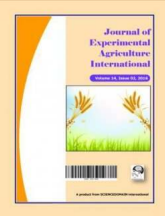


Journal of Experimental Agriculture International

19(2): 1-7, 2017; Article no.JEAI.38168
ISSN: 2457-0591
(Past name: American Journal of Experimental Agriculture, Past ISSN: 2231-0606)

Modulation of Cholesterol in Laying Chickens Fed Sun-Dried Garlic Powder

Funmilayo Grace Adebiyi[1], Anthony Durojaiye Ologhobo[2] and Isaac Oluseun Adejumo[3*]

[1]College of Medicine, University of Ibadan, Ibadan, Nigeria.
[2]Animal Biochemistry and Nutrition Research Unit, Department of Animal Science, University of Ibadan, Nigeria.
[3]Animal Nutrition, Biotechnology and Food Safety Laboratory, Department of Animal Science, Federal University Gashua, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors ADO and FGA designed the study. Author ADO supervised the study. Author FGA carried out the feeding trial. Authors FGA and IOA performed the analyses and handled literature. Author IOA wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JEAI/2017/38168
Editor(s):
(1) Hugo Daniel Solana, Professor, Department of Biological Science, National University of Central Buenos Aires, Argentina.
Reviewers:
(1) Wagner Loyola, Brazil.
(2) Benjamin Valladares Carranza, Autonomous University of The State of Mexico, Mexico.
Complete Peer review History: http://www.sciencedomain.org/review-history/22282

Original Research Article

Received 15th November 2017
Accepted 6th December 2017
Published 14th December 2017

ABSTRACT

Poultry eggs are excellent source of all essential nutrient for persons of all ages but they have been reported to contain high level of cholesterol. This study was conducted to investigate the effect of graded levels of sun-dried garlic powder on performance, serum lipids and egg yolk cholesterol of Isa Brown laying hens. Fresh garlic bulbs were purchased from a commercial market in the northern part of Nigeria. The fresh garlic paste was subsequently thinly spread on clean a mat in direct sunlight for two days during harmattan period. The sun-dried garlic was added as an additive to the basal diet at 1%, 2%, 3%, and 4% inclusion level. Fifty 18 weeks-old Isa Brown chickens were randomly distributed to the 5 dietary treatments. There were no significant differences observed for feed efficiency, egg weight and egg mass among the treatments. The highest feed

**Corresponding author: E-mail: smogisaac@gmail.com;*

intake was observed by chickens fed 1% garlic-based diet when compared with the control group, while 3% and 4% garlic-based diets obtained lower feed intake than the control. Birds on 1% and 2% garlic inclusion had the best hen day production.

Keywords: Allium sativum; atherosclerosis; laying hens; egg parameters.

1. INTRODUCTION

Poultry eggs have been reported to be an excellent source of all essential nutrient for persons of all ages [1]. Unfortunately, poultry eggs have been reported to contain high level of cholesterol. The high cholesterol content of egg has limited its use in human diet. Kritchevsky and Krit-chevsky [2] recorded that the cholesterol content of egg could be as high as 208mg/egg. High intake of cholesterol contributes a great deal to the development of coronary heart diseases. It has been observed that an intake of an egg per day increases coronary heart disease by 2% [3]. This has therefore prompted a considerable research into production of low cholesterol eggs. Deposition of cholesterol is necessary to facilitate proper development of the embryo. This is why it was difficult to produce low cholesterol egg through genetic selection [1]. Research on production of low cholesterol eggs therefore centers mostly on diet and pharmacological interventions. But the high cost of hypocholesterolemic drugs limits use for investigating efficacy in lowering egg-yolk cholesterol. Reports show that lipid metabolism in chicken could be manipulated by dietary intake of fiber, spices, like onion, garlic, ginger and cholesterol lowering drugs like lovastatin and atocotrienol [4-7].

