Samanthi. Rajarata University Journal 2015, 3: 17-24

ORIGINAL RESEARCH

Dietary Garlic (*Allium sativum L.*) Supplementation on Performance, Meat Quality and Lipid Profile in Broilers

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Abstract

Garlic is known to be one of the natural feed additives which reduces serum cholesterol of broilers. This study was carried out to investigate the growth performances, carcass quality and lipid profile of broilers with different garlic incorporation levels. Four experimental diets were prepared by mixing garlic powder at the ratio of 0, 0.5, 1 and 2 kg/ton with a commercial broiler ration. Two hundred, day-old broiler chicks were randomly assigned to four treatment diets with three replicates of sixteen birds each. Growth performances were reported weekly and carcass quality parameters and lipid profile of blood were measured at 42 d of age. Data were analyzed using one way Analysis of Variance in SAS. The highest ($p<0.05$) feed intake was observed in birds fed with zero garlic level. The highest weight gain and lowest feed conversion ratio were observed in birds fed with 1 kg/ton of garlic ($p<0.05$).

However, there were no differences ($p>0.05$) in dressing percentages among birds fed with different diets. The lowest total serum cholesterol was reported for birds fed with 2 kg/ton garlic in diet followed by those fed with 1 kg/ton garlic in diet. Muscle protein contents were significantly higher ($p<0.05$) in birds fed with 1 kg/ton and 2 kg/ton levels of garlic in diet compared to zero and 0.5 kg/ton garlic levels. In conclusion, garlic powder is an excellent feed additive at the rate of 1 kg/ton to improve the broiler performances and meat quality while reducing their blood cholesterol.

Keywords: Broiler chicks, Feed additive, Garlic, Lipid profile, Performances

Introduction

Feeding is a very important management practice in broiler industry. Good nutrition reflects good bird performances and its quality products. Energy sources, protein sources, vitamins, minerals and feed additives are the major feed ingredients that provide nutrients to the broilers. Feed additives are nutritious or non nutritious substances used in animal feeds to improve animal performances [1]. Feed additives such as antibiotics, antioxidants, enzymes, growth promoters and flavoring agents make an important contribution to all aspects of animal production and it is used in poultry industry to improve broiler performances [2].

Garlic which belong to the family *Liliacea, is* one of natural feed additives which can be mixed with poultry diets. Garlic contains at least 33 sulfur containing compounds, several enzymes 17 amino acids and, minerals including selenium [3]. Garlic is best known as a spice and herbal medicine for the treatment and prevention of diseases [4]. It is also considered as a plant with anticancer, immune modulatory, anti-inflammatory, hypoglycemic and cardiovascular protecting effects. In addition, garlic has stimulating effects on immune and digestive systems of the bird due to very high aromatic oil content[5].

The fast growing nature of broilers and their short generation interval has been associated with use of antibiotics. Most of the time, antibiotics are used as growth promoters in poultry feed to improve the quality of the products. The use of antibiotic based growth promoters is currently facing serious criticism. It is believed and shown that these cause illness and development of microbial resistance to the products and their potential harmful effect on human health[6]. More than 70% of total expenses in broiler management is in the form of feed management. The cost of feed in broiler management can be reduced by feed supplements like garlic[7]. Garlic provides sharp odor, appetizer property and bitter taste and gives flavor to the feeds. In addition, it helps to improve feed palatability, feed intake and feed efficiency. Now a days, people are more concerned about their diets and there is a high demand for healthy diet, especially for low fat and low cholesterol diets. Many studies found that, garlic has ability to reduce the serum and liver cholesterol [8].

The objective of this study was to investigate the effects, of supplementing garlic (as raw garlic powder). in broiler rations on growth performances, meat quality and serum lipid profile of broilers under Sri Lankan conditions.

Materials and Methods

Animal experiment

The animal experiment was conducted at Livestock Experiment Unit, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama. Two hundred day old broiler chicks were obtained from a commercial hatchery (Air Force Breeder Farm, Sigiriya). These chicks were randomly assigned to four dietary treatments with three replicates per each. There were sixteen birds in each replicate. Experiment was conducted as a Complete Randomized Design (CRD). Four treatment diets were prepared by mixing regular diet supplementing with raw garlic powder at 0, 0.5, 1 and 2 kg / ton diet. Commercial starter and finisher feeds were used as basal diet.

