



Administration of garlic and neem in broiler diet for safe meat production

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Abstract

This study was conducted to observe the effect of different administration method of garlic and neem on growth performances, feed efficiency and serum biochemical parameters for safe broiler production. The experiment was done for a period of 32 days with 384 one-day-old straight run broiler chicks. The broiler chicks were divided into six groups each of 64 birds and replicated to four subgroups each of 16 birds. The dietary groups were; control (basal diet; no additives), antibiotic (basal diet + antibiotic), garlic in feed (basal diet + 0.25% garlic powder), garlic in water (basal diet + garlic extracts), neem in feed (basal diet + 0.25% neem powder) and neem in water (basal diet + neem extracts). Results showed that the body weight and body weight gain increased significantly ($P < 0.05$) in both the garlic and neem groups compared to the control group. Feed intake was not different ($P > 0.05$) among the treatment groups. Garlic in feed and water and neem in feed groups showed better FCR ($P < 0.05$) compared to the other treatment groups. There were no significant ($P > 0.05$) difference in meat yield, bone development and dressing parameters except head and gizzard in different dietary groups. Supplementation of garlic with feed and water significantly ($P < 0.05$) decrease cholesterol, triglyceride and LDL compared to the other groups. However, both the garlic and neem groups showed numerically higher HDL compare to the control group. There were no significant ($P > 0.05$) differences in serum glucose and GPT among different treatment groups. GOT was significantly ($P < 0.05$) lower in neem groups than that of garlic and antibiotic groups. Additive groups showed higher profitability than control group. Based on the results of the study, it may be suggested that the garlic and neem could be used both in feed and water as potential feed additives for safe broiler production.

Key words: neem, garlic, safe broiler, growth performance

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Introduction

In the last few decades, poultry sector has become commercially organized, scientific and vibrant industry in Bangladesh. Addition of antibiotics in low doses to the feed of poultry improves growth performance (Lu *et al.*, 2008). Although, their use in animal feed has shown several side effects such as resistance towards the drug and evidence of resistant strains that become zoonotic (Wegener *et al.*, 1999). The use of antibiotic has been prohibited in the European Union since 2006 (Castanon, 2007). To minimize the loss in growth through the banning of antibiotic, there is a need to find alternatives. There are a number of non-therapeutic alternatives such as enzymes, inorganic acids, probiotics, prebiotics and herbs. Two herbal plants which are nutritionally adequate and locally available in Bangladesh that can be used as feed additives are garlic

(Gbenga *et al.*, 2009) and neem (Ezzat *et al.*, 2018).

Garlic (*Allium sativum*) has long history of use as medicinal supplement. Garlic has been found to lower serum and liver cholesterol (Qureshi *et al.*, 1983), inhibit bacterial growth (Cavallito *et al.*, 1994) and reduce oxidative stress (Horie *et al.*, 1992). Tollba and Hassan (2003) found that garlic as a natural feed additive, improved broilers growth, feed conversion ratio (FCR) and decreased mortality rate. Demir *et al.* (2003) indicated that there was a reduction in crypt depth in the ileum of broilers given dietary natural growth promoters such as garlic. Konjufca *et al.* (1997) reported that serum and liver cholesterol decreased significantly when broiler diets were supplemented garlic powder. Horton *et al.* (1991) concluded that triglyceride was not affected by garlic in broiler chickens. Stanacev *et al.* (2011) in their results stated a significantly higher weight in chickens with added 2% of garlic extract. Neem (*Azadirachta*

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indica) contains several bioactive ingredients. Neem leaf and its constituents have been demonstrated to exhibit immunomodulatory, anti-inflammatory, anti-hyperglycemic, anti-ulcer, anti-malarial, anti-fungal and antihelminthic, antioxidant, antimutagenic and anticarcinogenic properties (Agarwal, 2002). Esonu *et al.* (2006) have shown that neem leaf meal could be of some value in the diet of laying hens both as feed ingredient and egg yolk pigmenter. Different authors have reported the use of neem dry leaf as protein source and for controlling infections (Onyimonyi *et al.*, 2012; Tollba *et al.*, 2009). Biu *et al.* (2006) used aqueous extract of neem to control poultry coccidiosis. The feeding neem leaves to immunosuppressed birds increase their humoral and cell mediated immune responses (Sadekar *et al.*, 1998).