Studies on garlic have indicated that garlic contains hypoglycemic and hypolipidemic properties. The protective effects of organo-sulphur compounds from garlic on atherosclerosis have been attributed to its capacity to reduce lipid content in the arterial wall. Orekhov and Griinwald [8] recorded that the organo-sulphur compound in garlic caused direct antiatherogenic (preventive) and antiatherosclerotic (causing regression) effects in the arterial wall. Mathevv et al. [9] concluded that the antiatherogenic of these organo-sulphur compounds could be attributed to the reactions that inhibit HMG-CoA reductase and other lipogenic enzymes. Though there have been controversial reports on the efficacy of garlic and its products as an hypolipidemic agent. Chowdhury et al. [10] reported that sun-dried garlic paste up to 8% could be used as a hypocholesterolemic agent in practical layers diets. However, some studies show that <3% of garlic powder was just enough to reduce both tissue and serum cholesterol in chicken [5,11-12]. This study was designed to investigate the effect of graded levels of sun-dried garlic powder on performance, serum lipids and egg yolk cholesterol of Isa Brown laying hens.

2. MATERIALS AND METHODS

Locally produced 100 kg fresh garlic bulbs were purchased from a commercial market in the northern part of Nigeria. The garlic bulbs were gently pounded to separate into cloves. The cloves were ground to paste. The fresh garlic paste was subsequently thinly spread on clean a mat in direct sunlight for two days during harmattan period. The sun-dried garlic was added as an additive to the basal diet at 1%, 2%, 3%, and 4% inclusion level. The calculated protein and energy content of the basal diet are 17.07% and 2600 Kcal/kg respectively. The composition of the experimental diets is shown in Table 1.

Fifty 18 weeks-old Isa Brown chickens were randomly distributed to 5 dietary treatments. Each dietary treatment consisted of 5 replicates of 2 birds each. The birds were housed in galvanized iron cages under an intensive management system and the birds were allowed to acclimatize for 2 weeks. The experiment commenced at 20 weeks of age for the next 20 weeks. Feed and water were provided for the birds*ad-libtum*. Weekly feed consumption was obtained by finding the difference between the quantity of teed given to each replicate at the beginning of each week and the left over at the end of the week. The body weight of each bird was taken at the start of the experiment. After which the body weights for each bird were measured every 4 weeks. The eggs laid were collected and the percentage hen-day production was determined from the daily egg production records. The egg mass was calculated thus:

Egg mass = (Egg production x egg weight) / 100.

Eggs collected from each bird in each treatment at weeks 5, 10, 15 and 20 were used for the measurements of internal and external egg

quality parameters. The weight of eggs laid by birds in each replicate was taken using a sensitive electronic scale. The weight of the shell was taken with a sensitive electronic scale. The egg shell thickness was taken using micrometer screw gauge. The egg yolk was separated from the albumen and the weight was also measured using an electronic scale. The yolk colour was determined using the colour range of Rouchecolour fan numbered 1-15 while the yolk height was determined by the use of a vernier caliper. The vernier caliper was also used to measure the egg diameter.

Blood was collected from each bird at week 10 and 20 through the jugular vein. Blood samples for serum lipid analysis was collected in a sterile plain test-tube. The blood was allowed to clot and then centrifuged at 2000 rpm for 10 minutes. The sera samples were carefully removed using pasture pipette and were stored at -20℃ until further analysis. The serum samples were analyzed for Total cholesterol (TC), Triglycerides (TG) and High-Density Lipoprotein Cholesterol (HDLc) using Randox kit (CH201, TR210 and CH203 respectively (Randox Laboratories Limited, Antrim, UK). Eggs used for analysis of yolk cholesterol were collected from each bird at 10^{th} and 20^{th} week of the experiment. The yolk was carefully separated from the albumen using a separating pan. The samples were stored at -20℃ until analysis. One gram of yolk was placed into a centrifuge tube. Twenty milliliters of chloroform: methanol (2:1) was added, blended on a vortex mixture. A 10//L volume of the clear extract was used for the assay of Total Cholesterol. Cholesterol Assay Kit by Dialab (D00119, Dialab GmbH, Austria) was used for the cholesterol estimation.

