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Synbiotic, probiotic and neem leaf as alternatives to antibiotic growth promoter in broiler diet

M Ahammed✉ and MN Rahman

Department of Poultry Science, Bangladesh Agricultural University, Mymensingh-2202

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Correspondence:
M Ahammed ✉: musabbir.ps@bau.edu.bd

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ABSTRACT

The feeding trial was carried out to compare the effect of probiotic, synbiotic and neem (*Azadirachta indica*) leaf as alternatives to antibiotic in broiler chicken diets. The experiment was performed for a period of 28 days with a number of 500 day-old straight run broiler chicks. Birds were divided into five dietary treatment groups with 4 replications having 25 birds in each. The dietary groups were; control (Basal diet), synbiotic, probiotic, neem leaf powder (NLP) and antibiotic group. The experimental diets were consisted as broiler starter (day-old to 14 days) and broiler grower (15 to 28 days). The supplementation of synbiotic, probiotic, NLP and antibiotic in the broiler diets had significant effect on growth performance. Diets supplemented with synbiotic showed significantly ($p<0.05$) higher live weight and weight gain at the end of the experiment compare to the control and antibiotic group. NLP and probiotic supplemented groups also showed significantly higher ($p<0.05$) body weight and body weight gain compared to control and showed almost similar performance compared to antibiotic group. Better FCR ($p<0.05$) was also noticed in synbiotic group (1.60) compare to the control (1.79), antibiotic group (1.65), NLP group (1.69) and probiotic group (1.70). There were no significant differences in meat quality characteristics among the dietary groups. The cost of production per kg of live broiler was slightly lower in synbiotic group compared to control and antibiotic groups. With regards to profit, synbiotic groups showed higher profitability than other groups. The result indicated that supplementation of synbiotic, probiotic and NLP in broiler diet had a positive effect on growth performance and profitability. It is therefore suggest that the synbiotic, probiotic and NLP could be potential feed additives in broiler diet and synbiotic could be considered as a better antibiotic alternative for broiler production.

Introduction

The use of antibiotic in animal feed is being questionable for a long time due to its relation to the development of pathogenic resistance to human health (Smith *et al.*, 2003). Evidence shows that antibiotic resistance genes can be transmitted from animal to human microbiota (Greko *et al.*, 2001). Moreover, numerous of these synthetic medications and growth promoters are added to broiler diets to stimulate fast development, but their usage has many drawbacks, including high cost, negative side effects on bird health, prolonged residual characteristics, and carcinogenic impact in humans (Cardozo *et al.,* 2004). In several countries of the world, including Bangladesh the use of most antibiotics growth promoters (AGP) has been banned to preserve the effectiveness of important human drugs (Casewell *et al.,* 2003). Recently, alternatives for substituting these traditional growth promoters have been

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evaluated and herbal plants, probiotics, prebiotics, synbiotics, enzymes, essential oils, photobiotic, organic acid etc. feeding have been the area of interest.

Synbiotic is a combination of probiotics and prebiotics that have a synergistic effect that can improve the health status of the disease, the efficiency of feed ingredients, antibacterial activity, immunity to infection and the performance of broiler chickens. Synbiotic give a live culture and feed them to promote the survival, persistence, and development of beneficial organisms in avian guts as the particular substrate for fermentation (Gaggia *et al*., 2010). Fructo-oligosaccharides and *bifidobacteria*, as well as lactitol and *lactobacilli*, are well-known probiotic and prebiotic combinations are use as synbiotics (Yang *et al*., 2009). Synbiotic bacteria were shown to increase intestinal morphology and nutritional absorption in broilers, resulting in better performance (Hassanpour *et al*., 2013).

