Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Effect of garlic powder (*Allium sativum*) on growth, dressing parameters, serum biochemical contents and profitability of broiler

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Abstract

This study was conducted to evaluate the effect of garlic an alternative feed additive in broiler diet. The experiment was carried out for a period of 32 days with a number of 340 day-old straight run broiler chicks. Birds were divided into five dietary treatment groups with 4 replications each having 17 birds. The dietary groups were; control (basal diet; no additives), antibiotic (basal diet + antibiotic), garlic 0.25% (basal diet + 0.25% garlic powder), garlic 0.50% (basal diet + 0.50% garlic powder) and garlic 0.75% (basal diet + 0.75% garlic powder). Results showed that the body weight, body weight gain and total FCR were not differ significantly ($P>0.05$) among the treatment groups. Total feed intake in different dietary levels showed significant ($P<0.05$) difference. Control group showed significantly ($P<0.05$) higher feed intake than the other dietary groups. The results also showed thatthe serum glucose concentration was reduced ($P<0.05$) in all garlic supplemented groups compared to the control and antibiotic groups. Total cholesterol level was significantly ($P<0.05$) lower in the 0.75% garlic group compared to the control and antibiotic groups. In case of dressing parameter, 0.75% garlic group showed lowest ($P<0.05$) abdominal fat compared to the other groups. Cost of production per kg live broiler was lower in antibiotic and control groups compared to the garlic group. With regards to profit, antibiotic groups showed higher profitability than the other groups. It can be concluded that the addition of garlic powder to broiler diet had positive effect on cholesterol and glucose levels and had no effect on feed intake, body weight gain, meat yield, bone development, carcass parameters. It can be suggested that the garlic could be a potential feed additive in broiler diet.

Key words: garlic, growth, dressing parameters, serum biochemical content, broiler

 Bang. J. Anim. Sci. 2017. 46 (4):215-224

Introduction

Poultry meat production is one of the most important and first growing industry of agriculture in Bangladesh to meet up the requirement of protein and nutrition. The consumers of today's world are much aware of their health and the quality of their food items. Safe food is not luxury for the rich, rather a right for everybody. Unfortunately, some uneducated or dishonest poultry growers aren't following the withdrawal period for antibiotics in their broiler feed, which adversely effects on human health. Since 1950's farmers have been using antibiotics in animals feed regularly to attain increased growth rate (Ogle, 2013). With the commercialization, the use of several chemicals, antibiotics, growth promoters at sub-therapeutic levels over extended period is also increased, which have adverse effects in poultry health and its residues in meat can cause danger for human health.

The use of antibiotics as feed additives is hazardous due to cross- resistance and multiple resistances of pathogens. Considering this, European Union (EU) has banned antibiotic growth promoters since 2006 (Castanon, 2007). Thus, during the last decade many studies had investigated the use of new and promising feed-additives including probiotics, prebiotics, enzymes, and plant extracts in animal feeding (Sarica *et al*., 2005). Since, Bangladesh is very rich in herbal and medicinal plants, inclusion of medicinal plants and herbs such as garlic (*Allium sativum*) in poultry diet could be a good approach. Garlic has prescribed as a folk medicine for thousands of years, from the time of the ancient Greeks to the early Egyptians (Horton *et al*., 1991). Furthermore, garlic contained abundant bioactive components like sulfur containing compounds (alliin, diallylsulfides and allicin, ajoene) which act as antimicrobial (Gebreyohannes and Gebreyohannes, 2013; Jaber and Al-Mossawi, 2007), antibacterial (Tsao and Yin, 2001), antifungal (LedezmaandApitz-Castro, 2006),

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antiviral (Tsao and Yin, 2001), antioxidant (Prasad *et al*., 1995), antithrombotic (Fukao *et al*., 2007), anticancer (Dorant *et al*., 1996).

Moreover, garlic has been found to lower serum and liver cholesterol (Qureshi *et al*., 1983a) and abdominal fat percentage (Ashayerizadeh *et al*., 2009). Numerous reports have been published and described the beneficial effects of garlic ongrowth efficiency of broilers (Kumar *et al*., 2010). Ramakrishna *et al*. (2003) suggested that garlic supplementation enhances the activity of pancreatic enzymes and provides an environment for better absorption of nutrients. The use of garlic as a spice for human consumption is very common but considering the bioactive component their use in broiler diet is not a common idea in Bangladesh. Literature on the effect of feeding garlic on broiler performance as well as its cost effectiveness under Bangladesh condition is scanty. Therefore, this study was planned to explore some recent information on the effects of garlic powder on growth performance, dressing parameters, serum biochemical contents and economics of broiler production.