2.1 Statistical Analysis

Data were analysed by analysis of variance of Completely Randomised design using SPSS version 16 and the means were separated using Duncan multiple range test of the same software. Values are expressed as mean (standard error of mean (SEM)). The level of statistical significance was $p<0.05$.

3. RESULTS

The performance parameters and serum lipids and yolk cholesterol of laying chickens fed varying levels of sun-dried garlicare presented in Tables 2 and 3 respectively, while Fig. 1 shows the egg parameters of chickens fed varying levels of sun-dried garlic. No significant differences were observed for feed efficiency, egg weight and egg mass among the treatments. The highest feed intake was observed by chickens fed 1% garlic-based diet when compared with the control group, while 3% and4% garlic-based diets obtained lower feed intake than the control. The 2% garlic-based diet compared with the control group. Garlic inclusion increased total cholesterol and HDL cholesterol in laying chickens, while it decreased LDL cholesterol and egg yolk cholesterol levels in the

Table 1. Composition of the diets fed to experimental birds

Ingredients	1(0%)	2(1% SDG)	3(2% SDG)	4(3% SDG)	5(4% SDG)
Maize	44.5	45.0	46.5	47.0	47.5
Palm kernel cake	9.0	9.0	8.0	8.0	8.0
Corn bran	8.0	8.0	7.0	6.0	5.0
Wheat bran	9.5	7.0	6.0	5.0	4.0
Groundnut cake	7.0	8.0	8.5	9.5	10.5
Soybean cake	9.5	9.5	9.5	9.0	8.5
Sun-dried garlic	0	1	2	3	4
Fish meal	2.0	2.0	2.0	2.0	2.0
Bone meal	3.0	3.0	3.0	3.0	3.0
Oyster shell	6.6	6.6	6.6	6.6	6.6
Salt	0.25	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0. 1 5	0.15	0.15	0.15
Total	100	100	100	1 00	100
Calculated analysis					
Crude protein (%)	17.07	17.14	17.06	17.07	17.08
Metabolizable energy (Kcal/kg)	2600	2596.5	2596. 1	2582.5	2568.9

experimental animals. There was no significant difference recorded for the mean egg yolk weight, shell weight and shell thickness, among the treatment groups. The egg yolk height of layers fed diets supplemented with 2%, 3% and 4% SDG was significantly increased when compared with birds fed 1% SDG and control diet. The egg yolk height of birds fed 1% SDG was similar to that of the control diet.

4. DISCUSSION

The results indicate that birds fed 1% SDG powder had higher feed intake compare with others. This implies that 1% inclusion of SDG powder may increase acceptability of feed in laying hens. This is consistent with the findings of Rahardja et al. [13] who observed an increase in feed intake when laying hens were fed 1% garlic powder. The feed efficiency for the treatment groups were similar, which is in agreement with this result of Sarranta and Dey [14] who reported that the inclusion of garlic powder in diet of Japanese quails did not affect the feed efficiency. The same trend was reported by Yalcin et al. [5] when laying hens were fed 0.5% and 1% garlic powder. In contrast, Shabby et al. [15] recorded that inclusion of 1-4% garlic powder in the diet of Nile tilapia fish increased feed efficiency. The highest feed efficiency ratio recorded by

Table 2. Performance parameters of laying chickens fed varying levels of sun-dried garlic

