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Research Article

Effects of Grit Supplementation to Diets Containing Maize and Barley as Cereal Grains on Performance and Slaughter Characteristics in Broilers

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Abstract

The aim of this study was to determine the effects of grit supplementation to the diets containing maize and barley as cereal grains on performance and slaughter characteristics in broilers. In the experiment, a total of 160 Ross 308 male broiler chicks were allocated to 2 experimental groups with 4 replicate pens containing 20 birds per each for 5 weeks of experimental period. Granite grit was added at the level of 0 and 0.8% to the basal diets containing barley and maize as cereal grains for control and treatment groups, respectively. Granite grit supplementation had no significant effect on final body weight and body weight gain. Feed intake during the experiment was significantly reduced by grit supplementation ($P<0.05$). However, no significant differences were observed with the feed conversion ratio. Granite grit supplementation to the diets of broilers increased the relative weight of gizzard ($P=0.001$) and decreased the relative weight of abdominal fat ($P<0.05$). Dietary treatments did not affect blood serum total cholesterol and triglyceride. In conclusion, granite grit supplementation might be used in broiler nutrition due to having increment in the relative weight of gizzard and reduction in relative weight of abdominal fat.

Keywords: *Broiler, Slaughter characteristics, Gizzard, Grit, Performance*

Tahıl Taneleri Olarak Mısır ve Arpa Kapsayan Karma Yemlere Grit İlavesinin Broylerlerde Performans ve Kesim Özelliklerine Etkileri

Öz

Bu çalışmada amaç, tahıl tanesi olarak mısır ve arpa kapsayan karma yemlere grit ilavesinin broylerlerde performans ve kesim özelliklerine olan etkilerinin belirlenmesini oluşturmuştur. Denemede, toplam 160 adet Ross 308 erkek broyler 5 haftalık deneme süresince her birinde 20 civciv bulunan 4 tekrarlı 2 deneme grubuna ayrılmıştır. Granit grit tahıl tanesi olarak mısır ve arpa kapsayan kontrol ve deneme grupları temel rasyonlarına sırasıyla %0 ve %0.8 düzeylerinde eklenmiştir. Granit grit ilavesinin, deneme sonu canlı ağırlık ve canlı ağırlık kazancı üzerine önemli bir etkisinin olmadığı görülmüştür. Deneme süresince yem tüketimi grit ilavesiyle önemli miktarda azalmıştır ($P<0.05$). Gruplar arasında yem dönüşüm oranı bakımından istatistik açıdan önemli bir farklılık gözlenmemiştir. Mısır ve arpa kapsayan rasyonlara granit grit katkısı relatif taşlık ağırlığını artırmış ($P=0.001$) ve relatif abdominal yağ ağırlığını azaltmıştır ($P<0.05$). Grit ilavesi kan serumu toplam kolesterol ve trigliserit düzeylerini etkilememiştir. Sonuç olarak, tahıl tanesi olarak mısır ve arpa kapsayan karma yemlere granit grit ilavesinin relatif taşlık ağırlığını artırması ve relatif abdominal yağ ağırlığını azaltması nedeniyle broyler beslenmesinde kullanılabileceği saptanmıştır.

Anahtar sözcükler: *Broyler, Grit, Kesim özellikleri, Performans, Taşlık*

INTRODUCTION

Grit, as a stone and a rock fragment derived from granite, is used by the birds to enhance the mechanical digestion in gizzard [1]. Especially, one of the main advantages of dietary grit inclusion is its positive effect on gizzard

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development and functionality. The gizzard, serves as teeth, is one of the organs of the digestive system of birds. This specialized stomach, constructed of thick muscular walls, is used for grinding up feed, often aided by particles of stone or grit [2]. However, broilers are usually fed with an easily digestible mash or pelleted diet. Pellet feeds used in poultry provide high feed consumption, but adversely affect gizzard development [3]. Insufficient stimulation of gizzard development reduces nutrient absorption and digestibility due to an increase in the rate of passage of feed from gizzard to intestines [4]. It has been reported that gizzard development is substantially stimulated if diets are consisted of whole cereals or insoluble fibre [5]. Especially, the use of grit is gaining importance in nutrition with grain or roughly milled grain [6]. Grit stones in the gizzard of the birds lead to better grinding which allows longer retention of the digesta and a better feed flow [5,7-9]. It has been reported that half of the feed had passed the gizzard within 2 h [10]. The granite grit increases the size of the gizzard and its muscular power [2,5]. Grit also provides supplementary calcium and other minerals that are important for seed-consuming animals [7].