The current study was conducted to determine usefulness of garlic and neem in broiler feed and water as a natural growth promoting substance to replace antibiotics. Therefore the proposed study was attempted to generate more information on the effects of this two medicinal plants.

Materials and Methods

Experimental design, birds and diets

The study was conducted at Bangladesh Agricultural University Poultry Farm, Bangladesh Agricultural University, Mymensingh. A total of 384 unsexed one-day-old Cobb 500 broiler chicks were fed the experimental diets during the period from 1–32 days of age. The chicks were randomly assigned into six dietary treatments; each treatment consisted of four replications (16 birds/replication). A gable type open sided house was partitioned into 24 pens of equal size by using wire net. Area of each pen was 20 square feet. The dietary groups were; control (basal diet; no additives), antibiotic (basal diet + antibiotic), garlic in feed (basal diet + 0.25% garlic powder), garlic in water (basal diet + garlic extracts), neem in feed (basal diet + 0.25% neem powder) and neem in water (basal diet + neem extracts). Corn-soybean meal basal diet was formulated to meet the nutritional requirements according to Cobb 500 standard. Ingredient and nutrient composition of both starter and grower diet are shown in Table 1 and Table 2.

Managemental practices

Shed and necessary equipments 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, *ad libitum* feed and water were offered to the broilers. Feed was supplied two times daily, once in the morning and another at afternoon in such a way that feeder was not kept empty. Fresh and clean water was made available at all times. 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 2.5°C per week continued up to 4 weeks of age. Vaccination and other routine poultry management practices were carried out neatly.

Data collection

Body weight and feed intake of bird

All the birds were weighed weekly in the morning, before feeding and watering. Live weight and feed consumption of the birds were recorded weekly and were used to calculate broiler performance.

Dressing parameter, meat yield and bone development

At the end of the experiment, one bird from each replication were randomly selected, fastened for 12 hours, weighed and slaughtered to complete bleeding. After complete bleeding, the slaughtered birds were immersed in hot water (approximately 50°C to 55°C) for 2 minutes in order to loosen feathers from the carcasses. Final processing was performed by removing the head, shank, viscera, oil gland, kidneys, lungs, heart and liver of the carcasses. After that, dressing percentage was recorded. Moreover, liver, gizzard, heart and abdominal fat were calculated as a percentage from the hot weight of the birds. 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.

Table 1: Feed formulation of broiler in different dietary treatments

Ingredients	Treatments					
	Control	Antibiotic	Garlic in feed	Garlic in water	Neem in feed	Neem in water
Broiler starter diet (0 to 21 days)						
Maize	54.99	54.97	54.74	54.99	54.74	54.99
Soya meal	31	31	31	31	31	31
Protein concentrate	7	7	7	7	7	7
Dicalcium phosphate	1.35	1.35	1.35	1.35	1.35	1.35
Limestone	0.8	0.8	0.8	0.8	0.8	0.8
Soybean oil	4	4	4	4	4	4
Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.12	0.12	0.12	0.12	0.12	0.12
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25
Choline chloride	0.03	0.03	0.03	0.03	0.03	0.03
Common salt	0.36	0.36	0.36	0.36	0.36	0.36
Antibiotic	-	0.02	-	-	-	-
Garlic	-	-	0.25	-	-	-
Neem	-	-	-	-	0.25	-
Total	100	100	100	100	100	100
Broiler grower diet (22 to 32 days)						
Maize	60	59.98	59.75	60	59.75	60
Soya meal	24.09	24.09	24.09	24.09	24.09	24.09
Protein concentrate	8	8	8	8	8	8
Di calcium phosphate	1.35	1.35	1.35	1.35	1.35	1.35
Limestone	0.7	0.7	0.7	0.7	0.7	0.7
Soybean oil	5	5	5	5	5	5
Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.12	0.12	0.12	0.12	0.12	0.12
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25
Choline chloride	0.03	0.03	0.03	0.03	0.03	0.03
Common salt	0.36	0.36	0.36	0.36	0.36	0.36
Antibiotic	-	0.02	-	-	-	-
Garlic	-	-	0.25	-	-	-
Neem	-	-	-	-	0.25	-
Total	100	100	100	100	100	100

Lysine: L-lysine HCl (98.5%); Methionine: DL methionine (99%)

Blood collection and serum biochemical analysis

Blood samples were taken at the end of the experiment from the jugular vein from four birds per treatment group (one bird per replication). Blood collection tubes were placed in a slanting position (45° angles) 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°C until analysis. Serum was analyzed for total serum cholesterol, glucose, Triglyceride, HDL, GPT, GOT using commercial test kits.