Probiotics, as defined by FAO/WHO, are living microorganisms that, when provided in sufficient quantities, a health benefit reflects on the host (Fuller, 1989). Probiotics appear to be good alternatives to the usage of AGP (Tomasik and Tomasik, 2003), who have been used on poultry and animals to boost mean weight gain (Tannock *et al.,* 1999). Several microorganisms, including fungus, notably mushroom and yeast, bacteria, and mixed cultures of diverse microbes, have been explored or employed as probiotics. Probiotic species like *Lactobacillus, Streptococcus, Bacillus, Bifidobacterium, Enterococcus, Aspergillus, Candida,* and *Saccharomyces* are commonly used in broiler nutrition to prevent poultry pathogens and diseases and improve broiler growth performance (Awad *et al*., 2009).

Neem (*Azadirachta indica*) is a useful conventional medicinal plant in Bangladesh. In all parts of the neem tree has some medicinal properties and is commercially exploitable for the development of medicines and industrial by-products (Bhowmik *et al.*, 2008). These plants are used as digestive stimulants, antidiarrhoic, antiseptic, antiinflammatory, antiparasitic and appetite stimulants in human beings as well as animals.The antimicrobial activity of extracts of neem leaves against such microorganisms as *Staphylococcus spp*, *Streptococcus spp*, *Pseudomonas spp* and *Escherichia coli*, and some fungal strains have been reported many researchers (Valarmathy *et al.,* 2010).

As a result, the proposed experiment was designed to the comparison of different antibiotic alternatives on growth performance of broilers and to determine the most effective antibiotic alternatives for broiler production.

Materials and Methods

Experimental birds and layout

The experimental work was conducted at Bangladesh Agricultural University (BAU) Poultry Farm, under the Department of Poultry Science, Bangladesh Agricultural University, Mymensingh.

Table 1: Ingredients and chemical composition of broiler starter and broiler grower diets

Items	Starter	Grower
Ingredients (kg/100kg, fresh basis)		
Maize	54.99	60
Soya meal	31	24.09
Protein concentrate (CP, 60%)	7	8
Di calcium phosphate	1.35	1.35
Limestone	0.8	0.7
Soybean oil	4	5
L-lysine HCl (98.5%)	0.1	0.1
DL methionine (99%)	0.12	0.12
Vitamin-mineral premix*	0.25	0.25
Choline chloride (50%)	0.03	0.03
Common salt	0.36	0.36
Total	100	100
Chemical composition (%) (Calculated)		
Dry matter	89.68	87.09
ME (kcal/kg)	3050	3150
Crude protein	23.66	20.59
Ca	1.21	1.05
Available P	0.45	0.42
Lysine	1.24	1.06
Methionine+Cystine	1.00	0.92

**Vitamin-mineral premix supplied the following per kg of diet: Vit A, 12,000 IU; Vit D3, 4,000 IU; Vit E, 45 mg; Vit K3, 2.2 mg; Vit B1, 1.2 mg; Vit B2, 5.5 mg; Vit B6, 3 mg; Vit B12, 0.03 mg; Niacin, 50 mg; Panthothenic acid, 10 mg; Folic acid, 0.5 mg; Biotin, 0.08 mg, Mn, 70 mg; Fe, 48 mg; Cu, 5 mg; Zn, 60 mg; Se, 0.2 mg; I, 1 mg.*

A total of 500 Indian River commercial straight run chicks were divided into five dietary groups having four replications in each (twenty five birds in each replication). The five dietary treatment groups were as follows: Control (without feed additives); Synbiotic (50g/100kg feed); Probiotic (50g/100kg feed); NLP (200g/100kg feed); and antibiotic (50g/100kg feed).

Experimental diets and feed additives

The starter and grower phases of broiler diets were designed separately. The starter diet was supplied to the birds from day-old to 14 days and grower diet was supplied for next 14 to 28 days. Composition of feed ingredients and nutrient contents of diets are shown in Table 1. Basal diets were formulated by referring the Indian River management guide for broilers to meet the nutrients levelsfor the starter and the grower phase respectively. Feed and

water were supplied *ad libitum*. During the feeding trial, initial body weight was recorded just after arrival. For the first few days, feeds were given on a newspaper along with one plastic drinker in each pen. After brooding two round plastic tube feeders and one medium plastic drinker were used per pen.