Numerous studies have been conducted to evaluate the efficacy of granite grit in broiler diets. Yıldız et al.[6] reported that inclusion of insoluble grit to the broilers diets increased the weight and the volume of the gizzard of the broilers. Moghaddam et al.[11] showed that use of grit supplementation to diets significantly improved the growth performance in broilers fed with grit 2 mm than that of those were not given. However, Bennett and Classen [12] stated that supplying insoluble grit had no beneficial effect on production parameters to laying hens fed whole barley or mash diets. Fuerjiafu [13] also reported that feeding grit to broiler chickens did not improve the gizzard weight and the performance and did not regulate the feed flow. Garipoğlu et al.[1] showed that although optional insoluble granite-grit consumption by broilers increased the weight of gizzard and length of gut, it did not improve growth performance. On the other hand, the amounts of grit in bird gizzards depend not only on the behaviour or need of birds, but also on retention of these particles in the gizzard. For instance, hard diets may reduce grit retention in the gizzard [7]. Due to these reasons, 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 containing maize and barley as cereal grains on performance and slaughter characteristics.

MATERIAL and METHODS

Animal Care and Use

All experimental procedures were approved by The Animal Ethics Committee of the Ankara University (2018-19-124).

Birds, Housing and Feeding

A total of 160 Ross 308 seven-day-old male broiler chicks were divided into one control and one treatment group with 4 replicates per group, each of which consisted of 20 chickens. The chickens were housed in environmentally controlled pens and provided with continuous light during the 5 week of experimental period. Temperature was adjusted to the according to the recommended conditions for Ross 308 broiler during the study [14]. Average room temperature was 30±2°C on the first week and then gradually lowered to average 22±2°C, and this temperature was maintained up to slaughter age. Each pen had wood shavings litter, feed (in mash form) and water were provided *ad libitum* throughout the experiment.

The starter diets and grower diets were mainly consisted of maize, barley and soybean, and were offered to birds from 7-21, and 21-42 days of age, respectively. The ingredients and chemical composition of the basal diets for starter and grower periods are shown in *Table 1*. 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. Granite grit used in this experiment contained 68.22% SiO_2, 16.75% Al_2O_3, 4% K_2O, 3.7%Na_2O,

Table 1. *The ingredients and chemical composition of the basal diets*

Ingredients, g/kg	Starter Diet (7-21 d)	Grower Diet (21-42 d)
Maize	320.0	360.0
Barley	200.0	200.0
Soybean meal	300.0	263.0
Full-fat soya	70.0	75.0
Fish meal	40.0	20.0
Sunflower seed oil	41.0	53.0
Limestone	10.0	10.0
Dicalcium phosphate	10.0	10.0
Salt	2.5	2.5
Vitamin premix[a]	2.0	2.0
Mineral premix[b]	1.0	1.0
DL-methionine	1.5	1.5
Lysine	1.0	1.0
Choline chloride	1.0	1.0
Analyzed nutrient values		
ME, kcal/kg[c]	2998	3105
Crude protein, %	23.52	21.07
Calcium, %	0.99	0.91
Total phosphorus, %	0.72	0.69

[a] Contained per 2 kg: 11.000.000 IU vitamin A, 3.500.000 vitamin D_3, 100 g vitamin E, 3 g vitamin K_3, 3 g vitamin B_1, 6 g vitamin B_2, 15 g calcium D-pantothenate, 1 g vitamin B_6, 20 mg vitamin B_{12}, 35 g niacin, 1.5 g folic acid and 200 mg biotin; [b] Contained per 1 kg: 30 g Cu, 120 g Mn, 110 g Zn, 2 g I, 300 mg Se and 50 g Fe; [c] Calculated [18]

1.68% Fe_2O_3, 0.48% MgO, 0.38% TiO_2, 1.40% P_2O_5, 0.72% MnO and 1.80% CaO.

