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Influence of phytogenic feed additives and prebiotic in vegetable protein based diet on broiler performance

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Abstract

This study was conducted to determine the effect of phytogenic feed additive and prebiotic on vegetable protein base diet in broiler performance. A total of 90 chicks (Cobb-500) were weighted and randomly assigned to the three treatment groups (T_o, T_1 and T_2) and supplemented with either phytogenic feed additives or prebiotic and reared for 28 days. Data on live body weight, body weight gain, feed intake and feed conversion (FC) were taken at weekly interval. Results revealed that significant ($P<0.05$) increase in live body weight of broilers was evident in both phytogenic feed additive and prebiotic supplemented groups comparing to the control group at 4th weeks of age. No significant ($P>0.05$) differences were found in live weight gain among the treatment groups on weekly intervals along the whole experimental period. However, significant differences ($P<0.05$) were evident on cumulative weight gain at 3rd and 4th weeks of age. In case of feed intake at the age of 3rd and 4th weeks, significant ($P<0.05$) differences were obtained with decreased feed intake in both phytogenic feed additive and prebiotic supplemented groups comparing to the control group. In case of feed conversion (FC), there were significant ($P<0.05$) differences among the groups on 1st week and 4th week of age. Best FC was accounted for prebiotic supplemented group along the whole experimental period. The survivability rates were 96.67%, 100% and 100% in control group, phytogenic feed additive and prebiotic supplemented group respectively. Results finally showed that vegetable protein when supplemented with phytogenic prebiotic feed additives and prebiotic c an additive beneficial effect on performance of when compared to non-supplemented control diet. So, ration using vegetable protein mixed with phytogenic feed additives or prebiotic can be recommended for broiler.

Key words: Phytogenic, prebiotic, vegetable protein, growth performance, feed conversion.

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Introduction

Bangladesh is an agro-based country where more than 80 percent of the population depends on agriculture. Poultry and poultry products play a vital role in the income generating framework of the rural people of Bangladesh. Phytogenic feed additives and prebiotics are used with poultry feed from long days in Bangladesh. They comprise a wide range of plant-derived natural bioactive compounds and essential oils are a major group (Chengbo *et al.,* 2015). These are bioactive compounds with positive effects on animal growth and health, and are often applied to essential oils (EOs), botanicals and herbal extracts (Puvaca *et al.,* 2013). A large variety of the plants have properties of potentially improving feed intake, digestion, feed conversion and body weight gain. The mode of action of these feed additives is not

completely clear. Some phytogenic compounds are known to have antimicrobial, antiviral, antifungal and antioxidative properties (Brenes *et al.,* 2010), and traditionally been used as complementary or alternative medicines to improve human health or cure human diseases (Kim *et al.,* 2008). They also act as digestibility enhancers, stimulating the secretion of endogenous digestive enzymes (Lee *et al.,* 2003). These traits made phytogenic additives a promising group of growth promoters that are already being used in practice.

Prebiotic are nondigestible feed ingredients that can positively affect the animal organism by stimulating the activity and growth of beneficial native bacteria in the gastrointestinal tract and eliminate the pathogenic ones (Alloui *et al.,* 2013). It has been shown that prebiotics stimulate the growth of endogenous microbial population. Some studies demonstrated the beneficial effects of prebiotics on improvement of growth performance of broiler (Rahmani *et al.,* 2005; Rahmani and Speer, 2005).

Nutritional supplements combining probiotic and prebiotics are referred to as synbiotics, which are a combination of "a probiotic and a prebiotic that beneficially affects the host by improving the survival and establishment of live microbial dietary supplements in the gastrointestinal tract" (Trachoo *et al.,* 2008). The main importance of this form of synergism is that a probiotic alone, i.e. without a source of nourishment which can be represented by a prebiotic, cannot survive well in the digestive system (Bhupinder *et al.,* 2010). Synbiotics are gaining popularity and scientific credibility as functional food (feed) supplements at nutritional and therapeutic levels. It is believed that they can ensure a high level of viable probiotic cells once ingested (Trachoo *et al.,* 2008). Some studies have shown the importance and benefits of this kind of synergy between probiotics and prebiotics and the effectiveness in helping young animals to achieve better growth performance (Patterson *et al.,* 2003).

The objective of this study was to examine the effects of dietary supplementation of prebiotics or phytogenic product in broiler diets compared to standard broiler feed on the performance of broiler to investigate the effect of vegetable protein on broiler diet.