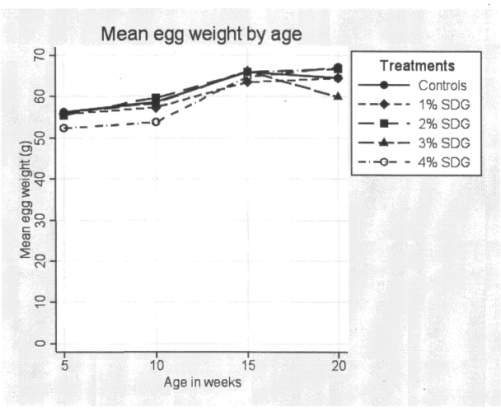
Parameters	Treatments				
	Control diet	1% garlic	2% garlic	3% garlic	4% garlic
Average daily feed intake (g)	99.7±0.57^{b}	101.4±0.32^{a}	99.3±0.46^{bc}	99.1±0.83^{c}	96.4±0.93^{d}
Feed efficiency	2.53±0.24^{ns}	2.34±0.10^{ns}	2.49±0.12^{ns}	2.52±0.21^{ns}	1.99±0.09^{ns}
Egg weight (g)	61.3±1.31^{ns}	60.3±1.09^{ns}	61.2±1.02^{ns}	60.2±0.91^{ns}	59.5±0.90^{ns}
Hen day production (%)	66.9±3.27^{c}	73.7±2.24^{a}	71.7±3.27^{b}	66.3±2.95^{c}	60.9±3.31^{d}
Egg mass (g/day/hen)	40.8±3.90^{ns}	43.7±1.92^{ns}	41.1±2.06^{ns}	40.1±3.62^{ns}	39.6±1.96^{ns}

ns = Non significant, means with different superscripts within the same rows are significant different at P=0.05

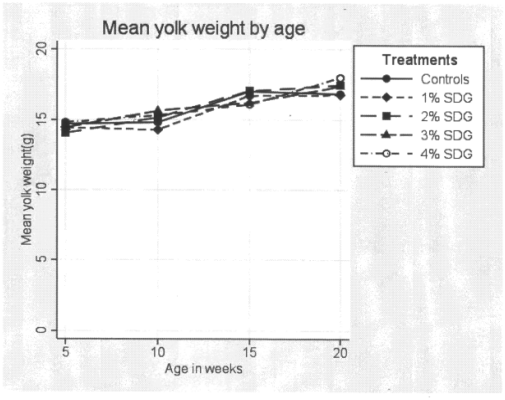
Table 3. Serum lipids and yolk cholesterol of laying chickens fed varying levels of sun-dried garlic

Parameters	Treatments				
	Control diet	1% garlic	2% garlic	3% garlic	4% garlic
Cholesterol (mg/dL)	124.6±1.70^{a}	101.4±4.06^{b}	82.4±1.16^{d}	91.7±1.12^{c}	103.0±1.47^{b}
HDL-cholesterol (mg/dL)	29.4±3.68^{d}	36.2±2.07^{c}	38.7±0.53^{bc}	44.0±1.67^{a}	40.9±0.54^{b}
Triglycerides (mg/dL)	81.3±0.51^{a}	78.4±0.72^{b}	75.6±0.97^{d}	74.9±0.55^{e}	76.9±0.67^{c}
LDL cholesterol (mg/dL)	78.0±2.53^{a}	50.0±7.78^{b}	27.1±1.00d	32.0±2.88^{c}	49.5±1.44b
Egg yolk cholesterol (mg/g)	14.4±1.06^{a}	12.7±1.38^{b}	10.2±0.87^{c}	10.2±0.82^{c}	10.5±1.01^{c}

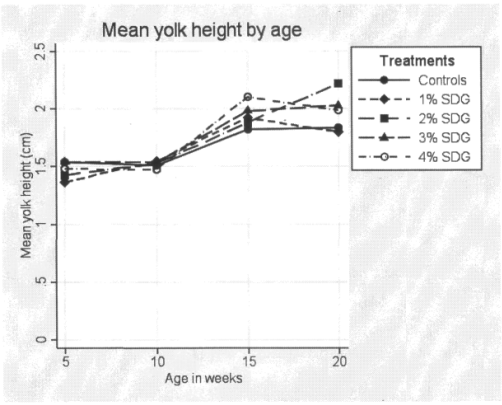
ns = Non significant, means with different superscripts within the same rows are significant different at P=0.05