Traits Measured

Nutrient compositions of the diets were determined according to the AOAC [15]. The samples were ashed in a muffle furnace prior to the analysis of calcium and total phosphorus [16,17]. Metabolizable energy levels of diets were estimated using the Carpenter and Clegg's equation [18]. 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 day 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°C. Serum cholesterol and triglyceride levels were determined using a Hitachi auto-analyzer (Hitachi, Tokyo) and its accompanying commercial kits.

At the end of the study (day 42), 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, liver, heart, spleen, gizzard and bursa Fabricius were weighed and expressed as percentage of slaughter weight.

Statistical Analyses

Data were analysed using 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 [19].

RESULTS

The effect of dietary grit supplementation on body weight and body weight gains of broilers is shown in *Table 2*. Granite grit supplementation to the diets containing maize and barley as cereal grains did not significantly affect the final body weight and body weight gain.

The effect of dietary grit supplementation on feed intake of broilers is shown in *Table 3*. Feed intake during the experiment was significantly reduced ($P<0.05$) by grit supplementation. Feed conversion ratio was not

Table 2. *Effects of dietary grit supplementation on body weight and body weight gain of broilers*

Period, days	Grit, %		Significance
	0	0.8	
Body weight, g			
7	148.66	148.90	0.955
14	368.88	364.34	0.435
21	713.68	718.67	0.770
28	1158.93	1158.88	0.999
35	1654.68	1662.30	0.942
42	2135.83	2157.24	0.869
Body weight gain, g			
7-14	220.21	215.44	0.353
14-21	344.80	354.33	0.649
21-28	445.26	440.21	0.918
28-35	495.75	503.43	0.857
35-42	481.15	494.94	0.698
7-21	565.01	569.77	0.812
21-42	1422.15	1438.58	0.887
7-42	1987.17	2008.34	0.874

n=4; No statistical significant differences between groups

Table 3. *Effects of dietary grit supplementation on feed intake and feed conversion ratio of broilers*

Period, days	Grit, %		Significance
	0	0.8	
Feed intake, g			
7-14	329.98	324.23	0.240
14-21	579.17^{a}	543.33^{b}	<0.001
21-28	819.59	811.27	0.232
28-35	1011.05a	957.85b	0.004
35-42	1020.33	1016.99	0.428
7-21	909.15^{a}	867.56^{b}	<0.001
21-42	2850.96^{a}	2786.10^{b}	0.004
7-42	3760.11^{a}	3653.67^{b}	<0.001
Feed conversion ratio, g feed/ g weight gain			
7-14	1.50	1.51	0.827
14-21	1.69	1.54	0.182
21-28	1.86	1.89	0.918
28-35	2.05	1.93	0.525
35-42	2.14	2.07	0.627
7-21	1.61	1.53	0.190
21-42	2.02	1.96	0.715
7-42	1.90	1.83	0.591

n=4; ^{a,b} means a row followed by different letters differ significantly ($P<0.05$)

Table 4. *Effects of dietary grit supplementation on slaughter characteristics of broilers*

Characteristics, %	Grit, %		Significance
	0	0.8	
Carcass yield	75.18	74.65	0.161
Abdominal fat	1.97[a]	1.67[b]	0.008
Heart	0.60	0.58	0.236
Liver	2.68	2.70	0.759
Gizzard	1.51[b]	1.65[a]	0.001
Spleen	0.15	0.16	0.684
Bursa Fabricius	0.20	0.21	0.728

n=32; [a,b] means a row followed by different letters differ significantly (P<0.05)

Table 5. *Effects of dietary grit supplementation on serum total cholesterol and triglyceride in broilers*

Blood Parameters, mg/dL	Grit, %		Significance
	0	0.8	
Total cholesterol	93.25	94.88	0.736
Triglyceride	82.97	82.38	0.774

n=32; No statistical significant differences between groups

affected significantly by grit supplementation during the experimental period *(Table 3)*. However, 0.8% granite grit supplementation improved total feed conversion ratio numerically by 3.68% (P>0.05).

The effects of dietary grit supplementation on carcass yield and weight percentages of internal organs in broilers are shown in *Table 4*. In this study, granite grit supplementation did not significantly affect carcass yield. In contrary, 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.