Materials and Methods

***Experimental Birds and Design*:** A total of 90 chicks Cobb 500 strain of mixed sex (male and female) of 37.30±0.01gm average body weights were obtained from a local hatchery where they had been vaccinated for Marek's and Newcastle diseases and infectious bronchitis post hatch via a coarse spray. The experiment was carried out for 28 days where starter period was 0 to 14 days and grower period was 15 to 28 days. Chicks were equally and randomly divided and distributed in three dietary treatment groups (T_0, T_1 and T_2) with three replications. There were 30 birds per treatment group and 10 birds per replication. Care and management of the birds adhered to the accepted guidelines (FASS, 2010).

***Collection of experimental broiler chicks*:** Phytogenic feed additive (0.04%) like Anta®Phyt MO (DR. Eckel GMBH, Germany) which is based on natural plant extracts, essential oils, herbs, and a prebiotic complex and also the prebiotic (0.1%) Megamos® (Popular Pharmaceutical Ltd., Agrovet Division, Bangladesh) which is based on Mannan oligosaccharides and Beta-glucan were collected from local market.

***Formulation and feeding diets*:** Mash feed was prepared from raw feed ingredients which were supplied to experimental birds. Ration was formulated according to the requirement of birds. Starter ration was given from day 0 to 14 days and grower ration was given from day 15 to 28. Phytogenic feed additive and prebiotic were supplied from 1st day to 28th day with other feed ingredients. Feed was supplied adlibitum along with fresh clean drinking water. The composition of different feed ingredients and nutritive value of starter and grower rations are given in Table 1.

***Measured parameters*:** Body weights were obtained at day 7, 14, 21 and 28 of age. Feed consumption was determined for the same time periods and birds

were checked twice a day. The body weight gain was calculated by deducting initial body weight from the final body weight of the birds. Quantity of offered feed was weighed weekly. Refusal feed was recorded to determine the feed intake per week. Feed intake was calculated weekly as gm/bird. Subsequently, feed conversation (FC) was measured weekly by dividing feed intake by weight gain.

Table. 1. Ingredients and nutritive composition of the experimental broiler Starter ration (0-14 days) and Grower ration (15-28 days)

Ingredients (kg/100kg)	Starter ration (0-14 days)	Grower ration (15-28 days)
Maize	50	53
Auto Rice Polish	4.153	2.283
Soybean Meal	35.5	33.45
Full fat Soya	4.5	4.5
Soybean oil	2.0	3.0
Molasses	0.5	0.5
Limestone	1.5	1.35
Salt	0.3	0.3
Vitamin mineral premix	0.25	0.25
DCP	0.9	0.9
L-lysin	0.1	0.07
DL-Methionine	0.2	0.2
Toxi mold	-	0.05
Maduramycin	0.06	0.05
Enzyme	0.025	0.06
Antioxidant	0.012	0.025
Total	100	100
Metabolizable Energy (Kcal/kg)	2920	3009
Crude Protein (gm/100gm)	22.79	21.92
Crude Fiber (gm/100gm)	4.07	3.79
Calcium (gm/100gm)	0.94	0.87
Phosphorous (gm/100gm)	0.68	0.66
Lysin (gm/100gm)	1.38	1.29
DL Methionine (gm/100gm)	0.53	0.52

Vitamin Mineral Premix provided following per kg diet: Vit. A 5000 IU, D_3 1000 IU, K 1.6 mg, B1 1 mg, B2 2mg, B3 16 mg, B6 1.6 mg, B9 320 µg, B12 4.8 µg, H 40 mg, Cu 4 mg, Mn 40 mg, Zn 20 mg, Fe 2.4 mg, I 160 µg.

***Statistical Analysis*:** Statistical analysis was conducted with the Statistical Package for Social Science (SPSS for Windows Version 23; SPSS Inc. 233 South Wacker Drive, Chicago, USA) to determine if variables differed between treatment groups. Results are expressed as Means ± SE.The body weight, body weight gain, feed intake and feed conversion ratio were compared among the groups by 1-way ANOVA and subsequent Duncan's Multiple Range Tests (DMRT). Probability values of less than 0.05 ($P<0.05$) were considered significant.

Results and Discussion

The results of the present research are presented in this chapter with necessary discussion.

