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Effect of red chili and garlic nutrition as feed additives on growth performance of broiler chicken

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ABSTRACT

The study was conducted to investigate the effect of dietary supplementation of spice herbs [red chili (*Capsicum annum*) and garlic (*Allium sativum*)] on growth performance of broiler chickens. A total of 450 day old Cobb-500 broiler chicks were randomly allocated to six dietary treatments each with three replicates of 25 chicks/replicate (n=75). The six experimental groups were as follows: The control group (T_0) received the commercial broiler diets whereas T_1, T_2, T_3, T_4 and T_5 groups received the commercial broiler diets with addition of 0.50%, 0.75% red chili, 0.50%, 0.75% garlic and 0.50% mixture of red chili and garlic respectively. Parameters measured were feed intake, digestibility, growth performance and blood parameter of commercial broiler chickens. Feed intake and body weight gain of birds in T_4 group were significantly ($P<0.05$) higher compared to all other groups. Feed conversion ratio (FCR) was significantly lower in T_3 group as compared to all other groups ($P<0.05$). The breast, back, liver, gizzard, heart and ESR contain were not increased significantly ($p<0.05$).The dressing percentages were significantly higher in the birds of T_1 group than the other groups ($P<0.05$). The relative weight of thigh and wing were significantly higher in T_4 group compared to other groups. However, the spleen, proventriculus, Packed cell volume (PCV) and hemoglobin contain increased significantly in T_3 group ($P<0.05$). The cost of production and return per bird was highly economic in treatment T_3 (Commercial feed + 0.5% garlic) as compared to other treatment groups. It is concluded that the use of garlic as feed additives (0.75% level) is more efficient to enhance the growth performance of broiler chicks.

INTRODUCTION

Besides of significant role of medicinal herbs, aromatic plants and spices in everyday human nutrition for improvement of taste, aroma and color of food, these additives have been conveniently used in animal nutrition for enhancement of health, production and animal wellbeing. Now a day with the prohibition of antibiotic use in poultry nutrition due to the development of microbe resistance and modification of natural gut microbiota, in this regards substitute growth promoters must be generated. Elimination of antibiotics as growth promoters has directed to poultry performance problems, feed conversion ratio incensement, and intensification in the incidence of certain poultry diseases (Wierup, 2001). The substitutes to antibiotics as growth stimulators are abundant (Simon, 2005; Puvača et al, 2003). Plant derived additives used in poultry nutrition to increase performance have been designated "phytogenic feed additives" (Windish et al, 2008). This form of feed additives has recently gained attention for use in poultry industry with snowballing numbers of scientific publications since the prohibition of antibiotics growth promoters in 1999. Natural growth promoters like as prebiotics, probiotics, synbiotics, enzymes, spice herbs, plant extracts etc., can be extensively used to feed broiler chickens without any hostile effect on the performance of birds (Borazjanizadeh et al, 2011). The crucial mode of action of these natural growth promoting feed additives can be accredited predominantly to the maintenance of feed hygiene and also from the beneficial effect on the

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gastrointestinal microbiota through regulatory pathogens (Roth and Kirchgessner, 1998), stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, stimulation of immune responses and antibacterial, antiviral and antioxidant activity (Dorman, 2000; Hosseini-Vashan et al, 2012). In commercial broiler production primarily powder forms of red chili (*Capsicum annum*) and garlic (*Allium sativum*) are used independently or in combination as natural feed additives (Grashorn, 2010; Puvača et al, 2013; Puvača et al, 2014) as an alternative of common artificial growth promoters like as antibiotics (Demir, 2003).

Red chili (C*apsicum annuum***)** plays a significant role in reducing the deposition of cholesterol and fat in the body and contributes to decline levels of triglycerides and work to support the vascular system in the body. Hencken (1991) elucidated that red chili (*Capsicum annuum***)** is rich in vitamin C which have a substantial influence in improving production through subsidizes the decrease of heat stress on a fact that birds consumption of red chili (*Capsicum annuum***)** induce a significant change in energy balance when individuals are given free access of feed (Yoshioka et al, 2001). A recent studies involved in poultry performance showed that mixtures of active compounds for red chili causes chemo preventive and chemotherapeutic effects.