No significant differences were observed among the treatment groups in terms of blood serum total cholesterol and triglyceride levels during the experiment as shown in *Table 5*.

DISCUSSION

In the present study, inclusion of granite grit to the diets containing maize and barley as cereal grains did not significantly affect the final body weight and body weight gain. Similarly, some researchers stated that inclusion of insoluble grit had no effect on body weight and body weight gain of laying hens [12] and broilers [1,20,21]. However, Moghaddam et al.[11] reported that body weight gains were significantly improved in broilers added with grit having 2 mm size compared to chickens treated by grit having 3 and 4 mm in size (P<0.05) in direct proportion to the numerical increase in gizzard volume. Erener et al.[2] reported that grit supplementation to high energy and low fiber diets increased final body weight and total body weight gain.

Bale-Therik and Sabuna [22] showed that the diets contained grit had a significant effect on the body weight gain of local chicken as a result of improved digestibility of ingesta by increasing the grinding capability in the presence of grit. The differences in literatures may be due to the differences in source and particle size of the grit, diet ingredients and the diet composition.

In our study, during the experiment, feed intake was significantly reduced (P<0.05) by grit supplementation. Although feed conversion ratio was not statistically affected, 0.8% granite grit supplementation improved total feed conversion ratio numerically by 3.68% (P>0.05) *(Table 3)*. This numerical increment for feed conversion ratio can be explained by reduced feed intake. Similarly, Yalçın et al.[21] reported that feed intake during the experiment was significantly reduced and feed conversion ratio was not affected by grit addition to the diets based on maize and soybean. Erener et al.[2] also stated that although inclusion of grit to broiler diets decreased feed intake by approximately 10 g (P<0.01), grit consumed by chicks provided better performance in terms of feed intake and feed conversion ratio. Adeniji [23] reported that inclusion of 5% grit decreased feed intake and improved feed conversion ratio of one-day old pullet chicks fed rice husk. Garipoğlu et al.[1] stated that grit supplementation to diets of broiler decreased the feed intake. In contrary, feed intake and feed conversion ratio of broilers [13] and turkey toms fed to diets containing whole barley (up to 20%) [24] were not affected by grit addition. Contrary to all findings, Jin et al.[25] reported that the addition of dietary crude fiber and grit supplementation up to 4% to gosling diets improved average daily feed intake (P<0.001) and also stated that feeding grit may probably release more nutrients such as starch to supply more energy.

In the present experiment granite grit supplementation did not significantly affect carcass yield, weight percentages of heart, liver, spleen and bursa Fabricius. However, the most important findings in our study are the results of the increment in the relative weight percentage of gizzard (P=0.001) and the reduction in abdominal fat (P<0.05) with grit supplementation. Similar results were obtained in the study with grit supplementation to the diets based on maize and soybean [21]. Decrease in abdominal fat as the main source of poultry waste is very important point in broiler production. Some researchers [1,2,11] stated that there were no differences with using grit among the groups in terms of carcass yield and relative percentages of organ weight. Some early studies [1,26-28] showed that granite grit usage increased the weight of gizzard but had no effect on performance of broilers, which is also consistent with our results. This result can be explained by a large proportion and different size of the grit stones consumed by chicks

retained in the gizzard [2,29]. Besides, it has been reported by Makivic et al.[30] that insoluble fiber supplementation stimulates gizzard function by prolonging the transit time of ingested feed from the proventriculus to the gizzard, in despite of being not any increase of gizzard relative weight. Insoluble grit such as granite grit is more resistant of the dissolving pH secreted in the proventriculus, therefore having a longer retention time in the gizzard [29]. Some researches revealed the beneficial effects of grit stones on development of gizzard and thus had better performance of broiler [2,6,25,31,32]. Liu [20] stated that broilers fed granite grit had significantly larger values of gizzard content weight, relative gizzard content and empty gizzard weight. However, Fuerjiafu [13] reported that there was no significant difference in gizzard weight between grit-fed birds and non-grit-fed birds. Larsson [29] concluded that granite grit did not have any significant effects on performance and gizzard development in broilers.