Cost benefit analysis

Cost benefit analysis was done at the end of the experiment.

Statistical analysis

Data of body weight, body weight gain, feed consumption, FCR, dressing parameters and serum biochemical parameters were subjected to analysis of variance (ANOVA) in a completely randomized block design (CRD) using SAS (2009) statistical package program. Differences among all treatments were separated by Duncan's multiple comparison tests. In the result $P < 0.05$ was considered statistically significant.

Table 2: Nutrient composition of starter diet and grower diet (Calculated)

Nutrients	Starter diet (0-21 days)	Grower diet (22-32 days)
DM %	89.68	87.09
ME kcal/kg	3050	3150
CP%	23.66	20.59
CF%	3.81	2.88
EE%	5.71	4.81
Lys %	1.24	1.06
Met %	0.50	0.63
Met + Cys %	1.00	0.92
Ca%	1.21	1.05
Available P %	0.45	0.42

Results

Body weight and body weight gain

Body weight of birds at different week of age is shown in Table 3. Body weight of one-day-old chicks was almost similar. Significant difference ($P < 0.05$) was found at 4th week and 32nd day among different dietary treatment groups. At 4th week neem in water group showed the highest body weight compare to the control and garlic group. At the end of the experiment numerically higher body weight was found in garlic in feed group, followed by neem in feed, garlic in water, neem in water and control group except in antibiotic group. There was a significant variation ($P < 0.05$) on body weight gain at 32nd days and total between antibiotic and control groups, whereas supplemented groups had no significant difference with antibiotic group.

Feed intake and feed conversion ratio (FCR)

Feed intake of broiler showed no significant variation ($P > 0.05$) among the dietary groups (Figure 1). Considering the total feed intake, garlic in feed and neem in feed & water groups showed numerically higher feed intake compared to the control group. Feed conversion ratio was found significant variation ($P < 0.05$) on 4th week, 32nd day and total period among different dietary groups (Figure 2). At 4th week neem in feed showed numerically better FCR compare to the control group accept antibiotic group. At 32nd day's garlic in water group showed significantly ($P < 0.05$) better FCR than antibiotic group. Garlic in feed, garlic in water and neem in feed groups showed numerically better FCR compared to the control group when considering the total FCR.

Meat yield, bone development and different dressing parts of broiler

There were no significant ($P > 0.05$) difference in meat yield (breast meat, thigh meat, drumstick meat and wing meat) and bone development (Table 4). Significant difference ($P < 0.05$) was found only in head weight and gizzard weight among different dietary groups.

Serum biochemical parameter

The data represented in Table 5 and Figure 3 indicates that there were no significant ($P > 0.05$) differences in serum glucose and GPT among different treatment groups, whereas significant ($P < 0.05$) difference was found in serum cholesterol, triglyceride, HDL, LDL and GOT. Garlic in water, garlic in feed and neem in water group showed the lowest serum cholesterol concentration compare to the antibiotic and control group.