Table 2: Growth performance of broiler in different dietary treatments at different ages

Week	Treatments					p-value
	Control	Synbiotic	Probiotic	NLP	Antibiotic	
Body weight (g/bird)						
1st	233.32±2.57	230.98±2.30	232.14±1.25	235.30±3.47	234.74±2.83	0.752
2nd	428.75±15.95	421.70±7.96	423.05±6.18	417.65±2.83	430.55±5.53	0.838
3rd	697.05±32.54	764.42±20.03	722.35±28.70	713.05±21.12	722.35±8.99	0.390
4th	1080.35^{b}±35.92	1323.83^{a}±31.96	1256.38^{a}±35.3	1227.95^{a}±20.9	1232.00^{a}±28.44	0.001
Body weight gain (g/bird)						
1st	191.71±2.57	189.37±2.30	190.53±1.26	193.69±3.47	193.13±2.83	0.752
2nd	195.43±14.01	190.72±9.75	190.91±6.19	182.35±1.71	195.81±3.01	0.789
3rd	268.30±25.96	342.73±15.30	299.30±24.11	295.40±18.81	291.80±3.65	0.152
4th	383.30^{a}±4.10	559.40^{b}±23.49	534.00^{b}±15.96	514.90^{b}±7.85	510.3^{b}±22.03	0.001
Total	1038.74^{a}±16.91	1282.22^{b}±11.68	1214.77^{b}±14.97	1186.34^{b}±8.34	1191.09^{b}±11.6	0.012

Values with different superscripts in the same row differ significantly (P<0.05). Data are presented as mean ±SE, NLP, Neem leaf powder.

Table 3: Feed intake (g/bird/week) of broiler in different dietary treatments at different ages

Week	Treatments					p-value
	Control	Synbiotic	Probiotic	NLP	Antibiotic	
1st	204.56±1.10	195.71±1.98	203.89±1.70	198.48±2.06	201.81±0.95	0.840
2nd	400.63±0.78	369.99±3.52	374.18±8.02	361.05±1.93	385.74±3.57	0.712
3rd	499.04±8.19	505.38±2.85	487.86±6.15	499.22±2.79	469.80±2.11	0.362
4th	755.10^{b}±29.87	962.17^{a}±11.86	998.63^{a}±12.81	952.56^{a}±15.27	908.42^{a}±11.16	0.048
Total	1859.34^{b}±23.02	2051.52^{a}±6.23	2065.11^{a}±8.12	2004.9^{ab}±11.64	1965.30^{ab}±13.5	0.036

Values with different superscripts in the same row differ significantly (P<0.05). Data are presented as mean ±SE, NLP, Neem leaf powder.

A commercial synbiotic named "SynBac" was employed in the feeding trail. It was made in Thailand by K.M.P.BIOTECH CO., LTD. and distributed by PVF Agro Limited in Dhaka, Bangladesh.In the feeding trial, a commercial probiotic called "PRO.B" was used. It was manufactured by K.M.P. BIOTECH CO., LTD. in Thailand and distributed by PVF Agro Limited in Dhaka, Bangladesh. Mature neem leaves were collected from BAU campus. The leaves were sun-dried for 10 days before being used in diet preparation. The fine mesh was collected using a dry mill blender and stored in an airtight plastic container until it was used for screening and feed preparation. The antibiotics employed in the experiment were known as "Renamycin." It was manufactured by Reneta Limited, Dhaka.

Renamycin soluble powder includes 200 mg of oxytetracycline USP per gram.

Data collection and record keeping

Throughout the experiment, the growth performance data (body weight, weight gain and feed intake) and dressing parameters (dressing percentage, breast, thigh, drumstick and wing weight) were collected. Weekly body weight, body weight gain and feed intake of broilers in different groups were recorded. Feed conversion ratio (FCR) was calculated by the ratio of weight gain and feed intake. At the end of feeding trial, four broilers with body weight similar to average from each treatment (one per replication) were selected and slaughtered. Then the weight of carcass (without feet, neck, and head) and organs including abdominal fat, liver, heart and gizzard were weighed. Dressed broilers were cut into different major parts such as breast, thigh, drumstick, and wing. Finally, each cutup parts were weighed and recorded.