Materials and Methods

Experimental design and broiler diet

A total of 340 day-old straight run Cobb 500 commercial broiler chicks were randomly divided intofive dietary treatment groups and then each treatment group into four replications. The experiment was carried out over a period of 32 days. The dietary treatment groups were; control (basal diet; no additives), antibiotic (basal diet + antibiotic), garlic 0.25% (basal diet + 0.25% garlic powder), garlic 0.50% (basal diet + 0.50% garlic powder) and garlic 0.75% (basal diet + 0.75% garlic powder). Two types of broiler diets were formulated namely starter (0-21 days) and grower (22-32 days). The nutrient requirements (ME, CP, CF, EE, Ca, P, Lysine and Methionine) were satisfied as per recommendation of Cobb-500 broiler strain. Composition of ingredients and estimated nutrient contents of diets are shown in Table 1 and 2.

Table 1. Ingredientsand chemical composition of broiler starter diet

Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Maize	54.5	54.5	54.5	54.5	54.5
Soya meal	30.9	30.9	30.9	30.9	30.9
Protein concentrate	8	8	8	8	8
Di calcium phosphate	1.35	1.35	1.35	1.35	1.35
Limestone	0.8	0.8	0.8	0.8	0.8
Soybean oil	4.5	4.5	4.5	4.5	4.5
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.12	0.12	0.12	0.12	0.12
Vitamin-mineral premix	0.30	0.30	0.30	0.30	0.30
Common salt	0.34	0.34	0.34	0.34	0.34
Antibiotic	-	0.02	-	-	-
Garlic	-	-	0.25	0.50	0.75
Total (kg)	100	100	100	100	100
Chemical composition (calculated)					
ME (Kcal/kg)	3113	3113	3113	3113	3113
CP%	23	23	23	23	23
Ca%	0.83	0.83	0.83	0.83	0.83
Av. P%	0.44	0.44	0.44	0.44	0.44
Met%	0.51	0.51	0.51	0.51	0.51
Lys%	1.25	1.25	1.25	1.25	1.25

ME= Metabolizable Energy, CP= Crude Protein, Ca= Calcium, Av. P= Available Phosphorus, Met= Methionine, Lys= Lysine

Table 2. Ingredients and chemical composition of broiler grower diet

Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Maize	60	59.98	59.75	59.75	59.75
Soya meal	24.09	24.09	24.09	24.09	24.09
Protein concentrate	8	8	8	8	8
Di calcium phosphate	1.35	1.35	1.35	1.35	1.35
Limestone	0.7	0.7	0.7	0.7	0.7
Soybean oil	5	5	5	5	5
Lysine	0.1	0.1	0.1	0.1	0.1
Methionine	0.12	0.12	0.12	0.12	0.12
Vitamin-mineral premix	0.30	0.30	0.30	0.30	0.30
Common salt	0.36	0.36	0.36	0.36	0.36
Antibiotic	-	0.02	-	-	-
Garlic	-	-	0.25	0.50	0.75
Total (kg)	100	100	100	100	100
Chemical composition (calculated)					
ME (Kcal/kg)	3187	3185	3179	3179	3179
CP%	20.6	20.6	20.58	20.58	20.58
Ca%	1.05	1.05	1.05	1.05	1.05
Av. P%	0.42	0.42	0.42	0.42	0.42
Met%	0.48	0.48	0.48	0.48	0.48
Lys%	1.06	1.06	1.06	1.06	1.06

ME= Metabolizable Energy, CP= Crude Protein, Ca= Calcium, Av. P= Available Phosphorus, Met= Methionine, Lys= Lysine

Management practices

Experimental shed and necessary equipment's were properly cleaned, washed, dried, disinfected and subsequently left empty for a week before the arrival of chicks. Feeders were cleaned in every week and drinkers were cleaned twice daily. Starter diet was provided for the first 21 days and grower diet was provided to the broiler up to 32 days of age. In all cases, adlibitum feed were offered to the broilers. Feed was supplied four times daily, once in the morning, noon, afternoon and again at night in such a way that feeder was not kept empty. Fresh and clean water was made available at all times. Fresh and dried rice husk was used as litter material and spread over the floor at a depth of about 3 cm. After first two weeks, the upper part of the litter with droppings was removed and replaced with new one. After 14 days, litter was stirred in every alternative day to dry up quickly and to remove harmful gases. The chicks were brooded in respective pens using one 100 watt electric bulbs in each pen. The chicks were provided with a temperature of 35°C at first week of age, decreasing gradually at the rate of 3°C per week continued up to 4 weeks of age.