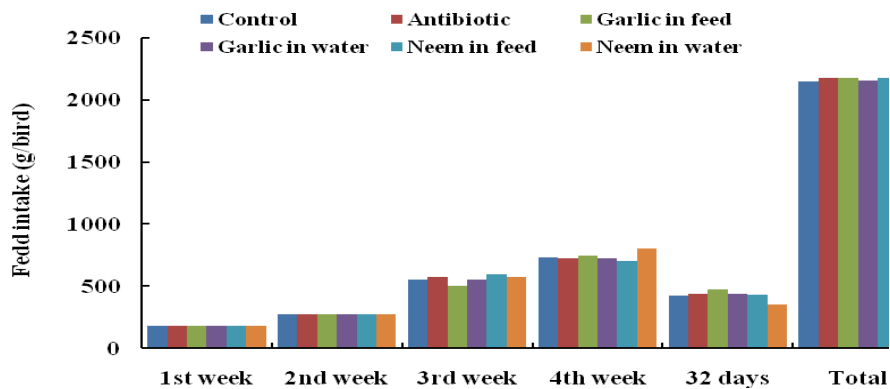


Figure 1: Weekly feed intake of broiler in different treatments

Garlic and Neem in broiler diet

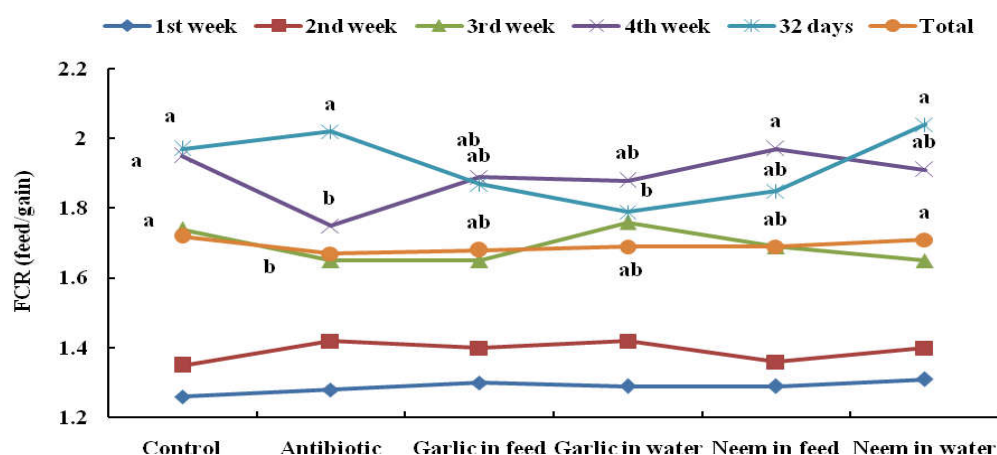


Figure 2: Weekly feed conversion ratio of broiler in different treatments

Table 3: Body weight and body weight gain of broiler in different dietary treatments

Items	Treatments					
	Control	Antibiotic	Garlic in feed	Garlic in water	Neem in feed	Neem in water
Body weight (g/bird)						
Initial weight	44.22±0.20	44.29±2.24	44.06±0.22	44.38±0.13	44.06±0.22	44.29±0.23
1 st week	187.03±3.55	185.16±1.49	183.59±1.49	184.38±1.28	183.59±1.49	183.59±1.49
2 nd week	387.19±3.61	376.47±5.32	380.32±6.89	375.54±3.87	382.82±6.61	377.00±6.67
3 rd week	705±12.01	726.25±11.62	685.47±25.61	691.57±13.58	733.22±11.61	725.47±17.97
4 th week	1080.3±17.0 ^{bc}	1138.6±19.9 ^{ab}	1084.5±21.7 ^{bc}	1076.3±14.6 ^c	1090.5±21.8 ^{abc}	1145.8±17.2 ^a
32 nd days	1296.95±6.44 ^b	1353.60±11.81 ^a	1338.37±18.89 ^{ab}	1320.60±20.18 ^{ab}	1323.92±20.83 ^{ab}	1317.62±18.69 ^{ab}
Body weight gain (g/bird)						
1 st week	142.81±3.53	140.86±1.38	139.53±1.57	140.00±1.28	139.53±1.67	139.29±1.47
2 nd week	200.16±5.79	191.32±5.23	196.72±8.13	191.16±5.06	199.22±8.04	193.40±7.45
3 rd week	317.81±12.41	349.79±10.23	305.16±26.76	316.03±17.39	350.41±7.43	348.47±14.57
4 th week	375.33±9.02	412.42±28.20	399.07±44.16	384.77±20.76	357.28±28.83	420.36±33.39
32 nd days	216.62±14.76 ^{ab}	214.93±9.06 ^{ab}	253.83±36.70 ^a	244.27±18.18 ^a	233.42±27.45 ^{ab}	171.78±2.87 ^b
Total	1252.73±6.63 ^b	1309.30±11.82 ^a	1294.30±18.67 ^{ab}	1276.23±20.10 ^{ab}	1279.85±20.62 ^{ab}	1273.32±18.56 ^{ab}

a,b,c values with different superscripts in the same row differ significantly (P<0.05); Data are presented as mean±SE

Table 4: Meat yield, bone development and dressing parameter of broiler in different dietary treatments (% in relation to body weight)