Table 4: Feed conversion ratio of broiler in different dietary treatments at different ages

Week	Treatments					p-value
	Control	Synbiotic	Probiotic	NLP	Antibiotic	
1st	1.05±0.01	1.06±0.01	1.06±0.01	1.04±0.02	1.04±0.01	0.745
2nd	2.05±0.14	1.94±0.12	1.96±0.06	1.98±0.03	1.97±0.03	0.764
3rd	1.86±0.17	1.61±0.07	1.63±0.14	1.69±0.11	1.61±0.02	0.101
4th	1.97^{a}±0.05	1.76^{c}±0.05	1.87^{bc}±0.04	1.85^{bc}±0.03	1.78^{c}±0.07	0.001
Cumulative	1.79^{a}±0.03	1.60^{c}±0.03	1.70^{b}±0.04	1.69^{b}±0.03	1.65^{b}±0.03	0.026

Values with different superscripts in the same row differ significantly (P<0.05). Data are presented as mean ±SE, NLP, Neem leaf powder.

Table 5: Dressing percentage and meat yield characteristics of broiler in different dietary treatments (% in relation to body weight)

Parameter	Treatments					p-value
	Control	Synbiotic	Probiotic	NLP	Antibiotic	
Dressing%	56.24±1.69	56.54±1.10	57.34±1.99	57.12±3.10	58.94±0.86	0.866
Breast meat	14.27±1.58	13.09±0.36	15.34±1.08	13.74±0.01	15.43±0.06	0.336
Thigh meat	7.57±0.02	8.05±0.66	9.63±0.22	7.56±0.85	9.81±1.44	0.253
Drumstick meat	6.88±1.05	6.37±0.32	7.05±0.01	6.11±0.74	7.37±0.34	0.630
Wing meat	3.44±0.70	3.69±0.66	3.70±0.32	3.40±0.28	2.80±0.55	0.754
Head weight	1.55±0.35	1.26±0.25	1.63±0.22	1.38±0.18	2.05±0.04	0.263
Neck weight	2.66±0.43	1.93±0.25	2.89±0.64	1.95±0.23	2.94±0.43	0.358
Leg weight	4.55±0.20	3.24±0.52	3.65±0.90	3.17±0.44	4.47±0.57	0.690
Liver weight	3.18±0.42	2.85±0.16	3.40±0.54	2.60±0.42	3.11±0.06	0.320
Heart weight	0.95±0.26	0.84±0.17	1.22±0.04	0.89±0.11	1.48±0.03	0.116
Gizzard weight	2.83^{a}±0.09	2.09^{b}±0.08	2.54^{a}±0.15	1.86^{b}±0.14	2.70^{a}±0.19	0.017
Abdominal fat	0.77±0.08	0.92±0.85	1.35±0.34	1.22±0.28	1.30±0.01	0.791

Values with different superscripts in the same row differ significantly (P<0.05). Data are presented as mean ±SE, NLP, Neem leaf powder,

Cost and profit calculation

The production cost considered as the cost of day-old chicks, feed, electricity, vaccination and medication, management and housing cost. Total selling price was calculated by final live body weight of the broilers produced and the price per unit weight. Net profit was calculated differences between the production cost and selling price.

Statistical analysis

The data were organized methodically in preparation for analysis using the Statistical Computer Package Software (SAS, 2002). In a Completely Randomized Design, data were exposed to one-way ANOVA (CRD). Duncan's Multiple Range Test (DMRT) was used to compare the means in case of significant difference ($p<0.05$).