However, the granite grit supplementation had been reported to have no significant effects on the relative weight percentage of abdominal fat in broiler [2] but was increased in goslings [25]. In contrary, the chicks fed 5% grit had a better (P>0.05) fat retention than the chicks fed 0% grit [23] Similar to the present study, some researchers showed that grit had no effect on serum total cholesterol and triglyceride level in broilers [21] and goslings [25].

As a conclusion, addition of 0.8% granite grit having a particle size of 1-2 mm to the diets containing maize and barley as cereal grains may be useful supplement in broilers in the field due to the improvements in relative weight of gizzard and reduction in relative weight of abdominal fat. However, further studies are needed to test the efficiency of granite grit supplementation in broilers fed diets having different fiber composition.

REFERENCES

1. Garipoğlu AV, Erener G, Ocak N: Voluntary intake of insoluble granite-grit offered in free choice by broilers: Its effect on their digestive tract traits and performances. *Asian-Australas J Anim Sci*, 19 (4): 549-553, 2006. DOI: 10.5713/ajas.2006.549

2. Erener G, Ocak N, Garipoğlu AV, Şahin A: Insoluble granite-grit allows broiler chicks to have better growth performance and gut health. *Rev Bras Zootec,* 45 (11): 650-654, 2016. DOI: 10.1590/s1806-92902016001100002

3. Sacranie A, Svihus B, Denstadli V, Moen B, Iji PA, Choct M: The effect of insoluble fiber and intermittent feeding on gizzard development, gut motility, and performance of broiler chickens. *Poult Sci*, 91(3): 693-700, 2012. DOI: 10.3382/ps.2011-01790

4. Svihus B: Function of the digestive system. *J Appl Poult Res,* 23 (2): 306-314, 2014. DOI: 10.3382/japr.2014-00937

5. Svihus B: The gizzard: Function, influence of diet structure and effects on nutrient availability. *Worlds Poult Sci J*, 67, 207-224, 2011. DOI: 10.1017/S0043933911000249

6. Yıldız B, Yıldız H, Bahadır A: Yemin fiziksel yapısı ile yemleme şeklinin broylerlerde muskuler mide üzerindeki etkisi. *Turk J Vet Anim Sci,* 25, 295-300, 2001.

7. Gionfriddo JP, Best LB: Grit use by house sparrows: Effects of diets of grit size. **In,** Nolan V, Ketterson ED, Thompson CF (Eds): Current Ornithology, 89-148, Springer Nature Switzerland, 1999.

8. Hetland H, Svihus B, Olaisen V: Effect of feeding whole cereals on performance, starch digestibility and duodenal particle size distribution in broiler chickens. *Br Poult Sci*, 43 (3): 416-423, 2002. DOI: 10.1080/00071660120103693

9. Hetland H, Svihus B, Choct M: Role of insoluble fiber on gizzard activity in layers. *J Appl Poult Res,* 14 (1): 38-46, 2005. DOI: 10.1093/japr/14.1.38

10. Svihus B, Hetland H, Choct M, Sundby F: Passage rate through the anterior digestive tract of broiler chickens fed on diets with ground and whole wheat. *Br Poult Sci*, 43 (5): 662-668, 2002. DOI: 10.1080/0007166021000025037

11. Moghaddam AAR, Ebrahimnezhad Y, Teli AAS: The effects of different sizes of insoluble grit on growth performance and carcass traits in broiler chickens. *J BioSci Biotechnol,* 5 (1): 87-91, 2016.

12. Bennett CD, Classen HL: Performance of two strains of laying hens fed ground and whole barley with and without access to insoluble grit. *Poult Sci*, 82 (1): 147-149, 2003. DOI: 10.1093/ps/82.1.147

13. Fuerjiafu B: The effect of the grit stone on feed passage rate in broiler chickens. *MSc Thesis* in Feed Manufacturing Technology. Norwegian University of Life Science, Department of Animal and Aquacultural Sciences, 2016.

14. Aviagen: Ross Broiler Management Handbook. Huntsville, AL, Aviagen Group, 2014.

15. AOAC: Official Methods of Analysis, Association of Official Analytical Chemists. AOAC International. 17th ed., Maryland. Chapter 4: 1-41, 2000.

16. 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.