***Effect of phytogenic feed additive and prebiotic on body weight of broilers*:** Table 3 represents that there was no significant ($P>0.05$) difference in body weight up to the 3rd weeks but significant differences ($P<0.05$) were observed at the end of 4th weeks of age. The highest body weight was observed on the prebiotic supplemented group, and the lowest body weight was observed on the control group and this is strongly concordant with the findings of some researchers (Hernandez *et al.* 2004; Cross *et al.,* 2007). They reported that phytogenic feed additive and prebiotic increase the body weight of broiler and among the different groups, prebiotic supplemented group showed better results than others groups. Zakeri *et al.* (2011) found the similar results when they used mannanoligosaccharide (MOS) as prebiotic.

Table 2. Weekly body weight (gm/broiler) of broiler on different treatment groups

Age	T_0 (Control) Mean±SE	T_1 (Phytogenic feed additives) Mean±SE	T_2 (Prebiotic) Mean±SE	Level of sig.
Day 1	37.25±0.026	37.34±0.021	37.29±0.030	NS
1st week	145.93±0.99	143.72±0.94	154.28±4.18	NS
2nd week	341.98±15.9	346.27±11.95	377.25±2.98	NS
3rd week	750.53±10.07	759.08±16.72	797.26±5.61	NS
4th week	1219^{a}±6.33	1250^{ab}±6.99	1298.8^{b}±4.68	*

Mean values having uncommon superscripts differ significantly. SE=Standard Error, NS=Non significant at 5% level, *= Significant at 5% level

Table 3. Weekly body weight gain (gm/broiler) of broiler on different treatment groups (Basal diet-control, phytogenic feed additive and prebiotic)

Age (weeks)	T_0 (Control) Mean±SE	T_1 (Phytogenic feed additives) Mean±SE	T_2 (Prebiotic) Mean±SE	Level of sig.
1st week	109.41±0.49	106.37±0.92	117.02±4.20	NS
2nd week	196.05±15.70	213.74±6.40	222.79±1.60	NS
3rd week	408.55±19.12	410.30±7.40	420.01±3.59	NS
4th week	468.44±7.99	487.51±9.38	501.52±7.98	NS

Mean values having uncommon superscripts differ significantly. SE=Standard Error, NS=Non significant at 5% level, *= Significant at 5% level

***Effect of phytogenic feed additive and prebiotic on body weight gain of broiler*:** Table 4 shows that phytogenic feed additive and prebiotic groups represented increased weekly body weight gains but no significant (*P>0.05*) difference was found among the treatment groups on weekly intervals along the whole experimental period.

Table. 4. Cumulative body weight gain (gm/broiler) of broiler on different treatment groups (Basal diet-control, phytogenic feed additive and prebiotic)

Age (weeks)	T_0 (Control) Mean±SE	T_1 (Phytogenic feed additives) Mean±SE	T_2 (Prebiotic) Mean±SE	Level of sig.
1-2	305.47±16.10	326.21±1.64	339.81±2.82	NS
1-3	714.01^{a}±9.37	736.51^{ab}±8.99	759.82^{b}±5.45	*
1-4	1182.4^{a}±6.06	1224^{b}±4.29	1261.3^{ab}±4.66	*

Mean values having uncommon superscripts differ significantly. SEM=Standard Error, NS=Non significant at 5% level, *= Significant at 5% level.

After the end of 4th weeks of age, the increased body weight gains were observed in both phytogenic feed additive and prebiotic containing groups in comparison with the control group. Increased body weight gain due to supplementation of phytogenic feed additive is in aggrement of the previous studies (Cross *et al.,* 2007; Mountzouris *et al.,* 2011). Similar results of increasing body weight with supplementation of prebiotic were also reported by Sims *et al.* (2004) and Zdunczyk *et al.* (2005). This is due to the well utilization of vegetable protein by increased digestive enzyme activity on prebiotic supplemented diet. The cumulative body weight gain of broiler on vegetable protein base diet containing phytogenic feed additive and prebiotic at different ages is presented in Table 4. Though, there was no significant (*P>0.05*) difference in cumulative body weight gain of broilers among the experimental groups on 2nd weeks. But significant differences (*P<0.05*) in cumulative body weight gain were evident at the end of 3rd and 4th weeks of age and higher body weight gain was observed in both in phytogenic feed additive and prebiotic supplemented groups comparing to the control group.

***Effect of phytogenic feed additive and prebiotic on feed intake of broilers*:** The results of feed intake of birds are given in Table 5. Tabular results showed that feed intake at 1st and 2nd weeks of broilers did not differ significantly (*P>0.05*) among the experimental groups. However, at the end of 3rd and 4th weeks significant differences (*P<0.05*) were observed with decreased feed intake in both phytogenic feed additive and prebiotic groups comparing to the control group.