Before the arrival of chicks, rooms, brooder guards, feeders and waterers were thoroughly cleaned. Broiler chicks were divided into four groups and each group included fifty chicks. They were randomly distributed into four brooders and reared under good hygienic conditions. Chicks spent ten days of brooding period and 60 W electric bulbs were used to provide the initial heating and lighting. All chicks were provided with Vitamin E, Selenium and glucose solution with drinking water to reduce stress. They were also provided with Enfroxacillin as antibiotic and multi vitamin with drinking water up to 5 days. All birds were vaccinated against infectious bursal disease (IBD) at the age of 7 and 14, and for new castle disease at the ages of 18 and 24 days. Feeds were provided according to the Veterinary Research Institute, Gannorruwa (VRI)

recommendations. Broiler starter diets were fed from d 1 to d 21 and after 21 days of feeding, starter diets were changed to the finisher diets. Water was provided *ad libitum*. All other general management practices were followed until the birds were slaughtered.All birds were slaughtered at the end of the experiment. Anti mortem inspections were done by visual observations. All birds were starved for about 16 - 20 hours. Birds were weighed before slaughter. Birds were kept in killing cones and major blood vessels (carotid arteries and jugular veins) were cut within 10 seconds and bleeding was taking place for at least 3 minutes. Scalding was done by dipping the carcass in hot water (60^0C - 65^0C) for 2 - 5 minutes. Leg was cut from the shank.

Feathers were removed by de- feathering machine and remaining feathers were shaved by a sharp knife. Then a cut was made at the end of the abdomen to open the abdominal cavity. Entire digestive tract, respiratory tract and heart were removed. Liver was removed and gall bladder was peeled away. Gizzard was cleaned and inner layer was removed. Then, carcass weight was noted. Finally, meat was packed and stored under freezing (-18^0C) condition.

Data Collection and Calculations

Given feed, remaining feed and body weight were measured weekly throughout the study period. Feed intakes, weight gains, feed conversion ratio (FCR) and dressing percentages were calculated as follows.

$$\text{Feed intake (g)} = \text{Given feed} - \text{Remain feed}$$

$$\text{Weight gain of bird (g)} = \text{Final weight (42d)} - \text{Initial weight (day 1)}$$

$$\text{FCR} = \frac{\text{Feed intake}}{\text{Weight gain}}$$

$$\text{Dressing percentage (\%)} = \frac{\text{Carcass weight}}{\text{Live weight}} \times 100$$

Blood samples were collected in to sterilized tubes (without an anticoagulant) between 8.00 - 10.00 am from six randomly selected fasting birds from each replicate. Immediately serum were separated by centrifugation at 1500 g for 20 min. Then, samples were stored in -20 ^{0}C until analysis. Enzymatic colorimetric test was used to determine the total serum cholesterol and high density lipoprotein (HDL) cholesterol.

$$\text{Cholesterol Concentration} = \frac{\Delta \text{ A sample}}{\Delta \text{ A Starndard}} \times \text{Standard Concentratio}$$

$$\text{HDL Cholesterol} = \frac{\Delta \text{A sample}}{\Delta \text{A starndard}} \times \text{Standard Concentration}$$

Low density lipoprotein (LDL) cholesterol content was calculated by subtracting the HDL cholesterol content from total cholesterol content.

$$\text{LDL Cholesterol} = \text{Total cholesterol} - \text{HDL Cholesterol}$$

After slaughtering the birds, meat samples (approximately 25 g) were taken from breast area. Crude fat and protein (CP) contents in meat were analyzed according to the Association of Official Analytical Chemist (AOAC) methods[9].The cost of different diets were (Rs/kg) recorded. Feed intake per bird during the study period was used to estimate the cost of feed consumed by a bird for the period.

Weight gain, feed intake, FCR, dressing percentage, lipid profile of blood, CP and CF of the meat were analyzed using the ANOVA procedure of SAS. Mean separation was done by Tukey's Studentized Range Test (TSRT). Statistical significance was declared at $p < 0.05$.

Results and Discussion

Growth Performances

Table 1. Growth performances of broilers fed with different levels of garlic in the ration

Treatments (Garlic kg / ton)	Feed intake (g)	Weight gain (g)	FCR
0	3750±18^{a}	1902 ± 30^{b}	1.97±0.03^{a}
0.5	3650±18^{b}	2018 ± 30^{a}	1.81±0.03^{b}
1	3614±18^{b}	2137 ± 30^{ab}	1.69±0.03^{b}
2	3640±18^{b}	2002 ± 30^{ab}	1.81±0.03^{b}

Data are presented as means ± SE

^{a,b}means within the same column with different superscripts are significantly different ($p< 0.05$)

There was a significant difference ($p< 0.05$) among total feed intakes in broilers fed with different treatment diets (Table 1). Feed intake of birds fed with the control diet (Garlic 0 kg/ton) was significantly higher ($p< 0.05$) than the birds fed with diets containing garlic powder. There was no difference ($p > 0.05$) in feed intakes among birds fed with different levels of garlic powder in their diets and numerically, birds fed diet containing 1 kg/ ton garlic powder recorded the lowest feed intake.Kamal and Omar *et al.*,[10] concluded that feed intake was reduced with garlic supplementation, probably due to the associated flavour factors. Also in this study, we observed a decreasing trend in feed intakes with increasing levels of garlic powder in their diets.