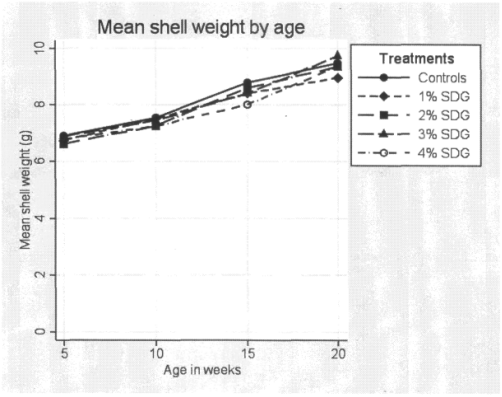


A. Egg weight of chickens fed garlic



B. Yolk weight of chickens fed garlic





C. Yolk height of chickens fed garlic **D. Yolk height of chickens fed garlic**

Fig. 1. Egg parameters of chickens fed varying levels of sun-dried garlic

Shabby et al. [15] was at the inclusion of 3% garlic powder. The reason for this disparity in result might be due to the difference in the genetic components of the animal used in each experiment.

Egg weight was not affected by varying levels of SDG powder as averaged over 20 weeks period. The result of the present is in line with the findings of Khan et al. [16] who reported that inclusion of 2, 6 and 8% oven dried garlic powder exerted no significant difference on egg weight of native Desi laying hens. Ashfaq [17] also reported that inclusion of garlic powder in diets of layers had no significant effect on egg weight in commercial layer stock. In contrast, El-Habbak et al. [18] reported that egg weight in commercial layers increased with supplementation of ethanol extracted garlic because egg laying rate was decreased. Also, Yalcin et al. [5] recorded an increase in egg weight when the diets of laying hens were supplemented with 0.5 and 1% commercial garlic powder. This may be due to the use of different preparation of the garlic powder and the use of ethanol extracted garlic which could yield different chemical constituents. Feeding of graded levels of garlic did not affect egg mass. This agrees with the reports of Chowdhury et al. [10] who recorded no significant difference in egg mass when laying hens were fed 2, 4, 6, 8, and 10% garlic powder.It is indicated that inclusion of 1% and 2% SDG could be sufficient to increase hen day production in Isa Brown layers. Olobaloke and Mulugeta [19] also recorded a decline in egg production at 5% inclusion of garlic powder in the diet of Dekalb white strain hens. In contrast to this finding, Reddy et al. [20] reported that egg production was not significantly affected by inclusion of 0.02% garlic oil in the diet of Babcock layers during the 8 weeks trial. The reason for this difference might be the use of low level of garlic concentration and commercial garlic oil used.

The effect of the inclusion of varying levels of SDG on egg yolk weight was not significant. Also, Rahimi et al. [21] earlier reported no significant difference in yolk weight when laying hens were fed either 1.5% SDG or combination of 1.5% SDG and 200 mg/kg of cupric sulphate pentahydrate. Likewise, the study of Yalcin et al. [5] recorded no differences in yolk weights when SHSY-type brown layers were fed 0, 5, and 10 g/kg garlic powder. The mean value of egg shell weight was not significant among treatment groups. It may be implied that intake of SDG did not exert negative effects in the formation of egg shell neither did it affect its weight.However, Canogullari et al. [22] reported that inclusion of 0.5%, 1% and 2% garlic powder exerted a significant decrease in egg shell weight of 50-week old Hyline white layers. Ghasemi et al. [23] also recorded decrease in shell weight when a 0.2%; mixture of garlic and thyme was included in layer diets. These inconsistent findings may be due to the differences in age and strains of the experimental birds.

The report of the study by Aouadi et al. [24] suggested that inclusion of 10% fresh garlic in the equivalent of 2-3% powder garlic to rat feed was sufficient to exert hypocholesterolemic effect on rat serum. A similar trend was also observed by Lim et al. [25] who reported that the levels of serum total cholesterol in hens fed diets containing 1%, 3% and 5% garlic powder were lower than that of the control. However,