Garlic (*Allium sativum***)** is one of the utmost conventionally used plants as a spice herb for many years. Garlic has been used for a diversity of causes which most of them has been accepted scientifically: antibacterial, antifungal, antiparasitic, antiviral, antimicrobial, antiatherosclerosis, hypolipidemic, antithrombosis, antihypertension, antidiabetes, anticholesteremic, anticancerous, and vasodilator attributes (Mansoub, 2011). There are numerous active constituents in garlic like as ajoene, s-allyl cysteine, diallyl sulphide and the greatest active one is allicine (Rahmatnejad and Roshanfekr, 2009). Allicine conceivably diminishes low density lipoprotein (LDL), triglycerides and cholesterol in serum (Alder and Holub, 1997) and tissues (Demir, 2003; Stanaćev et al, 2012) and it has been extensively used in treatments against cardiovascular diseases (Tanamai et al, 2004). In commercial broilers, it was stated that garlic, as a natural feed additive have enhanced broiler growth and feed conversion ratio, and declined mortality rate (Stanaćev et al, 2010). Garlic also demonstrates hypocholesterolemic effects on chickens through inhibition of the most essential enzymes that contribute in the synthesis of cholesterol and lipids (trihydroxy-tri-methylglutaryl coenzyme A reductase, cholesterol-7α hydroxylase and the synthesis of fatty acids). Moreover, this additive has a comparatively low market price, is added in small amounts of 0.2 to 2%, thus not rise production costs, which is of specific importance to manufacturers (Zekić et al, 2014).

Therefore, the aim of this study was to investigate the effect of dietary spice herbs such as red chili (*Capsicum annuum*) and garlic (*Allium sativum*) on feed intake, digestibility, growth performance and carcass quality of commercial broiler chicken.

MATERIAL AND METHODS

Ethical approval

This research was carried out as a part of MS in Animal Nutrition research after the approval of competent authority of the Director of Research and Dean P.G. Studies, Sylhet Agricultural University, Sylhet, Bangladesh.

Location of study

The experiment was carried out at the at Nashir poultry farm located at Islampur village, city of Sylhet district which lies approximately on latitude 24°53′56″ N, and longitude 91°52′19″ E with an average elevation of 26 m(85ft) above sea level. This region is the north eastern region of Bangladesh of Eastern Surma- Kushiyara floodplain agro climatic zone of Bangladesh, which includes Sylhet, Mouluvibazar, Sunamgonj and Habigonj districts. A climate is tropical monsoon bordering on a humid subtropical climate with an average temperature of 28.1 °C; August is the hottest month of the year. January is the coldest month, with temperatures averaging 18.5 °C. The average annual rainfall is 3876 mm.

Source and processing of turmeric and ginger

Groundnut red chili and garlic used in this study was bought from a local spice market in raw form. Then, it was cleaned and cut into smaller pieces and dried sufficiently in the sunlight to remove moisture content. After drying, required amount of red chili and garlic was prepared by fine grinding and passing through 1 mm sieve to make powder form.

Experimental birds and diets

About 1-day-old 450 broiler chicks of Cobb-500 strain with average body weight 40.00-40.28 g were wing banded and distributed randomly into six groups having three replicates of 25 birds each by randomized block design and allocated to six dietary treatments as T_0, T_1, T_2, T_3, T_4, and T_5. All experimental birds were fed commercial broiler starter (1-15 days) and grower feed (16-30 days). Experimental birds in control group (T_0) were fed only commercial broiler ration while, birds in T_1, T_2, T_3, T_4 and T_5 groups were fed on commercial broiler ration supplemented with 0.50% red chili powder, 0.75% red chili powder, 0.50% garlic powder, 0.75% garlic powder and combination of 0.50% red chili powder and 0.50% garlic powder, respectively. Ingredient compositions of these starter and grower rations are presented in Table-1.

Table 1
Nutrient Composition of supplied ration.