Growth performances of bird

Body weights, body weight gain of the experimental bird were measured for every week from the initial day to final day of the study. Feed intake and Feed conversion ratio (FCR) were calculated on weekly basis.

Measurement of dressing parameters, meat yield and bone development

At the end of the experimental period, two broilers with average pen weights from each replication were selected, slaughtered and dissected. After complete bleeding, head, legs, feathers, viscera and skin were removed in order to determine carcass weight. Meat (breast, thigh, drumstick and wing) and bone (whole leg, drumstick, thigh and wing) relative weights were determined by weighing each meat or bone with respect to body weight. The length of drumstick and thigh bones was measured in centimeters (cm). Relative weights of dressing parameters (head, neck, skin and abdominal fat) and internal organ (liver, heart and gizzard) were also determined by calculating the weight of each parameter or organ with respect to body weight.

Blood collection and measurement of serum biochemical parameters

At the end of the experiment one bird of average body weight from each replication was taken randomly for the collection of three or four ml of blood sample.Tubes were placed in a slanting position (45ºangles) at room temperature for clotting. After 2 hours separated blood serum was transferred to an eppendorf tube and centrifuged at 3000 rpm for 10 minutes. The serum was then transferred into another eppendorf tube and preserved at -20^{0}C until analysis. The eppendorf tubes were marked properly with permanent marker for easy identification during chemical analysis. After separation of serum from the blood, serum was transferred to laboratory for serum lipid profile determination.Serumtotal cholesterol levels was determined by enzymatic (CHOD-PAP) colorimetric method and Glucose plasma levels were determined by using an enzymatic colorimetric kit (GOD-PAP).

Statistical analysis

Data were analyzed by using the general linear models of SAS (2009) to estimate variance components with a completely randomized design. Duncan's multiple comparison tests were used to examine significant differences among the treatment means. The level of significance was set at P<0.05.

Results and Discussion

Body weight and body weight gain of broiler

Body weight and body weight gain of broilers in different dietary groups are presented in the Table 3. Data indicates that the 2nd and 3rd week body weight showed significant difference (P<0.05) among the dietary groups. Garlic 0.75% group showed significant lower performance compared to the control and antibiotic group in 2nd week and 3rd week. Addition of garlic to experimental diets showed minor influence on body weight and body weight gain as compared to antibiotic. This was in general agreement with the previous studies regarding garlic (Galib and Huda 2013 and Zekić *et al*., 2014). The results of the present study contrasted with some of the previous observations which indicated no effect on the body weight and body weight gain in broiler (Choi *et al*., 2010; Fadlalla *et al*., 2010 and Issa and Omar, 2012). It has proved that garlic significantly enhanced villus and goblet cell numbers in the duodenum, jejunum and ileum of birds (Adibmoradi *et al.*, 2006). As a result of these intestinal morphological changes, the entire absorptive process in the birds is better activated. In this way nutrient absorption is enhanced with the resultant growth promoting effect (Tatara *et al*., 2005; Masoud, 2006). Langhout (2000) showed that herbal plant could stimulate the digestion system of birds, improve the function of liver and increase the pancreatic digestive enzymes and thus enhancement the metabolism. The improvement of performance observed in broilers by providing diet containing garlic powder might be due to the improvement of nutrient digestibility associated with the development of digestive tract and digestive organs (Lilja, 1983).

Feed intake

Data revealed in Table 3 indicate that total feed intake in different dietary levels showed significant difference. Control group showed significantly (P<0.05) higher feed intake over the other dietary groups. Among the supplemental groups, garlic 0.75% group showed significantly (P<0.05) the highest feed intake. This finding is also contrasted with Javandel *et al*. (2008) who reported that feed consumption was significantly higher in birds fed diets with lower concentration of garlic 0.125%, 0.25%. Isa (2011) also mentioned that feed intake was affected by herbal supplementation as single supplements. Moreover, some of the previous observations contrasted present study and indicated garlic had no effect on feed intake (Yalcın *et al*., 2006; Canogullar *et al*., 2009 and Raeesi *et al*., 2010).