Results and Discussion

Body weight and body weight gain

Body weight and body weight gain of broilers fed different diets are presented in Table 2. Data in Table 2 indicate that there was no significant different on initial, 1st, 2nd and 3rd weeks body weight among the dietary groups. Only the 4th and total body weight showed significant difference ($P<0.05$) among the dietary groups. Only the 4th week of age synbiotic group showed the highest body weight (1323.83 g) compared to the control (1080.35 g) group. At the end of feeding trial, highest body weight was found in synbiotic group (1282.22 g), followed by probiotic group (1256.38 g), antibiotic group (1232.00 g), NLP group (1227.95 g) and control group (1080.35 g). A significant variation was showed ($P<0.05$) on weight gain at 4th weeks and

Table 6: Cost benefit analysis of broiler in different dietary treatments

Parameter	Treatments				
	Control	**Synbiotic**	**Probiotic**	**NLP**	**Antibiotic**
a. Feed intake (g/ broiler)	1859.34	2051.52	2065.11	2004.91	1965.30
b. Final body weight (g/broiler)	1080.35	1323.83	1256.38	1227.95	1232.00
c. Feed price (BDT/kg)	47.65	47.65	47.65	47.65	47.65
d. Antibiotic cost	0	0	0	0	0.41
e. Cost for neem leaves	0	0	0	0	0
f. Cost for probiotic	0	0	0.48	0	0
g. Cost for synbiotic	0	0.82	0	0	0
h. Total feed cost BDT/kg	47.65	48.47	48.13	47.65	48.06
i. Feed cost BDT/bird	88.59	99.44	99.39	95.53	94.45
j. Chick cost BDT/bird	29	29	29	29	29
k. Miscellaneous*	20	20	20	20	20
l. Total cost of production /live bird	137.59	148.44	148.39	144.53	143.45
m. Total cost of production BDT/kg live bird	127.35	112.13	118.11	117.70	116.44
n. Total income/ bird (sales price BDT 155/ kg live bird)	167.45	205.19	194.74	190.33	190.96
Profit BDT/live bird	29.86	56.75	46.35	45.8	47.51
Profit BDT/kg live bird	27.64	42.87	38.89	37.30	38.56
Cost benefit ratio	0.82	0.72	0.76	0.76	0.75

*NLP, Neem leaf powder; *, vaccines, disinfectants, transport, bedding materials, labour etc.*

total period among the different dietary groups. At 4th weeks of age, synbiotic group (559.40 g) showed higher weight gain compare to the control group. However, there was no significant effect (P>0.05) on 1st week, 2nd week and 3rd week body weight gain among the different groups.

Feed intake

Data revealed in Table 3 that there was no significant (P>0.05) effect on 1st, 2nd and 3rd weeks feed intake over the other dietary groups. But feed intake on 4th week and overall period showed significant variation (P<0.05) among dietary groups. Probiotic group (998.63 g) showed the higher feed intake compare to others at 4th weeks of age. Considering the total feed intake, probiotic group (2065.11 g) and synbiotic group (2051.52 g) showed numerically higher feed intake compare to the control group (1859.34 g).

Feed conversion ratio

Result from Table 4 indicates that there was significant variations (P<0.05) on total feed conversion ratio among different dietary groups. At the end of feeding trial, significantly better FCR (P<0.05) was in synbiotic group (1.60) compared to the antibiotic (1.65) and control (1.79) group. However, antibiotic group (1.65), NLF group (1.69) and probiotic group (1.70) showed no significant difference. The Table also shows no significant variation (P>0.05) in the 1st, 2nd and 3rd weeks among different treatment groups. But at the 4th week of age, synbiotic group (1.76) showed better FCR when compared with the control group (1.97).

Dressing percentage and meat characteristics

Table 5 indicates that there were no significant differences (P>0.05) in meat yields of broilers among dietary treatment groups. Synbiotic, probiotic, NLP and antibiotic groups showed numerically higher dressing percentage compared to the control. Breast meat, thigh meat, thigh bone, drumstick meat, wing meat, and wing bone have no significant difference among the different dietary groups. No significant differences (P>0.05) in head, neck, leg, liver and abdominal fat weight in relation to body weight among different dietary groups were also found. Antibiotic group showed a higher head (2.05%) and heart (1.48%) weight; probiotic group showed a higher neck (2.89%), liver (3.40%) and abdominal fat (1.35%) weight compare to the control group. The control group showed a higher leg (4.55%) and gizzard weight (2.83%) as compared to different dietary treatments.