Ingredients	Starter (01-14 days)	Grower (15-35 days)
Moisture (%)	11.0	11.0
Energy (Kcal.)	3150	3175
Protein (%)	22.5	22.1
Fat (%)	5.0	5.0
Ash (%)	4.0	4.0
Lysine (%)	1.4	1.4
Methionine (%)	0.65	0.60
Phosphorus (%)	0.75	0.75
Calcium (%)	1.2	1.2

Feeding and management procedures

All the experimental birds were reared in well ventilated shed in deep litter pens and kept under uniform management conditions. Each pen was 5ft x 4ft which was for twenty five birds. The commercial feed mixtures and clean drinking water were supplied to the birds ad libitum throughout the study period to meet the nutrient requirement. Feed was supplied three times daily for the first seven days and gradually increased to four times. All the birds of each experimental group were weighed weekly in the morning, before feeding and watering. Feed intake was calculated by measuring the amount of feed offered and residue leftover after 24h. Feed conversion ratio was calculated by dividing the feed intake by weight gain. Vaccination and other biosecurity routine poultry management practices were carried out carefully.

Carcass quality evaluation

At the end of the experiment, four birds of each replicate were randomly selected and weighed to obtain final live weight and finally slaughtered by using sharp knife for complete bleeding, blood collected by using anticoagulant in test tube, feather of birds were plucked. Head, viscera and shanks were removed. Dressing percentage was calculated free from giblets (heart, gizzard, liver) and the weight of each organ was calculated as percentage of the carcass weight.

Economic study

Cost benefit analysis was calculated by comparing the total cost (Purchase cost of day old chicks, feeds, labor, electricity, Spicy etc.) and the return from selling of broilers and the gross return was calculated by the differences between sale price (Tk. /live bird) and total cost(Tk. /live bird).

Data Collection and Statistical Analysis

Data regarding feed intake was recorded on daily basis. Weight gain was calculated on weekly basis by subtracting weight of the respective week from the last week weight. FCR was calculated by dividing the feed intake by weight gain. The data collected on various parameters were subjected to one-way ANOVA using the general linear models (GLM) procedure of SPSS software. Treatment means were tested using the Duncan's multiple

range test, and statistical differences declared at $p<0.05$.

RESULTS AND DISCUSSION

Effect of red chili and garlic powder on the body weight, feed intake and FCR

Efficient nutritional management is required for improvement of production and also good health of broiler birds. Red chili and garlic powder were used in this experiment to observe the improvement of broilers growth performance. From all treatments group it is seen that highest feed intake was observed at T_4 (0.75% garlic) group and lowest at T_0 (control) group of birds (Table 2). However, there were significant in feed intake in T_1, T_2 and T_3.It was observed that feed intake of different treatments groups were statistically significant ($P<0.05$). Feed intake was increased gradually with their age. Most of the researchers attributed the better performance of the broiler birds fed garlic due to improvement in palatability and the quick digestive effects of this natural product. They further investigated that due to the effect of this natural product, the digestive tract would have been emptied earlier and feed consumption will have been increased. These findings are in agreement with the research of Hernandes et al, (2004) and Galib et al, (2011) who showed that plant extract of red chili supplementation improved apparent whole tract digestibility of the nutrients as well as feed intake. The highest weight gain was attained at T_4 (0.75% garlic) and the lowest weight gain at T_0 (control) group of birds (Table 2). It was observed from the results that the weekly average live weights of broilers were increased gradually from 1st to 5th week of age. It was observed that different live body weight among different treatments groups were statistically significant ($P<0.05$). The improvement in body weight gain in different levels of garlic powder could be attributed to the fact that herbal plant may provide compounds that enhance digestion and absorption of some nutrients in these diets which leading to improve the growth of birds. This result was in line with the finding of Onibi et al. (2009). They mention that supplementation of garlic powder (GP) in broiler diets 2.0 g/kg have significant ($P<0.05$) influence on body weight gains from 1st to 6th weeks of age. Some experts reported that red chili has characteristics as stimulant for feed digestion and conversion which increase body weight gain. Several studies have shown that plant extracts of red chili containing a mixture of capsaicin, cinnamaldehyde and carvacrol improved the growth performance of broiler chicken (Garcia et al. 2007; Henandez et al. 2004 and Kamel, 2001). Galib et al. (2011) stated that the effect of different levels of hot red chili (0.25%, 0.50%. 0.75% and 1.00%) on growth performance (feed intake, body weight gain and feed conversion ratio) of broilers.