Weight gain was significantly higher ($p< 0.05$) in birds fed with 0.5 kg / ton garlic in diet compared to control treatment (Table 1). However, weight gain was similar in birds fed with different garlic level in their diets. Results found for body weight gain were in agreement with Adimola *et al.*[7] results who reported that, garlic supplementation improved the slaughter weights and body weight gain of broilers. Further, according to Mansoub and Nazhad[11], body weight of broilers improved by feeding garlic (1 g/ kg) with basal diet. It has also been shown that, garlic constituents interact with gut endocrine system, and hence able to stimulate selective population of intestinal cell and cause enlargement of intestinal villi, particularly in duodenum section, with a resulting increase of absoprtive capacity. This mechanism could provide a clue for the improved weight gain of chicken despite the reduced intake of garlic supplemented diet[12].

There was a significant difference ($p< 0.05$) in FCR of broilers fed different treatment diets (Table 1). Feed conversion ratio of birds fed with control diet was significantly higher ($p< 0.05$) than the birds fed with diets containing garlic powder. However, there was no difference ($p> 0.05$) in FCR among birds fed with different levels of garlic powder in their diets. Numerically, birds fed diet containing 1 kg/ ton garlic powder recorded the lowest FCR among garlic supplemented diets. The results obtained in this experiment for FCR agreed with Fadlall*et al.*,[13] and Raseei *et al.*,[14] results who found better FCR when supplementing garlic in broiler diets.

According to the Slyranda *et al.*,[15], better FCR of the broilers may be attributed to the antibacterial properties of this supplement, which resulted in better feed absorption of the nutrients present in the gut and finely leading to improvement in FCR. This study also clarified that, the birds fed ration supplemented with garlic

utilized feed more efficiently than those fed ration without addition of garlic. In other reports, it has suggested that incorporation of garlic powder into poultry diet helps to reduce the turn-over rate and the number of sloughed cell in the intestinal epithelium, thereby saving large amounts of feed energy needed to perform this function, and directing such energy to productive puprose. This could also be a factor contributing to the better feed efficiency observed with garlic supplemented diets [10].

There was no difference (p> 0.05) in dressing percentages in birds fed with different treatments diets. Numerically, the highest dressing percentage was reported in birds fed 1 kg / ton garlic powder in their diet. Mahmood *et al.*,[16] concluded that, a basal feed containing garlic powder improves body weight gain and FCR but failed to produce positive effects on carcass yield in terms of dressing percentage.

Serum Lipid Profile

There was a significant difference (p< 0.05) in total cholesterol levels in birds fed with different treatment diets (Figure 1). However, total cholesterol levels were similar in birds fed with the control diet and 0.5 kg / ton garlic powder in their diet. Further, birds fed with 1 and 2 kg / ton garlic powder levels reported lower total cholesterol levels compared to 0 and 0.5 kg / ton garlic fed birds.

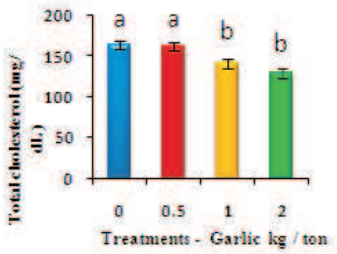

Figure 1. Total Serum Cholesterol

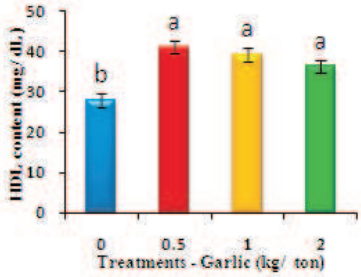

Figure 2. Serum High Density Lipoprotein

[a/b]means within the different treatments with different superscripts are significantly different (p < 0.05)

Ologhobo*et al.*,[17] reported that, garlic has reduced triglycerides and serum total cholesterol levels and the best results were obtained when fed 2% of garlic with basal diet. Results of this study agreed with above conclusion. In this experiment, total cholesterol content was significantly (p< 0.05) decreased by 1 and 2 kg / ton garlic supplementation. This may probably be due to the possible mechanism of hypocholestrolaemic and hypolipidemic action of garlic which depresses the hepatic activities of lipogenic and choleterogenic enzymes such as malic enzyme, fatty acid synthes, glucose-6-phosphatase dehydrogenase [10].