Feed conversion ratio

Resultspresented in the Table 3 indicated that 1st and 2nd week FCR were significantly differed among the groups. Better FCR was observed in garlic 0.5% groupin 1st week and control and antibiotic group in 2nd week of age. However, there were no significant effect (P>0.05) on 3rd week, 4th week, 32 days and total FCR of broiler in different treatment groups. In case of total FCR value, antibiotic and garlic groups (0.25% and 0.5%) showed numerically better FCR compared to the control.Report showed that birds received 3% garlic powder in their diets had better FCR than control group (Raeesi *et al.* 2010).Supplementation of garlic improved FCR as such as antibiotic compared with the control group in this study. The significant effect of garlic on FCR of broiler was in close agreement with Onyimonyi *et al*. (2012), Abd El-Latif *et al*. (2013) and Galib and Huda (2013). The

improvement in FCR upon the supplementation was probably due to the increased activity of sulfur compoundsmainlyalliin, allicin, ajoeneof garlic.

Meat yield and bone development

Figure 1 and Table 4 indicated that there were no significant (P>0.05) differences in meat yield (breast meat, thigh meat and wing weight) and bone development (thigh bone, drumstick bone, thigh length, drumstick length) among different treatment groups.This result was supported by Hashish *et al*. (1995). This result was in disagreement with previous research where supplementation of 1% garlic powder caused higher thigh yield while the poorest thigh yield belonged to 3% garlic powder group (Wibawa *et al*., 2016). Groups received 1% garlic powder significantly had higher breast yield than others (Qureshi *et al*. 1983

Table3. Growth performances of broiler in different dietary treatments

Parameters	Treatment					PSE
	Control	Antibiotic	Garlic 0.25%	Garlic 0.50%	Garlic 0.75%	
Body weight (g/bird)						
Initial wt.	41.57	41.47	41.59	41.41	41.38	00.24
1st week	147.00	152.62	146.94	151.26	149.53	05.38
2nd week	386.03a	384.26a	360.06ab	359.50ab	351.56b	20.01
3rd week	782.62a	770.44ab	712.03bc	722.97abc	704.29c	40.39
4th week	1107.49	1105.18	1059.37	1068.85	1041.33	45.43
32 days	1456.98	1458.90	1442.77	1442.17	1439.75	63.64
Body weight gain (g/bird)						
1st week	105.43	111.15	105.35	109.85	108.15	05.34
2nd week	239.03a	231.65ab	213.12abc	208.24bc	202.03c	17.48
3rd week	396.59	386.18	351.97	363.47	352.74	31.56
4rth week	324.87	334.74	347.34	345.88	337.04	28.68
32 days	349.50	353.71	383.40	373.31	398.42	41.66
Total	1415.41	1417.43	1401.18	1400.75	1398.37	63.62
Feed Intake (g/bird)						
1st week	126.47a	123.53ab	117.65c	119.12c	120.00bc	02.50
2nd week	288.24a	279.41c	285.29ab	282.35bc	287.35a	02.65
3rd week	505.88a	500.59b	491.18c	494.12c	498.24b	01.98
4th week	788.24a	776.47c	770.59d	773.53cd	782.35b	03.03
32 days	682.35a	670.59b	673.53b	679.41a	680.88a	03.26
Total	2391.18a	2350.59c	2338.24c	2348.53c	2368.82b	10.45
FCR (Feed/Gain)						
1st week	1.20a	1.11ab	1.12ab	1.08b	1.11ab	00.05
2nd week	1.21b	1.21b	1.34ab	1.36ab	1.42a	00.09
3rd week	1.28	1.30	1.40	1.36	1.41	00.11
4th week	2.43	2.32	2.22	2.24	2.32	00.19
32 days	1.95	1.90	1.76	1.82	1.71	00.21
Total	1.69	1.66	1.67	1.68	1.69	00.08

a,b,c values with different superscripts in the same row differ significantly (P<0.05). PSE, Pooled standard error

Table 4. Bone development of broiler in different dietary treatments (% in relation to body weight)

Parameter	Treatment					PSE
	Control	Antibiotic	Garlic 0.25%	Garlic 0.50%	Garlic0.75%	
Thigh bone	1.31	1.36	1.52	1.59	1.52	0.28
Drumstick bone	2.35	2.29	2.62	2.45	2.22	0.40
Thigh length (cm)	6.75	7.00	7.00	6.88	6.75	0.28
Drumstick length (cm)	9.50	10.00	9.63	9.63	9.50	0.62

PSE, Pooled standard error

Table 5. Dressing parts development of broiler in different dietary treatments (% in relation to body weight)