Table 5. Weekly feed intake (gm/broiler) of broiler on different treatment groups (Basal diet-control, phytogenic feed additive and prebiotic)

Age (weeks)	T_0 (Control) Mean±SE	T_1 (Phytogenic feed additives) Mean±SE	T_2 (Prebiotic) Mean±SE	Level of sig.
1st week	127.70±0.44	126.46±1.00	125.24±0.55	NS
2nd week	274±0.58	272.86±1.44	271.87±0.58	NS
3rd week	802.03^{a}±0.61	800.69^{ab}±1.13	797.79^{b}±0.87	*
4th week	961.67^{a}±0.64	958.23^{ab}±0.43	956.47^{b}±1.11	*

Mean values having uncommon superscripts differ significantly. SE=Standard Error

The lowest feed intake was observed on prebiotic supplemented diet, and highest feed intake was observed on the control group. Decreased feed intake was in agreement for phytogenic feed additives (Banerjee *et al.,* 2011; Ganguly *et al.,* 2013) and also for the prebiotic (Xu *et al.,* 2003; Yusrizal *et al.,* 2003. Salianeh *et al.* (2011) reported that dietary inclusion of prebiotic significantly decreased feed intake in broiler chickens compared with the control group.

The cumulative feed intake of broiler on vegetable protein base diet containing phytogenic feed additive and prebiotic at different ages is presented in Table 6. There were no significant (*P>0.05*) differences observed in cumulative feed intake among the experimental groups in 2nd and 3rd weeks of age. However, significant differences (*P<0.05*) in feed intake were evident at the age of 4th weeks. At the end of 4th weeks the lowest feed intake was observed on the prebiotic supplemented group, and highest feed consumption was observed in control group (Table 4).

Table 6. Cumulative feed intake (gm/broiler) of broiler on different treatment groups (Basal diet-control, phytogenic feed additive and prebiotic)

Age (weeks)	T0 (Control) Mean±SE	T1 (Phytogenic feed additives) Mean±SE	T2 (Prebiotic) Mean±SE	Level of sig.
2nd week	401.70±0.91	399.32±2.13	397.11±1.11	NS
3nd week	1203.7±0.34	1200±3.26	1194.8±1.98	NS
4nd week	2165.5^{a}±0.87	2158.2^{b}±3.74	2151.3^{b}±2.64	*

Mean values having uncommon superscripts differ significantly. SE=Standard Error, NS=Non significant at 5% level, *= Significant at 5% level.

***Effect of phytogenic feed additive and prebiotic on feed conversion (FC) of broiler*:** The result of FC is shown in Table 7. Here, significant (*P>0.05*) difference was observed among the groups on 1st weeks but in 2nd and 3rd weeks there was no significant (*P>0.05*) difference.

Table 7. Weekly feed conversion (FC) of broiler on different treatment groups (Basal diet-control, phytogenic feed additive and prebiotic)

Age (Weeks)	T0 (Control) Mean±SE	T1 (Phytogenic feed additives) Mean±SE	T2 (Prebiotic) Mean±SE	Level of sig.
1st week	1.18^{a}±0.01	1.20^{a}±0.01	1.08^{b}±0.03	*
2nd week	1.33±0.02	1.30±0.03	1.25±0.01	NS
3rd week	2.06±0.09	1.99±0.02	1.93±0.01	NS
4th week	2.29^{a}±0.06	2.08^{b}±0.01	1.99^{b}±0.02	*

Mean values having uncommon superscripts differ significantly. SEM=Standard Error, NS=Non-significant at 5% level, *= Significant at 5% level.

Again, after the end of 4th weeks, there was significant (*P<0.05*) difference on FC was observed among the groups. For phytogenic feed additives similar improved FC was observed by various researchers (Biavatti *et al*., 2003; Hernandez *et al*., 2004). Ertas *et al*., 2005) revealed by his investigation that the impact of a blend of essential oils originating from oregano, clove and anise in comparison to a conventional AGP (Avilamycin) significantly improved average feed conversion. The cumulative feed conversion (FC) of broiler on vegetable protein base diet containing phytogenic feed additive and prebiotic at different ages are presented in Table 8. There was no significant (*P>0.05*) difference among the experimental groups on 2nd weeks of age. However, significant differences (*P<0.05*) in decreased cumulative feed conversion were evident to the age of 3rd and 4th weeks in both phytogenic feed additive and prebiotic groups compared to the control group. At the end of 4th weeks the lowest cumulative FC was observed on prebiotic supplemented diet and highest was observed on the control group and this result was similar with the breeding company (Cobb-500, Commercial Broiler Management Guide, 2004).

