestive juices. Similar to the present results, Svihus *et al.* [18] showed that mortality was not affected by the usage of grit.

Svihus *et al.* [18] reported that feed intake, weight gain, feed conversion ratio and mortality in broilers were not affected by feeding granite grit (73% silica oxide and 13% aluminium oxide, sized between 1.6-3.6 mm). However gizzard weight was significantly increased with granite grit. Similarly some researchers [5]-[7] found that granite grit usage in broilers had no effect on performance but increased gizzard weight. Garipoğlu *et al.* [7] stated that broilers given grit did not gain more weight than those not given grit but they tended to have lower feed intake ($P<0.07$) and consequently lower protein and lower energy intake. However Moghaddam *et al.* [8] reported that body weight gain and feed conversion ratio were significantly improved in broilers fed grit having particle size of 2 mm. Moghaddam *et al.* [8] didn't see any effects of grit on carcass yield and relative percentages of organ weights. Fuerjiafu [9] found that grit supplementation didn't affect feed intake, weight gain, feed conversion ratio and gizzard weight. Some researchers showed that performances of hens [19] and turkeys [20] were not affected by grit supplementation. Erener *et al.* [21] reported that final body weight, total weight gain, feed conversion ratio and gizzard relative weight were improved, cumulative feed intake was reduced significantly with grit supplementation to high energy and low fiber diets. In the study of Erener *et al.* [21], the relative weight percentage of abdominal fat was not changed in broilers, but Ling *et al.* [22] reported that relative weight of abdominal fat was increased in goslings with grit. Similar to the present study, Ling *et al.* [22] showed that grit had no effect on serum total cholesterol and triglyceride level in goslings. Ling *et al.* [22] also speculated that feed with appropriate amount of grit would probably release more nutrients such as starch to supply more energy due to the improvement digestion progress with grit [23].

Reduction in abdominal fat with the usage of granite grit in this present study is important in broiler production. Because abdominal fat is regarded as the main source of poultry waste in the slaughterhouse [24].

In general, factors that affect grit-use pattern in gizzards are complicated and may include physical characteristics and the source of the grit, diet ingredients, diet composition, body weight and species of bird [22].

IV. CONCLUSION

As a conclusion addition of 0.8% granite grit having a particle size of 1-2 mm to the diets may be useful supplement in broilers in the field due to the some improvements in performance and in relative weight of gizzard and reduction in relative weight of abdominal fat. Further studies are needed to test the efficiency of granite grit supplementation in broilers.

REFERENCES

[1] J. P. Gionfriddo and L. B. Best, "Grit use by birds," in *Current Ornithology*, Springer, 1999, pp. 89-148.

[2] G. Duke, "Alimentary canal: Anatomy, regulation of feeding, and motility," in *Avian Physiology*, Springer, 1986, pp. 269-288.

[3] B. Svihus, "The gizzard: Function, influence of diet structure and effects on nutrient availability," *Worlds Poultry Science Journal*, vol. 67, pp. 207-223, 2011.

[4] C. U. Idachaba, F. O. Abeke, T. S. Olugbemi, and L. A. Ademu, "Influence of granite-grit on nutrient digestibility and haematological parameters of broiler chickens fed rice offal based diets," *Pakistan Journal of Biological Sciences*, vol. 16, pp. 1061-1064, 2013.

[5] G. P. D. Jones and R. D. Taylor, "Performance and gut characteristics of grit-fed broilers," in *Proc. Australian Poultry Ecience Symposium*, University of Sydney, 1999, pp. 57-60.

[6] V. L. Silva-Junior, J. T. B. Cotta, and A. I. J. Oliveira, "Effect of the forms of presentation of corn and the use of grit in the rations on performance in broiler," *Ciencia e Investigacion Agraria*, vol. 27, pp. 1165-1171, 2003.

[7] A. V. Garipoğlu, G. Erener, and N. Ocak, "Voluntary intake of insoluble granite-grit offered in free choice by broilers: Its effect on their digestive tract traits and performances," *Asian-Australian Journal of Animal Science*, vol. 4, pp. 549-553, 2006.