Parameter	Treatment					PSE
	Control	Antibiotic	Garlic 0.25%	Garlic 0.50%	Garlic0.75%	
Skin	5.45	6.78	6.55	6.37	6.53	1.38
Head	3.15	2.89	3.03	3.20	3.04	0.23
Neck	2.08	2.17	1.93	2.13	2.07	0.28
Leg	4.57	4.51	4.76	4.80	4.53	0.19
Liver	2.84	2.94	2.42	2.45	2.60	0.40
Heart	0.59	0.47	0.48	0.65	0.48	0.12
Abdominal fat	1.35a	1.11ab	1.17ab	1.10ab	1.001b	0.46
Gizzard	2.07	2.07	2.01	2.02	2.00	0.26

a,b values with different superscripts in the same row differ significantly (P<0.05). PSE, Pooled standard error

Dressing parameters

Table 5 indicated that the garlic group showed significantly (P<0.05) low abdominal fat weight compared to the control and antibiotic group. However, the treatments had no significant effect (P>0.05) on skin, head, shank, liver, spleen, kidney, heart, gizzard weight in relation to body weight. This result was supported by Sarica *et al*. (2005) and Raeesi *et al.*(2010) in garlic. Garlic showed significantly low abdominal fat weight than the control and antibiotic group. This result was inclined with the findings of Oleforuh-Okoleh *et al*. (2014). Reduction of abdominal fat upon the supplementation of garlic was probably due to the presence of sulfur compounds.

Cholesterol and glucose

Figure 2 indicated that total cholesterol was significantly (P<0.05) lower in the garlic group compared to the control and antibiotic groups. Garlic group 0.75% showed the lowest and control group showed the highest total cholesterol value. Garlic causes to reduce the cholesterol level significantly, as reported by Chowdhury *et al*. (2002) and Issa and Omar *et al*. (2012). These results agreed with previous reports where dietary supplementation of garlic powder in broilers was found to cause a significant decrease in the mean values of total cholesterol as compared to the control birds (Onyimonyi *et al*., 2012; AbdEl-Latif *et al*., 2013; Galib and Huda, 2013). Higher polyunsaturated fatty acids like arachidonate and eicosapentenoate in garlic could be responsible for preventing atherosclerosis (Issa and Omar *et al*. 2012). This may be due to the possible mechanism of hypo cholesterolemic and hypolipidemic action of garlic products which depresses the hepatic activities of lysogenic and cholesterogenicenzymes such as malic enzyme, fatty acid synthase, glucose-6-phosphatase dehydrogenase (Chi *et al*., 1982; Qureshi *et al*.,1983a) and HMG-CoA reductase (Qureshi *et al*., 1983b). To less cholesterol in the carcass, garlic powder facilitates activity of enzymes which are involved in the conversion of cholesterol to bilious acids (Bordia *et al*., 1975; Raeesi *et al*., 2010). Allicin also inhibits the action of HMG-CoA reductase, which is the most important enzyme that participates in the synthesis of cholesterol (Lawson, 1998). Konjufca *et al*. (1997) reported that garlic reduced plasma cholesterol by decreasing the activity of 3-hydroxy-3-methlyglutaryl reductase.

The data represented in the figure 2 indicates that the concentration of glucose was significantly (P<0.05) lower in the garlic group compared to the control and antibiotic groups. Maximum and mini-mum glucose concentrations were observed in antibiotic and 0.75%garlic groups, respectively. The present study reports that there was reduction in the serum glucose concentration in garlic supplemented group compared to the control group. These findings were similar to Kamal and Daoud (2003) who observed significant reduction in serum glucose concentration due to garlic supplementation. The significant reduction in glucose due to garlic supplementation in diets might be due to allicin and sulfur compounds of garlic.