Canogullari et al. [22] found that inclusion of 0.5% - 2% garlic powder had no significant reducing effect on plasma total cholesterol rather a significant increase was observed in birds fed 1% and 2% garlic powder. This observation may be due to the difference in preparation method of garlic powder. Also, 5% raw garlic in the diet of laying hens reduced feed intake while 2% inclusion of raw garlic had the highest hen-house production [26]. The authors reported that the highest hypocholesterolemic effect was observed by hens fed 3% raw garlic, followed by those fed 2%, 4%, 1% and 5% raw garlic respectively. Yeh and Liu [27] also reported 15% decrease in total cholesterol concentration of Sprague-Dawley rats fed 2 g/100 g of aged garlic extract. The reduction was attributed to both water-soluble and lipid-soluble compounds in garlic which they reported to be responsible for the cholesterol lowering effect of garlic. The reduced serum LDL cholesterol and increased HDL cholesterol observed in this study is in agreement with previous findings [6,22,26-31].

5. CONCLUSION

Inclusion of sun-dried garlic at 1% -5% inclusion levels decreased triglycerides, and low-density lipoprotein levels of laying hens, but increased high-density lipoprotein cholesterol. Birds on 1% and 2% garlic inclusion had the best hen day production.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Salma U, Miah AG, Tareq KMA, Maki T, Tsujii H. Effect of dietary *Rhodobacter capsulatus* on egg-yolk cholesterol and laying hen performance. Poult Sci. 2007; 86:714-719.
2. Kritchevsky SB, Kritchevsky D. Egg consumption and coronary heart disease: An epidemiologic overview. J Am Coll Nutr. 2000;19:5498-5555.
3. Weggemans RM, Zock PL, Katan MB. Dietary cholesterol from eggs increases the ratio of total cholesterol to high-density lipoprotein cholesterol in humans: A meta-analysis. Am J Clin Nutr. 2001;73:885-891.
4. Qureshi AA, Peterson DM. The combined effects of novel tocotrienols and lovastatin on lipid metabolism in chickens. Atherosclerosis. 2001;156:39-47.
5. Yalcin S, Onbasilar EE, Reisli Z, Yalgm S. Effect of garlic powder on the performance, egg traits and blood parameters of laying hens. J Sci Food Agric. 2006;86:1336-1339.
6. Prasad R, Rose MK, Virmani M, Garg SL, Pun JP. Lipid profile of chicken (*Gallus domesticus*) in response to dietary supplementation of garlic *(Allium sativum).* Int J Poult Sci. 2009;8:270-276.
7. Zhang GF, Yang ZB, Wang Y, Yang WR, Jiang SZ, Gai GS. Effects of ginger root (*Zingiber officinale*) processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. Poultry Science. 2009; 88:2159-2166.
8. Orekhov AN, Griinwald J. Effects of garlic on atherosclerosis. Nutrition. 1997;13:656-663.
9. Mathew BC, Prasad NV, Prabodh R. Cholesterol-lowering effect of or-ganosulphur compounds from garlic: A possible mechanism of action. Kathnuincht Univ Med J (KUMJ). 2003;*2:*100-102.
10. Chowdhury SR, Chowdhury SD, Smith TK. Effects of dietary garlic on cholesterol metabolism in laying hens. Poult Sci. 2002; 81:1856-1862.
11. Konjufca VH, Pesti GM,Bakalli RI. Modulation of cholesterol levels in broiler meat by dietary garlic and copper. Poult Sci. 1997;76:1264-1271
12. Ologhobo AD, Adebiyi FG, Adebiyi OA. Effect of long term feeding of raw and sun-dried garlic *(Allium sativuiri)* on performance and lipid metabolism of broiler chicks. In Proceedings of the Conference on International Research on Food Security, National Res. Manage. Rural Dev. Univ. Hohenheim. 2008;7-9.
13. Rahardja DP, Hakim MR, Pakiding W, Lestari VS. Hypocholesterolemic effect of garlic powder in laying hen: Low cholesterol egg? J. Indonesian Trop Anim Agric. 2010;35:16-21.
14. Sarrtanta A, Dey A. Effect of feeding garlic (*Allium sativum L.*) as a growth promoter in Japanese quails (*Coturnixcoturnix japonica*) and its