Parameter	Treatments					
	Control	Antibiotic	Garlic in feed	Garlic in water	Neem in feed	Neem in water
Meat yield						
Breast meat	11.07±1.04	10.91±2.02	12.26±0.11	12.48±0.18	12.61±0.82	12.87±0.43
Thigh meat	8.10±0.34	8.16±0.91	8.48±0.01	9.07±1.32	7.91±0.07	8.45±0.02
Drumstick meat	8.10±0.34	7.61±0.36	8.12±0.35	8.25±0.76	8.45±0.13	8.45±0.02
Wing weight	6.03±0.21	5.69±0.09	5.96±0.30	5.71±0.03	6.29±0.05	6.17±0.33
Bone development						
Thigh bone	2.07±0.13	1.79±0.14	1.99±0.22	2.13±0.33	1.97±0.11	2.26±0.01
Drumstick bone	2.97±0.70	2.69±0.06	2.89±0.42	2.26±0.19	3.05±0.07	3.01±0.09
Dressing parameters						
Skin	5.99±0.48	8.13±2.08	7.78±1.06	7.83±0.18	7.54±0.08	6.77±0.29
Head	2.75±0.002 ^b	2.40±0.07 ^b	3.16±0.16 ^a	2.45±0.13 ^b	2.69±0.09 ^b	2.56±0.13 ^b
Neck	2.52±0.42	2.32±0.02	2.44±0.32	2.12±0.07	1.23±0.67	2.18±0.08
Leg	9.42±0.91	7.92±0.34	9.23±1.45	8.12±0.62	8.81±0.14	8.97±1.19
Liver	2.86±0.44	2.57±0.23	2.25±0.04	2.26±0.06	2.51±0.27	2.17±0.23
Heart	0.70±0.21	0.52±0.03	0.54±0.01	0.47±0.08	0.54±0.02	0.42±0.009
Abdominal fat	0.86±0.05	1.17±0.34	1.12±0.20	0.59±0.08	1.07±0.14	0.82±0.17
Gizzard	1.89±0.05 ^{ab}	1.73±0.08 ^b	2.08±0.13 ^a	1.66±0.11 ^b	1.97±0.11 ^{ab}	1.96±0.02 ^{ab}

a,b values with different superscripts in the same row differ significantly ($P<0.05$); Data are presented as mean±SE

Table 5: Serum biochemical parameter of broiler in different dietary treatments

Parameter	Treatments					
	Control	Antibiotic	Garlic in feed	Garlic in water	Neem in feed	Neem in water
Glucose (mg/dl)	89.93±4.87	83.80±2.6	87.33±2.27	89.63±8.43	83.48±1.58	81.95±0.05
GOT (U/l)	2.42±0.09 ^b	3.21±0.29 ^{ab}	3.79±0.29 ^a	3.25±0.25 ^{ab}	2.63±0.29 ^b	2.62±0.029 ^b
GPT (U/l)	2.92±0.59	2.92±0.00	3.79±0.29	3.21±0.29	3.21±0.88	3.29±0.79

Glutamic pyruvic transaminase (GPT), Glutamic oxaloacetic transaminase (GOT), a,b values with different superscripts in the same row differ significantly ($P<0.05$); Data are presented as mean±SE

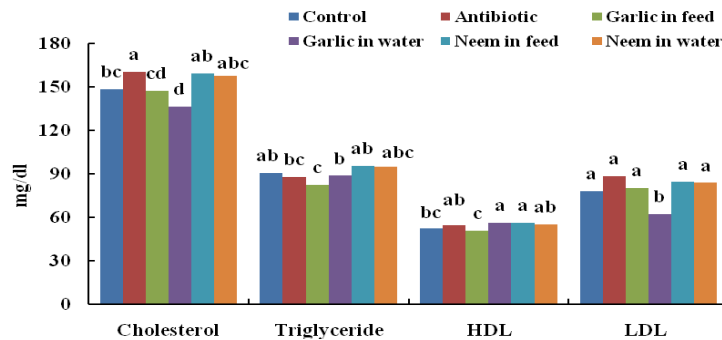


Figure 3: Serum lipid profile of broiler in different dietary treatments

Garlic in feed showed lowest triglycerides value compare to the control and antibiotic group. Supplementation of garlic in feed significantly decreased serum triglyceride level. Garlic in feed supplemented groups showed higher serum GOT than antibiotic group, whereas neem in feed and water group had lower GOT compared to other treatment group.

Cost benefit analysis

The cost of production per kg broiler was slightly lower but total income per broiler was higher in all supplemented groups compared to the control group. Profit per broiler was higher in antibiotic group followed by garlic in feed, neem in feed, garlic in water and neem in water group compare to the control group (Figure 4).