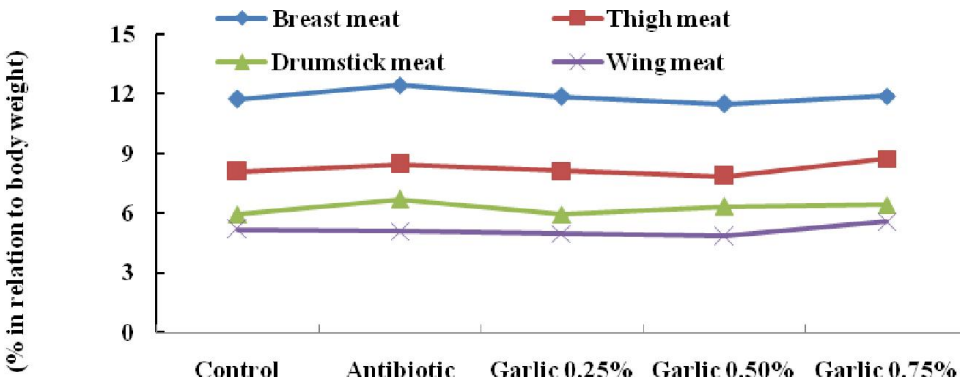

Figure 1. Meat yield of broiler in different dietary treatments

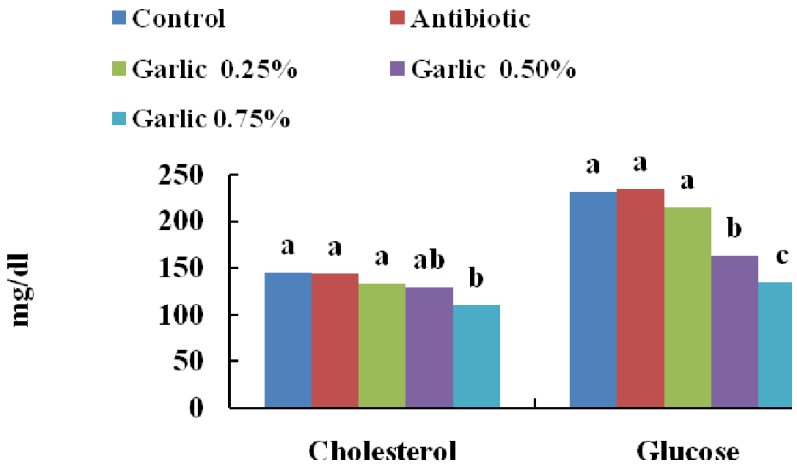

Figure 2. Cholesterol and glucose content of broiler in different dietary treatments

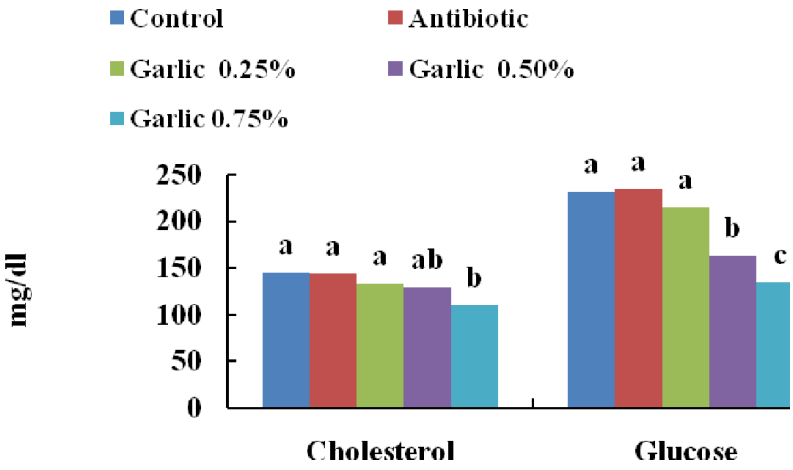

Figure 3. Cost benefit analysis of broiler in different dietary treatments

Cost-benefit analysis

The cost benefit analysis of the present research work is shown in the figure 3. Cost of production per kg live bird was numerically lower in antibiotic and control group compared to the garlic groups. Moreover, when live broiler was sold per kg at equal market price antibiotic and control group showed higher profitability compared to the garlic group. Dieumou *et al*. (2013) agreed with this result and stated that basal diet proves to be economically better than garlic extract. These results are dissimilar with the results of Fayed *et al*. (2011) and Zekić *et al*. (2014). They stated that dietary inclusion of garlic in the diet may be used for economical and efficient production of broilers.

Conclusion

It can be concluded that addition of garlic in the broiler diet had no negative effect on growth parameters. Moreover, abdominal fat, cholesterol and glucose level showed lower by garlic supplemented groups. In case of profitability, supplemental groups showed slightly lower value compared to the control and antibiotic groups but it could be sold at higher price as supplemented groups are safer and beneficial for the consumer health. Considering these results, it is clearly noticeable that extensively use of garlic as a potential feed additive in poultry diet can produce antibiotic free poultry meat.

Acknowledgement

The authors are grateful to Ministry of Science and Technology, Government of the People's Republic of Bangladesh for financial support of the research project.

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