Cost benefit analysis

The cost of production of the present study is shown in Table 6. The cost of production per kg of live broiler was numerically higher in control group compared with other groups. Moreover, when live broiler was sold per kg at equal market price, synbiotic group had higher (42.87BDT) profit/kg live bird followed by probiotic (38.89BDT), antibiotic (38.56BDT), NLP (37.30BDT) and control (27.64BDT) group respectively.

Discussion

Body weight and body weight gain

The current findings showed that including feed additives such as neem leaf powder, probiotic, and synbiotic into broiler feed significantly improved final body weight and weight gain when compared between the control and antibiotic treated groups. In case of synbiotic, these results are agreed with the findings of Raksasiri *et al.* (2018). Suparom *et al.* (2013) observed that broiler diet supplemented with synbiotics in improved production performance but had no influence on carcass quality. Al-Sultan *et al.* (2016) found that synbiotics supplemented diet significantly increased the birds' weight gain when compared with the control group. Furthermore, Awad *et al.* (2008) revealed that feeding broilers the synbiotics (Biomin®IMBO comprising *Enterococcus faecium* and oligosaccharide) enhanced average weight gain and feed to gain ratio. Synbiotic generally offered a balanced intestinal microbiota in the broilers and boost up growth performance (Abdel-Hafeez *et al.*, 2017). This was due to the proliferation of helpful bacteria resulting in probiotics' beneficial effects against the negative impacts of harmful microbial populations in the gut.

The results of this investigation for probiotics are consistent with those of Bai *et al.* (2013). They compared the probiotic-treated group to a control, an antibiotic, and a probiotic + antibiotic-treated group, and discovered that both antibiotics, probiotics, and their combination improved average body weight in broilers during the growing period (21-42 days) when compared with the control, but there was no difference in broiler weight gain during the starter phase.

Furthermore, Sabatkova *et al.* (2008) compared the efficacy of antibiotic growth promoter (Avilamycin) and probiotic (BioPlus 2B) to investigate the broiler performance and dressing yields. They concluded that the supplementation of probiotic improved 4–5% weight gain. Several researchers (Salim *et al.*, 2013; Shim *et al.,* 2012; O'Dea *et al.*, 2006) also reported that supplementation of probiotic in broiler feed improved body weight and body weight gain significantly.

Present results demonstrated the addition of NLP to experimental diets positively influenced body weight and weight gain. This is in general agreement with previous studies with Neem leaf meal and ginger extract (Rahman *et al.*, 2015); Tulsi and neem leaves extract (Khatun*et al.*, 2013); Neem, turmeric and papaya leaf meal (Mahejabin *et al.*, 2015); Neem, nishyinda, tulsi and turmeric extract (Uddin *et al.*, 2014); Neem leaf powder (Wankar *et al.*, 2009). The improvement of performance observed in broilers by providing diet containing NLP and reason was related to antimicrobial and antiprotozoal properties (Kale *et al.*, 2003; Bishnu *et al.*, 2009) of neem leaves, which help to reduce the microbial load of birds.

Feed intake

In present study, synbiotic, probiotic, NLP groups showed significantly higher feed intake when compared with control group. Abdel-Raheem *et al.* (2012) and Min *et al.* (2016) found that synbiotic supplementation in broiler diets significantly increased the feed intake when compared with the control group ($p<0.05$). Salehi-manesh *et al.* (2016) and Sarangi *et al.* (2016) reported no differences in feed intake using synbiotics in broilers diets. The variations in the results of these studies were due to differences in inclusion levels, variations in microorganisms, probiotic and/or symbiotic composition, nutritional strategies, lineage, environmental conditions, dietary ingredients (Midilli *et al.*, 2008), existing and/or applied microbiological challenge (Buenrostro *et al.*, 1983), or management practices (Bitterncourt *et al.*, 2011).