17. Farese G, Schmidt JL, Mager M: An automated method for the determination of serum calcium with glyoxal bis (2-hydroxyanil). *Clin Chem*, 13 (6): 515-520, 1967.

18. Carpenter KJ, Clegg KM: The metabolizable energy of poultry feeding stuffs in relation to their chemical composition. *J Sci Food Agric*, 7 (1): 45-51, 1956. DOI: 10.1002/jsfa.2740070109

19. Dawson B, Trapp RG: Basic and Clinical Biostatistics, 3rd ed., 161-182, Lange Medical Books/McGraw-Hill Medical Publishing Division, New York, USA, 2001.

20. Liu H: The effects of marble grit supplementation on the performance of broiler chicken. *MSc Thesis* in Feed Manufacturing Technology. Norwegian University of Life Science, Department of Animal and Aquacultural Sciences, 2016.

21. Yalçın S, Yalçın S, Onbaşılar İ, Eser H, Buğdaycı KE, Şehu A: Effects of granite grit supplementation to broiler diets on performance and carcass characteristics. *JOAAT*, 6 (1): 65-68, 2019. DOI: 10.18178/joaat.6.1.65-68

22. Bale-Therik JF, Sabuna C: Influence of grit on performance of local chicken under intensive management system. **In,** *The 5th International Seminar on Tropical Animal Production Community Empowerment and Tropical Animal Industry,* October 19-22, Yogyakarta, Indonesia. 2010.

23. Adeniji AA: Effects of dietary grit inclusion on the utilization of rice husk by pullet chicks. *Trop Subtrop Agroecosyst*, 12, 175-180, 2010.

24. Bennett CD, Classen HL, Schwean K, Riddell C: Influence of whole barley and grit on live performance and health of turkey toms. *Poult Sci*, 81 (12): 1850-1855, 2002. DOI: 10.1093/ps/81.12.1850

25. Jin L, Gao Y, Ye H, Wang W, Lın Z, Yang H, Huang S, Yang L: Effects of dietary fiber and grit on performance, gastrointestinal tract development, lipometabolism and grit retention of goslings. *J Integr Agric*, 13 (12): 2731-2740, 2014. DOI: 10.1016/S2095-3119(13)60729-7

26. Jones GPD, Taylor RD: Performance and gut characteristics of grit-fed broilers. *Proc Aust Poult Sci Sym*, 11, 57-60, 1999.

27. da Silva Junior VL, de Barros Cotta JT, de Oliveira AIG: Effect of the forms of presentation of corn and the use of grit in the rations on performance in broiler. *Cienc Agrotec*, 27 (5): 1165-1171, 2003. DOI: 10.1590/S1413-70542003000500027

28. Svihus B, Itani K, Borg K, Larsson EC, Ao R, Sudubilige A, Fuerjiafu B, Liu H, Hetland H, Sanson G, Kieronczyk B, Rawski M, Jozefiak D:

Performance and digestive function of broiler chickens given grit in the diet. *Br Poult Sci*, 58 (5): 530-535, 2017. DOI: 10.1080/00071668.2017. 1332404

29. Larsson EC: The effect of granite grit on broiler chickens performance and gizzard development. *MSc Thesis* in Feed Manufacturing Technology. Norwegian University of Life Science, Department of Animal and Aquacultural Sciences, 2016.

30. Makivic L, Glisic M, Boskovic M, Djordjevic J, Markovic R, Baltic M, Sefer D: Performances, ileal and cecal microbial populations and histological characteristics in broilers fed diets supplemented with lignocellulose. *Kafkas Univ Vet Fak Derg*, 25 (1): 83-91, 2019. DOI: 10.9775/kvfd.2018.20356

31. Heuser GF: Influence of the ration on gizzard development in chickens. **In,** Grit Seminar held under the auspices of the Granite Grit Institute of America at Boca Raton, Florida, Nov, 11-12, 1954.

32. Idachaba CU, Abeke FO, Olugbemi TS, Ademu LA: Influence of granite-grit on nutrient digestibility and haematological parameters of broiler chickens fed rice offal based diets. *Pak J Biol Sci*, 16 (19): 1061-1064, 2013. DOI: 10.3923/pjbs.2013.1061.1064