There was a significant difference (p< 0.05) in HDL concentrations in serum of birds fed with different treatment diets and higher (p< 0.05) HDL levels were recorded in birds fed garlic in their diets compared to the control diet (Figure 2). However, there was no significant difference (p> 0.05) in HDL concentrations among birds fed with different garlic powder levels and numerically, the highest HDL (41.17 mg / dL) was recorded in birds fed with 0.5 kg /

ton garlic powder in their diets. Prasad *et al.*,[18] concluded that, HDL was significantly increased by garlic supplementation in chicken up to 8 weeks of age in comparison to control group. Above results agreed with results of the present study. In this study, HDL concentration was increased with garlic supplementation.

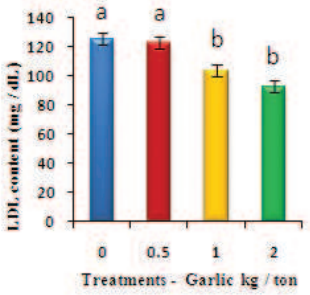

Figure 3. Serum Low Density Lipoprotein

[a,b]means within the different treatments with different superscripts are significantly different ($p < 0.05$)

There was a significant difference ($p< 0.05$) in LDL content in birds fed with different treatment diets (Figure 3). However, the LDL levels were similar in birds fed with control diet and 0.5 kg / ton garlic in diet. Further, LDL levels were similar in the birds fed with 1 and 2 kg / ton garlic powder in diets, but the levels were lower ($p< 0.05$) compared to the birds fed control diet and 0.5 kg / ton garlic in their diets. When broilers were supplemented with 1 g/ kg garlic reduction in total cholesterol and LDL cholesterol were observed by Mansoub[11]. The results of the present study also proved the same results. Apart from this, many studies reported decreased LDL levels with garlic supplementation compared to the birds fed with control diet. This effect can be explained by the possible mechanism of antioxidant and antiperoxide lowering action of garlic powder on LDL or the decrease in hepatic production of Very Low Density Lipoprotein (VLDL) which serves as the precursor for LDL in the blood circulation. This factor also contributed to the reduction of LDL content in birds fed with garlic supplement diet[10].

Meat Quality

There was a significant difference in crude protein content in the meat samples obtained from birds fed different diets. Birds fed with 1 kg / ton garlic level recorded the highest protein (25.7%) in the meat (Figure 4). Higher protein content affected the improving of meat quality.

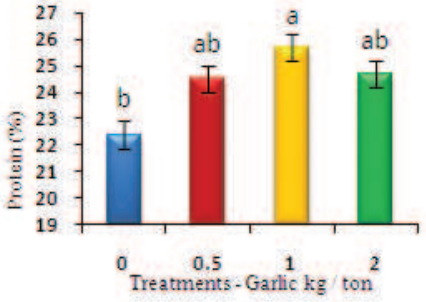

Figure 4. Muscle protein content

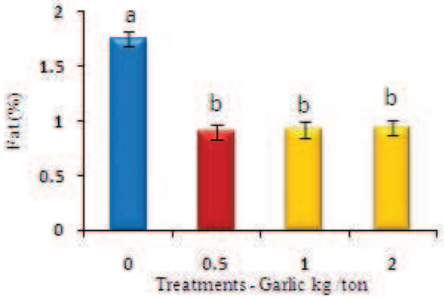

Figure 5. Muscle fat content

[a,b]means with different superscripts are significantly different ($p < 0.05$)

There was a significant difference ($p< 0.05$) in crude fat content in the meat samples obtained from birds fed different treatment diets and fat contents were significantly ($p< 0.05$) lower in the meat samples obtained from birds fed with garlic in their diets compared to birds fed control diet (Figure 5). However, fat content of birds fed with different garlic levels in their diets were similar. Fayed[12] reported that, cholesterol is usually associated with adipose tissue. Reduction of serum cholesterol causes reduction of fat deposition in adipose tissues and improves the meat quality.

Feed Cost

Birds fed with garlic powder showed lower feed costs compared to the birds fed with control diet (Table 2). This may be due to the improved feed efficiency which helps to gain more wight with lower feed intake. These findings were in agreement with Fadlalla [13] who reported that, the birds fed rations upplemented with garlic utilized their feed more efficiently than those feed ration without addition of garlic.