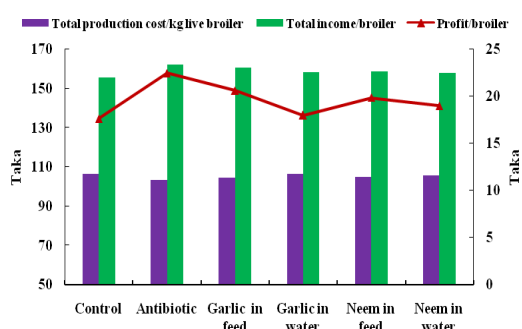


Figure 4: Cost benefit analysis of broiler in different dietary treatments

Discussion

Body weight and body weight gain

Supplementation of garlic in feed enhances body weight gain. This is in general agreement with previous studies with garlic (Zikic *et al.*, 2014; Galib and Huda, 2013 and Adeyemo *et al.*, 2013). Improvement in weight gain may be the cause of allicin (an antibiotic substance found in garlic), which inhibits growth of intestinal bacteria and inhibit aflatoxins producing fungi resulting in lowering the load of these organisms in the intestine and birds may absorb more nutrients leading to the improvement in weight gain of the birds using rations supplemented with garlic (Pourali *et al.*, 2010; Fayed *et al.*, 2011). 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). The results of the present

study contradicted to some of the previous observations that indicated garlic had no effect on body weight gain (Choi *et al.*, 2010 and Fadlalla *et al.*, 2010). We also found that supplementation of neem leaf with feed and water positively influenced the body weight and body weight gain of broiler compared to control group. This is in general agreement with previous studies those reported that supplementation of feed with neem enhances body weight gain, (Bishnu *et al.*, 2009; Sarker *et al.*, 2014). The improvement in weight gain might be due to anti-protozoal and immune stimulatory properties of neem leave that help to reduce the microbial load and improved the performance (Wankar *et al.*, 2009). Neem leaf might have suppressed the growth of harmful organisms, thereby create a conducting environment for digestion and give better performance (Adeyemo *et al.*, 2013). In the contrary to our findings, there were also some reports in which birds exhibited poor performance and lower body weights (Deore *et al.*, 2005). While some earlier reports showed no significant variations in weight gain feeding em leaf (Nidaullah *et al.*, 2010; Bonsu *et al.*, 2012 and Nnenna *et al.*, 2013).

Feed intake and FCR

The tested dose of neem and garlic had no significant effect on feed intake although supplemented groups intake higher feed than control. Onibi *et al.* (2009); Elagib *et al.* (2013); Galib and Huda (2013) also supported this result. Moreover, some of the previous observations contrasted present study and indicated garlic have no effect on feed intake (Yalcin *et al.*, 2006). Kale *et al.* (2003) reported that antimicrobial and antiprotozoal properties of neem leaves reduced the microbial load of birds and thus improved the feed consumption and feed efficiency of the birds. Supplementation of garlic in feed, garlic in water and neem in feed significantly improved the FCR. The higher body weight gains might be due to growth promoting and antimicrobial property of garlic and neem that helped to improve feed efficiency (Wankar *et al.*, 2009). Similar findings with respect to increased FCR were reported by earlier researchers (Zanu *et al.*, 2011; Ansari *et al.*, 2012). The significant effect of garlic on FCR of broiler was in close agreement with Tollba and Hassan (2003). Onyimonyi *et al.* (2012) and Galib and Huda (2013) reported supplementation of garlic in feed had better FCR.

Moreover, these results were not in agreement with Raeesi *et al.* (2010) who reported that supplementation of 1% garlic powder decreased feed conversion ratio (FCR) compared with the 0.5% supplemented and control group but garlic supplementation did not affect growth and feed intake in broilers. In contrary to findings of this study, some authors observed that the supplementation of garlic and neem leaves had no effect on FCR (Amouzmehr *et al.*, 2012). Supplementation of garlic and neem leaves extract may be attributed to the antibacterial properties, which resulted in better absorption of the nutrients present in the gut and finely leading to improvement in FCR.