[8] A. A. R. Moghaddam, Y. Ebrahimnezhad, and A. A. S. Teli, "The effects of different sizes of insoluble grit on growth performance and carcass traits in broiler chickens," *Journal of BioScience and Biotechnology*, vol. 5, pp. 87-91, 2016.

[9] B. Fuerjiafu, "The effect of the grit stone on feed passage rate in broiler chickens," Master's thesis, Department of Animal and Aquacultural Sciences, Feed Manufacturing Technology, Norwegian University of Life Sciences, 2016.

[10] AOAC, "Official methods of analysis, Association of Official Analytical Chemists," AOAC International, 17th ed., Maryland. ch. 4, pp. 1-41, 2000.

[11] ADAS, "The Analysis of Agricultural Materials. Ministry of Agriculture," Fisheries and Food, Agricultural Development and Advisory Service, 2nd ed, Her Majesty's Stationery Office, London, UK, 1981.

[12] G. Farese, J. L. Schmidt, and M. Mager, "An automated method for the determination of serum calcium with glyoxal bis (2-hydroxyanil)," *Clinical Chemistry*, vol. 13, pp. 515-520, 1967.
[13] K. J. Carpenter and K. M. Clegg, "The metabolizable energy of poultry feedingdtuffs in relation to their chemical composition," *Journal of Science Food and Agriculture*, vol. 7, pp. 45-51, 1956.
[14] B. Dawson and R. G. Trapp, *Basic and Clinical Biostatistics*, 3rd ed., New York, USA: Lange Medical Books/McGraw-Hill Medical Publishing Division, 2001.
[15] J. P. Gionfriddo and L. B. Best, "Grit use by birds," in *Current Ornithology*, Springer, pp. 89-148, 1999.
[16] H. Hetland, B. Svihus, and A. Krogdahl, "Effects of oat hulls and wood shavings on digestion in broilers and layers fed diets based on whole or ground wheat," *British Poultry Science*, vol. 44, pp. 275-282, 2003.
[17] B. Svihus, "Function of the digestive system," *The Journal of Applied Poultry Research*, vol. 23, pp. 306-314, 2014.
[18] B. Svihus, *et al.*, "Performance and digestive function of broiler chickens given grit in the diet," *British Poultry Science*, vol. 58, pp. 530-535, 2017.
[19] C. D. Bennett and H. L. Classen, "Performance of two strains of laying hens fed ground and whole barley with and without Access to insoluble grit," *Poultry Science*, vol. 82, pp. 147-149, 2003.
[20] C. D. Bennett, H. L. Classen, K. Schwean, and C. Riddell, "Influence of whole barley and grit on live performance and health of turkey toms," *Poultry Science*, vol. 81, pp. 1850-1855, 2002.
[21] G. Erener, N. Ocak, A. V. Garipoğlu, and A. Şahin, "Insoluble granite-grit allows broiler chicks to have better growth performance and gut health," *Revista Brasileira de Zootecnia*, vol. 46, pp. 650-654, 2016.
[22] J. Ling, G. Yu-yun, Y. Hui, W. Wen-ce, L. Zhen-ping, Y. Hui-yong, H. Song-bo, and Y. Lin, "Effects of dietary fiber and grit on performance, gastrointestinal tract development, lipometabolism and grit reention of goslings," *Journal of Integrative Agriculture*, vol. 13, pp. 2731-2740, 2014.
[23] S. J. Moore, "Use of an artificial gizzard to investgate the effect of grit on the breakdown of grass," *Journal of Zoology*, vol. 246, pp. 119-124, 1998.
[24] S. Yalçın, S. Yalçın, E. S. Gebeş, A. Şahin, H. M. Duyum, F. Escribano, and A. Ceylan, "Sepiolite as a feed supplement for broilers," *Applied Clay Science*, vol. 148, pp. 95-102, 2017.

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