Table 2
Effect of red chili and garlic powder on feed intake, weight gain and FCR of broiler chickens in (0-40) days of age.

Treatments	Traits		
	Feed Intake, g (Mean±SE)	Weight gain, g (Mean±SE)	FCR (Mean±SE)
T_0	2853.46^{c}±49.33	1651.33^{c}±36.17	1.736^{a}±0.03
T_1	3178.85^{b}±60.03	1917.04^{b}±55.47	1.669^{ab}±0.02
T_2	3185.17^{b}±56.04	1949.89^{b}±56.50	1.649^{ab}±0.03
T_3	3265.16^{b}±69.83	2015.66^{ab}±55.86	1.626^{b}±0.01
T_4	3444.26^{a}±55.74	2090.55^{a}±44.01	1.652^{ab}±0.01
T_5	2903.08^{c}±39.09	1746.08^{c}±27.10	1.668^{ab}±0.02
Level of significance	*	*	*

a,b,c, means in the same column with different superscripts are significantly different. T_0= Control diet (Commercial feed), T_1= Commercial feed + 0.5% red chili, and T_2= Commercial feed + 0.75% red chili, T_3= Commercial feed + 0.5% garlic, and T_4= Commercial feed + 0.75% garlic, $T_{5=}$ Commercial feed + 0.5% red chili+0.5% garlic, * means significant at 5% level.

Table 3
Effect of red chili and garlic powder (GP) on carcass characteristics of broiler chickens in (0-40) days of age.

Treatments	Traits (%)					
	Dressing	Breast	Wing	Thigh	Back	Neck
T_0	72.70^{ab}±.30	34.75±.49	9.86^{b}±.44	28.05^{ab}±.13	15.02±1.17	6.42±.41
T_1	73.95^{a}±.15	34.85±.91	10.91^{ab}±.13	26.46±1.45	13.86±.22	5.91±.07
T_2	73.85^{a}±.65	35.05±1.20	10.66^{ab}±.27	27.42^{ab}±.69	13.67±.64	5.67±.44
T_3	72.60^{ab}±.70	35.00±.14	10.92^{ab}±.14	27.03^{ab}±.06	15.11±.71	6.14±.31
T_4	72.15^{b}±.25	35.34±.62	11.68^{a}±.74	29.14^{a}±.24	15.86±.95	6.02±.32
T_5	72.15^{b}±.25	35.34±.62	11.32^{ab}±.59	28.40^{ab}±.49	14.38±.44	6.03±.99
Level of significance	*	NS	*	*	NS	*

a,b,c, means in the same column with different superscripts are significantly different. T_0= Control diet (Commercial feed), T_1= Commercial feed + 0.5% red chili, and T_2= Commercial feed + 0.75% red chili, T_3= Commercial feed + 0.5% garlic, and T_4= Commercial feed + 0.75% garlic, $T_{5=}$ Commercial feed + 0.5% red chili+0.5% garlic, NS= Non significant, * means significant at 5% level.

Table 4
Effect of dietary red chili and garlic powder on internal edible and non-edible parts of broiler chickens in (0-40) days of age.

Treatments	Traits (%)				
	Liver	Gizzard	Heart	Spleen	Proventiculus
T_0	4.49±.32	2.62±.17	0.605±.03	0.148±.01	0.47±.00
T_1	4.22±.50	2.52±.03	0.645±.06	0.121±.00	0.42±.01
T_2	4.32±.06	3.21±.66	0.645±.02	0.120±.00	0.52±.04
T_3	3.79±.01	2.76±.34	0.610±.10	0.133±.00	0.60±.07
T_4	4.35±.09	2.80±.16	0.625±.04	0.131±.01	0.58±.03
T_5	4.04±.87	2.82±.19	0.560±.07	0.123±.00	0.53±.04
Level of significance	NS	NS	NS	*	*

a,b,c, means in the same column with different superscripts are significantly different. T_0= Control diet (Commercial feed), T_1= Commercial feed + 0.5% red chili, and T_2= Commercial feed + 0.75% red chili, T_3= Commercial feed + 0.5% garlic, and T_4= Commercial feed + 0.75% garlic, $T_{5=}$ Commercial feed + 0.5% red chili+0.5% garlic, NS= Non significant, * means significant at 5% level.