Meat yield, bone development and different dressing parts of broiler

Supplementation of garlic and neem with feed and water had no significant effects on meat and bone development. Moreover, significant difference was not found in on other body parts accept head weight and gizzard weight in relation to body weight among different treatments. The results were in agreement with Nahid *et al.* (2014); Bonsu *et al.* (2012); Amouzmehr *et al.* (2012) in garlic and neem study. In the contrary with these findings, a significant increase in average dressing percentage with supplementation of garlic (Fayed *et al.*, 2011) and neem (Adeyemo *et al.*, 2013 and Zanu *et al.*, 2011) was also reported by earlier workers in broilers.

Serum biochemical parameter

Supplementation of garlic in feed and water significantly decrease the mean values of serum total cholesterol as compared to the antibiotic fed broilers (Onyimonyi *et al.*, 2012; Abd El-Latif *et al.*, 2013 and Galib and Huda, 2013). This may probably be due to the possible effects of hypocholesterolaemic and hypolipidemic action of garlic products which depresses the hepatic activities of lipogenic and cholesterol genicenzymes such as malic enzyme, fatty acid syntheses, and glucose-6-phosphatase dehydrogenase. Chowdhury *et al.* (2002) indicated that the sulphur containing bioactive compounds mainly allicin in garlic homogenates help to show cholesterol lowering effect. Allicin also inhibits the action of hydroxymethylglutaryl-CoA reductase, which is the most important enzyme that participates in the synthesis of cholesterol and lipids (Lawson, 1998). Upadhyay (1990); Lonkar and Jalaludeen (2009) reported

a decline in blood cholesterol levels of broilers fed Neem leaf meal. The progressive decrease in serum cholesterol observed in this study is in agreement with the report of Ogbuewu *et al.*, (2009) that administration of neem leaf extract decreased serum cholesterol significantly without changing serum protein, blood urea and uric acid levels in rats probably suggests a general decrease in lipid mobilization. It is possible that NLE has indirect inhibitory effects exerted at the levels of HMG-CoA reductase, a key enzyme in cholesterol biosynthesis (Ogbuewu *et al.*, 2009). Garlic in feed group showed reduced serum triglyceride levels compared to that of broilers of the control group. This effect can be explained by the possible inhibition of the Acetyl CoA synthetase enzyme that is necessary for the biosynthesis of fatty acids (Chi *et al.*, 1982 and Qureshi *et al.*, 1983). Eidi *et al.* (2006) reported that garlic extract significantly decreased serum total cholesterol, triglycerides. Addition of garlic and neem in feed and water separately caused a significant reduction in the levels of blood glucose, cholesterol, triglyceride, and increased HDL. The different values of serum biochemical parameters (GOT and GPT) was within normal ranges. Some researchers stated that garlic and neem did not induce significant effects on the activities of serum GOT and GPT (Zeinab *et al.*, 2010 and Onu, 2010). However, previous reports indicated that feeding garlic significantly decreases the serum activity of GPT in broiler (Abd El-Latif *et al.*, 2013). Jimoh *et al.* (2012) assumed that the hepatoprotective activity of garlic might be attributed to its excellent antioxidant potential to prevent liver damage thereby limiting the bioavailability of these biomarkers in the blood. Prabhakaran *et al.* (1996) reported that GOT and GPT concentration of blood serum decrease with advancement of age. These biochemical parameters varied due to the influence of sex, environment, exercise, nutritional status, species variation and climate (Dukes, 1995).

Cost-effectiveness of production

Supplementation of neem and garlic increased profitability per broiler compare to the control group. These results are in agreement with the result of Fayed *et al.* (2011) and Zekic *et al.* (2014). They stated that dietary garlic may be used in the diet for economical and efficient production of broilers. Though, Dieumou *et al.* (2013) disagreed with this result and stated that garlic would not be advisable in diet supplement

as basal diet proves to be economically better than garlic extract. These results are supported by the result of Mostofa *et al.* (2013) who reported that neem leave extract supplementation in the broiler rations may be useful for the safe, economical and efficient production of broiler and this formulation could be used as an alternative to commercial growth promoters.

Conclusion

It can be concluded that addition of garlic and neem to the broiler diet positively affects growth parameters and profitability but no negative effect on meat yield, bone development and dressing parameters. Moreover, garlic supplementation decrease serum cholesterol and triglyceride concentration. It can be suggested that both garlic and neem could be potential feed additives for safe broiler production. However, when compare to the application method supplementation with feed gives better result than water.

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Conflict of interest

The authors would like to declare that there is no conflict of interest

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