Table 8. Cumulative feed conversion (FC) of broiler on different treatment groups

Age (weeks)	T0 (Control) Mean±SE	T1 (Phytogenic feed additives) Mean±SE	T2 (Prebiotic) Mean±SE	Level of sig.
2	1.32±0.07	1.23±0.01	1.17±0.01	NS
3	1.69^{a}±0.02	1.63^{a}±0.02	1.57^{b}±0.01	*
4	1.83^{a}±0.01	1.77^{ab}±0.00	1.71^{b}±0.01	*

Mean values having uncommon superscripts differ significantly. SE=Standard Error, NS=Non significant at 5% level, *= Significant at 5% level.

***Effect of phytogenic feed additive and prebiotic on survivability of broiler*:** Survivability of broilers in each treatment group is given in Table 9. It was observed that survivability of broilers was higher in both phytogenic feed additive and prebiotic supplemented groups comparing to the control group due to the decreased diseases prevalence. These findings were in agreement with many researchers. Guo *et al.* (2004) demonstrated that plants and their

extracts could reduce the populations of coliforms and/or *C. perfringens*, and enhance both cellular and humoral immune responses of diseased chickens (either infected with avian *Mycoplasma gallisepticum* or *Eimeria tenella*). Silva *et al.* (2009) noted that beneficial effects of prebiotic on different immune functions performed by producing immunostimulating compounds such as the production of cytokines and immunoglobulins (particularly IgA) and also on macrophage phagocytosis.

Table 9. Survivability % of broiler on different treatment groups (Basal diet-control, phytogenic feed additive and prebiotic)

Age (Weeks)	T_0 (Control)	T_1 (Phytogenic feed additives)	T_2 (Prebiotic)
1-4	96.67	100	100

***Effect of phytogenic feed additive and prebiotic on cost benefit analysis of broiler*:** Cost-benefit analysis is presented in Table 10. There were no significant (*P>0.05*) differencs in chick cost, total feed cost and management cost but higher significant (*P<0.05*) differences were total feed cost, total cost and total live boiler cost among the treatment groups. In terms of profit, net profit and net profit (live broiler) were significantly (*P<0.05*) differed among the treatment group. Increased profit was observed both in phytogenic feed additive and prebiotic supplemented groups comparing to the control group and this result is similar with Scheuermann *et al.* (2009). Other researchers (Samarasinghe *et al.,* 2003; Parks *et al.,* 2001) found that growth performance improve by the use of prebiotic in broiler ration.

Table 10. Cost of production and returns of broilers in different treatment groups

	Cost items			
Parameter	**T0 (Control) Mean±SE**	**T1 (Phytogenic feed additives) Mean±SE**	**T2 (Prebiotic) Mean±SE**	**Level of sig.**
Chick cost (Tk./Chick)	40.00	40.00	40.00	NS
Growth promoter cost (Tk./Kg)	--	2000	1200	--
Growth promoter cost (Tk./Kg feed)	--	0.80	1.42	--
Total feed cost (Tk./Kg)	37.35	38.15	38.77	NS
Management cost (Tk./broiler)	15	15	15	NS
Total feed cost (Tk./broiler)	80.88^{b}±0.03	82.33^{ab}±0.14	83.40^{a}±0.10	*
Total cost (Tk./broiler)	135.88^{b}±0.03	137.33^{a}±0.14	138.40^{a}±0.10	*
Total cost (Tk./Kg live broiler)	123.41^{a}±0.36	120.74^{b}±0.15	120.32^{b}±0.88	*
	Income			
Market sale price (Tk./Kg broiler)	130	130	130	NS
Total sale price (Tk./broiler)	158.47^{b}±0.82	162.51^{b}±0.91	168.84^{a}±0.61	*
Net Profit (Tk./broiler)	22.59^{b}±0.81	25.17^{b}±0.78	30.43^{a}±0.68	*
Net Profit (Tk./Kg live broiler)	6.59^{b}±0.34	9.26^{a}±0.15	9.68^{a}±0.88	*

Mean values having uncommon superscripts differ significantly. NS = Non significant at 5% level, * = Significant at 5% level.

Conclusion

Vegetable protein supplementation with phytogenic feed additive or prebiotic revealed an additive beneficial effect on feed efficiency through the whole experimental period when compared to unsupplemented control diet. At last it may be recommended that vegetable protein can be used as an important protein source for broiler ration.

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