The average Feed Conversion Ratio (FCR) in different treatment groups (T_0, T_1, T_2, T_3, T_4, and T_5) were 1.73±.03, 1.66±.02, 1.64±.03, 1.62±.01, 1.65±.01 and1.66±.02, respectively. The result showed that the effect of increasing red chili and garlic in broiler feed had significant and positive effect on FCR. The most efficient FCR was found in broilers of group T_3 (0.5% garlic).The findings obtained in the present study agree with the result of Onu (2010) and Elagib et al., (2013). Garlic supplementation at 0.25 percent level in broiler finisher diets enhanced the feed conversion ratio of the birds (Onu, 2010) and the best performance was attained by the group of birds fed on diet containing 3 percent garlic powder had best feed conversion efficiency (Elagib et al., 2013). Addition of hot red pepper in broiler chicken

nutrition led to a better feed utilization (Al-Kassie et al., 2011).

Table 5
Effect of dietary red chili and garlic powder on hematology of broiler chickens in (0-40) days of age.

Treatments	Traits		
	Hb (g/dl) (Mean ± SE)	PCV (g/dl) (Mean ± SE)	ESR(mm/h) (Mean ± SE)
T0	7.82^{a}±0.15	32.00±0.00	1.78±.08
T1	7.51^{ab}±0.05	31.50±.50	1.65±.13
T2	7.61^{ab}±0.06	31.50±0.50	1.73±.02
T3	7.66^{ab}±0.21	32.00±1.00	1.70±.07
T4	7.24^{b}±0.05	31.50±0.50	1.80±.01
T5	7.74^{ab}±0.25	32.00±1.00	1.69±.02
Level of significance	*	*	NS

a,b,c, means in the same column with different superscripts are significantly different. T_0= Control diet (Commercial feed), T_1= Commercial feed + 0.5% red chili, and T_2= Commercial feed + 0.75% red chili, T_3= Commercial feed + 0.5% garlic, and T_4= Commercial feed + 0.75% garlic, $T_{5=}$ Commercial feed + 0.5% red chili+0.5% garlic, NS= Non significant, * means significant at 5% level.

Table 6
Total cost of production and profit per bird fed different diets at (0-40) days of age.

Parameters	Treatments					
	T_0	T_1	T_2	T_3	T_4	T_5
Feed cost (TK/ live bird)	122.10	136.01	136.31	139.74	147.40	124.24
Chick cost (TK/ live bird)	54	54	54	54	54	54
Management (TK/ live bird)	32.5	32.5	32.5	32.5	32.5	28.5
Spicy cost (TK/ live bird)	00	6.35	9.55	13.06	20.67	19.41
Medicine (TK/ live bird)	5	5	5	5	5	5
Total cost (TK/ live bird)	213.61	233.86	237.36	244.5	259.57	231.15
Market price (TK/Kg live bird)	133	133	133	133	133	133
Sale price (TK/ live bird)	219.58	254.76	259.21	267.99	277.97	232.21
Net Profit (TK/live bird)	5.79	20.90	21.85	23.49	18.4	1.06

T_0= Control diet (Commercial feed), T_1= Commercial feed + 0.5% red chili, and T_2= Commercial feed + 0.75% red chili, T_3= Commercial feed + 0.5% garlic, and T_4= Commercial feed + 0.75% garlic, $T_{5=}$ Commercial feed + 0.5% red chili+0.5% garlic.

Effect of red chili and garlic on carcass characteristics of broiler

The highest dressing percentage was recorded in broiler fed ration with 0.5% red chili ($T_{1)}$ where the lowest were in T_4 and T_5 groups. The statistical analysis showed that the differences of dressing percentage under different treatment groups were statistically significant (P<0.05). Singh *et al*, (2007) reported that supplementation of the amla and garlic combined powder at the rate of 5g/ kg in broiler feed results in enhanced dressing percentage and decreased mortality in broiler chicks.