influence on dressing parameters. 1991;26:142-145.
15. Shabby AM, Khattab YA, Rahman AMA. Effects of Garlic *(Allium sativum)* and chloramphenicol on growth performance, physiological parameters and survival of Nile tilapia (*Oreochromis niloticus*). J Venom Anim Toxins Incl Trop Dis. 2006; 12:172-201.
16. Khan SH, Hasan S, Sarda R, Anjum MA. Effects of dietary garlic powder on cholesterol concentration in native desi laying hens. Am J Food Technol. 2008;3: 207-213
17. Ashfaq M. Effect of a dietary mixture of garlic powder (*Allium sativum*) and ground kalongi (*Nigella saliva*) on the performance of layers. M.Sc. Thesis, University of Agriculture, Faisalabad, Pakistan; 2001.
18. El-Habbak MM, Saleh E, Arbid MS, Hegazi AG, Sofi H. Influence of garlic *(Allium sativum)* on some biological and biochemical changes in Japanese quails with special reference to its hypocholesterolaemic activity. Arch Gefiugelkd.1989;53:73-79.
19. Olobatoke RY, Mulugeta SD. Effect of dietary garlic powder on layer performance, fecal bacterial load, and egg quality. Poult Sci. 2011;90:665-670.
20. Reddy RV, Lightsey SF, Maurice DV. Effect of feeding garlic oil on performance and egg yolk cholesterol concentration. Poultry Science. 1991;70:2006-2009.
21. Rahimi S, Rafiei A, Lotfollahian H, Afsharnaderi A. Influence of combined usage of garlic powder and copper on egg yolk cholesterol concentration in laying hens. J Vet Res.2008;*63:*1-6.
22. Canogullari S, Karaman M, Erdogan Z, Baylan M, Kucukgul A, Duzguner V, Ozugur AK. Effect of garlic powder on egg yolk and serum cholesterol and performance of laying hens. The Bull. Vet. Inst. Put. 2009;53:515-519.
23. Ghasemi R, Zarei M, Torki M. Adding medicinal herbs including garlic (*Allium sativum*) and thyme (*Thymus vulgaris*) to diet of laying hens and evaluating productive performance and egg quality characteristics. Am J Anim Vet Sci. 2010;5: 151-154
24. Aouadi R, Aouidet A, Elkadhi A, Rayana MCB, Jaafoura H, Tritar B, NagatiK. Effect of fresh garlic *(Allium sativum)* on lipid metabolism in male rats. Nutrition Research. 2000;20:273-280.
25. Lim KS, You SJ, An BK, Rang CW. Effects of dietary garlic powder and copper on cholesterol content and quality characteristics of chicken eggs. Asian-Australasian Journal of Animal Sciences. 2006;19:582-586.
26. Adebiyi FG, Ologhobo AD, Adejumo IO. Raw *Allium sativum* as performance enhancer and hypocholesterolemic agent in laying hens. Asian J. Anim. Vet. Adv.; 2018. (In press)
DOI: 10.3923/ajava
27. Yeh YY, Liu L. Cholesterol-lowering effect of garlic extracts and organo-sulfur compounds: Human and animal studies. J Nutr. 2001;131:989S-93S.
28. Ademola SG, Lawal TE, Egbewande OO, Farinu GO. Influence of dietary mixtures of garlic and ginger on lipid composition in serum, yolk, performance of pullet growers and laying hens. Int J Poult Sci. 2012;11: 196-201
29. Bamidele O, Adejumo IO. Effect of garlic (*Allium sativum* L) and ginger (*Zingiber officinale* R.) mixtures on performance characteristics and cholesterol profile of growing pullets. Int J Poult Sci. 2012;11: 217-220.
30. Adebiyi FG, Ologhobo AD, Adejumo IO. Efficacy of *Allium sativum* as growth promoter, immune booster and cholesterol-lowering agent on broiler chickens. Asian J. Anim. Sci. 2017;11:202-213.
DOI: 10.3923/ajas.2017.202.213
31. Azeke MA, Ekpo KE. Egg yolk cholesterol lowering effects of garlic and tea. Journal of Biological Sciences. 2008;8:456-460.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22282