Table 2. Feed cost per bird

Treatments (Garlic kg/ton)	Feed Cost (Rs: / bird)
0	323.41
0.5	319.00
1	319.97
2	321.57

Conclusion The results of the present study indicated that the best production performance parameters are attained by the birds fed the diet supplemented with 1 kg / ton level of garlic powder. The lower serum total cholesterol, LDL concentration and higher

HDL concentration are attained by the birds fed with 2 kg / ton garlic in the diet. Considering the additional feed cost accounted for 2 kg /ton garlic level, 1 kg / ton garlic level is the best with better bird performances, serum lipid profile and meat quality.

References

1. Elagib HAA, El-AminWIA, ElaminKM, Malik HEE. Effect of dietary garlic (*Allium sativum)*supplementation as feed additive on broiler and blood profile.*Journal of Animal Science Advances*2003; 3(2): 58-64.

2. Khan HS, SardarR, AnjumMA. Effects of dietary garlic on performance and serum and egg yolk cholesterol concentration in laying hens. *Asian Journal of Poultry Science*2007; 1: 22-27.

3. Newall CA, Anderson LA, PhillipsonJD. Herbal medicines a guide for health care professionals, Pharmaceutical Press, London, 1996.

4. Adidmoradi M, NavidshadB, SeifdavatiJ, RoyanM. Effect of dietary garlic meal on histological structure of small intestine in broiler chickens. *Poultry Science*2006; 43:378-83.

5. Gardzielewska J, PudyszakT ,MajewskaK, JakubowskaM, PomianowskiJ. Effect of plant supplemented feeding on fresh and frozen storage quality of broiler chicken meat. *Animal Husbandry series of electronic Journal of Polish Agricultural University* 2003; 6:23-26.

6. Rahmatnejad E, RoshanfekrO, AhayerizadehM, AhayerizadehA.

Evaluation of several non-antibiotic additive on growth performance of broiler chicken. *Journal of Animal and Veterinary Advances 2009;* 8:1670 – 73.

7. Adimola, SG, FarinuGO, Babatunde GM. Serum lipid, growth and haematological parameters of broilers fed garlic. *World Journal of Agricultural Sciences* 2009;5(1):99-104.

8. Khan U, NikousefatZ, TufarelliV, NazS, JavdaniM, LaudadioV. Garlic (*Allium sativum*) supplementation in poultry diets: effect on production and physiology. *World's Poultry Science Journal*2010; 68:417-24.

9. AOAC (Association of Official Analytical Chemist). Official Methods Analysis, 2010.

10. Kamal JI, Omar JMA. Effect of garlic powder on performance and lipid profile of broilers. *Open Journal of Animal Sciences*2012;10: 4236.

11. Mansoub HN, NazhadMAM (2011). The effects of using Thyme, Garlic and nettle on performance, carcass quality and blood parameters. *Animals of Biological Research*2011; 2 (4):315-20.

12. Fayed RH, AbeerH, RazekA, OufM. Effect of dietary garlic supplementation on performance,carcass traits and meat quality in broiler chicken. Proceeding of: ISAH Congress, 2011.

13. Fadlalla MT, MohammedBH, BakhietAO.*Asian Journal of Poultry Science* 2010; 4: 182 – 89.

14. Raeesi MS, Hoeini–AliabadA, ShahnehAZ, PiraliS. Effect of periodically use of garlic (*Allium ativum*) powder on performance and carcass characteristic in broiler chickens. *World Academy of Science* 2010; 68:113 – 19.

15. Slyranda BA, IgnatiusK, AdathuA, AdoY, NuhuJB, AliyuAAU, GamboMBIbrahimMA, AbubakarH, BukarMM, Imam HAM, NumanT. Effects of feeding onion (*Allium sativum*) on some performance characteristic of broiler chickens. *Journal of Poultry Science*2011; 4 (2): 22 – 27.

16. Mahmood S, HassanMM, AlamM, Ahmad F. Comparative efficacy of *Nigella sativa* and *Aliumsativum* a growth promoters in broilers. *International Journal of Agriculture and Biology2009*;11:775 – 78.

17. Ologhobo AD, AdebiyiFG, AdebiyiOA. Effect of long term feeding of raw and sun dried garlic (*Aliumsativum*) on performance and lipid metabolism of broiler chick: Conference on International Research on Food Security, Natural Resource Management and Rural Development, Tropentag, University of Hohenheim, 2008; 7 – 9.

18. Prasad R,RoseM K, VirmaniM, GargSL, PuriJP. Lipid Profile of Chicken in responses Dietary Supplementation of Garlic. *International Journal of Poultry Science2009;* 8:270 – 76.