Back and breast percentage of broilers in different treatment groups (T_0, T_1, T_2, T_3, T_4 and T_5) also shown in the table 3. Slight variation observed among all values of carcass characteristics but back and breast percentages were not statistically significant (P>0.05) when compare with control group. The findings who stated that garlic supplementation in diet had no significant effects on major carcass components and organ characteristics of broiler (Javandel et al. 2008; Onibi et al., 2009).

Ceylan et al. (1998) showed beneficial effects of dietary red chili meal supplementation to reduce

fat content, increase carcass quality and dressing percentage, as well as to increase the breast, thigh, and giblet weight of broiler chickens. Dietary supplementation of red chili meal in that study also had favorable effect to reduce the cost per chick. However, they (Ceylan et al. 1998) also reported higher relative weight for breast and thigh meat in broiler fed red chili meal, but relative weights of other organs were the same for their results. The percentages of other parts of carcass (wing, thigh and neck) showed significant ($P<0.05$) improvement with the inclusion of garlic powder in the broiler diets. The relative weights of these organs were more or less similar. Raeesi et al., (2010) stated that supplementation of 1% and 3% garlic in the broiler diet had no significant effects on relative weights of carcass and different parts of carcass.

Effect of red chili and garlic on internal edible and non-edible parts of broiler

The results showed that there are no significant ($P>0.05$) differences in liver, gizzard and heart percentages however, statistically significant ($P<0.05$) differences were observed in spleen and proventriculus percentage. The study of Pourali et al., (2010) also showed no significant ($p>0.05$) influence on carcass parameters like dressing yield and giblet yield (heart, gizzard and liver) in all dietary groups of garlic supplementation.

Raeesi et al., (2010) reported garlic at levels of 1% and 3% had no significant effects on relative weights of carcass, fat pad, or digestive organs among different treatments except for the small intestine. These findings are in agreement with the findings of Hashish et al., (1995) and Ceylan et al., (1998). The improvement of total tract digestibility in broilers fed different levels of GP was probably due to herbal effects in increasing the microbial population especially the number of bacteria such as E. coli, Clostridium spp. and Enterococci. The efficacy of any dietary feed additives observed under less hygienic housing conditions, especially under the separate floor pens equipped with wood shaving litter stimulates the activity of the feed additives. The isoprene derivatives, flavonoids, glucosinolates and other plant metabolites may affect the physiological and chemical function of the digestive tract. The stabilizing effect on intestinal microflora may be associated with intermediate nutrient metabolism. The active principles of essential oils act as a digestibility enhancer, balancing the gut microbial ecosystem and stimulating the secretion of endogenous digestive enzymes and thus improving growth performance in poultry.

Effect of red chili and garlic on hematology of broiler

The values of different treated groups were more or less similar. The hemoglobin and PCV values among different treated groups were statistically significant ($P<0.05$) but ESR values was not significant ($P>0.05$). White Blood Cell (WBC) counts had no significant ($P>0.05$) difference across the treatments, which implies that the experimental diets at the levels of inclusion could be tolerated without compromising the welfare or immunity of the bird. The slight increase in the blood constituents of cockerel chicks with increased concentration of garlic may be associated with the effects of garlic bioactive compounds on improving antioxidant status of the bird which were reported by Nakatani (2000) and Rababah et al., (2004).

Cost benefit analysis

The data of table 6 show that the broiler was sold in live weight basis in the respective group. Here it was seen that all groups make a profit. Highest profit was gained from T_3 (0.5% garlic) and lowest from T_5 (Commercial feed + 0.5% red chili+0.5% garlic).

CONCLUSION

It is concluded that garlic supplementation was superior in comparison to red chili and mixture of garlic and red chili, supplementation of garlic (*Allium sativum*) improves the growth performance of broiler when added at the rate of 0.75% level as feed additives in broiler ration.

SIGNIFICANCE STATEMENT

This study discovers the possible application of red chili and garlic as a source of phytobiotic feed additive to replace the chemical antibiotic and

other growth promoter to accelerate the growth performance of broiler and make broiler farm profitable. This study will help the researcher to uncover the critical level of spice herb like feed additive application in broiler diet that many researchers were not able to explore. Thus, a new theory on these spice herb feed additive may be arrived at.

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Statement on Conflicts of Interest

The authors have declared that no conflicts of interest exist.

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