Probiotic dietary group showed significantly higher feed intake which was in agreement with the findings of Edens (2003), who reported the inclusion of desirable microorganisms (probiotics) in the diet allows the rapid development of beneficial bacteria in the digestive tract of the host, while improving its performance and feed intake. But several researchers (Panda *et al.,* 2000; Faria *et al.,* 2009; Rada *et al.,* 2013) found non-significant variation in feed intake between control and probiotic group.

NLP groups exhibited no significant difference but numerically higher feed intake compared to control. This finding is consistent with that of Neem and other herbal extracts (Uddin *et al.*, 2014). However, Neem, papaya and turmeric extracts (Mahejabin *et al.*, 2015) showed improved feed intake in treatment group compared to control. The cause behind it was due to reduction of microbial load of birds (Mahejabin *et al.*, 2015; Kale *et al.*, 2003). Several previous findings reported Neem leaf meal and ginger extract (Rahman *et al.*, 2015), Tulsi and neem extract (Khatun *et al*., 2013) had no significant difference in feed intake compared to the control.

Feed conversion ratio

In comparison with the control group, preset findings showed that the synbiotic dietary group had significantly better FCR than the antibiotic, NLP, and probiotic groups. Raksasiri *et al.* (2018); Suparom *et al.* (2013); Mountzouris *et al.* (2007); Awad*et al.* (2008) reported better FCR of broilers with synbiotic supplementation. In the present study, probiotic on FCR of broiler was in line with the agreement of Shim *et al.* (2012); O'Dea *et al.* (2006); Sabatkova *et al.* (2008); Zhou *et al.* (2010). Who found that diet supplementing with *Bacillus subtilis* and *B. licheniformis* improved feed conversion efficiency in broilers.The effect of NLP on FCR of broiler was in close agreement with tulsi and neem leaves extract (Khatun *et al.*, 2013); Neem and other herbal extract (Uddin *et al.*, 2014); Neem leaf meal and ginger extract (Rahman *et al.,* 2015); Neem, papaya leaf and turmeric extract (Mahejabin *et al.*, 2015).

Dressing percentage and meat characteristics

The findins of the present study showed no significant effects of synbiotic, probiotic, NLP and antibiotic supplementation on broiler dressing percentage, breast meat and thigh meat compared to control. Similar results were reported by Sarangi *et al.* (2016), who showed that the supplementation of synbiotics did not influence the dressing percentage, breast meat and thigh meat yield of broilers. Ashayerizadeh *et al.* (2009) also observeded similar results as they fed diet supplemented with synbiotics (Primalac and Biolex-MB) and found no significant effect in the carcass, thigh meat yield, and breast meat yield percentages. Opposite results were found by Abdel-Raheem *et al.* (2012), as they reported that dressing percentage, breast and thigh meat yield increased as compared with other groups. The author Moreira *et al.* (2001) discovered no

significant effect in carcass yield between probiotic and control diet fed birds which is the agreement with the present study. Supplementation of NLP had no significant effects on breast meat, thigh meat, drumstick meat, wing meat, thigh bone and drumstick bone weight. Moreover, significant difference were not found in live weight, skin, head, neck, leg, liver, spleen, kidney, heart, gizzard in relation to body weight among different dietary groups. This result is supported by neem leaf meal (Laboni *et al.*, 2007); tulsi and neem leaves extract (Khatun *et al.*, 2013); neem and other herbal extracts (Uddin *et al.*, 2014); neem, papaya leaf and turmeric extract (Mahejabin *et al.*, 2015).

Cost-effectiveness of production

Making profit is the primary aim of every business, and it could be adjusted by lowering input or raising the output to an optimal level. If the feed additives (synbiotic, probiotic, NLP) used are not profitable but helpful for healthy meat production, the producers avoid using these type of feed additives in their poultry feed. Profit is important to everyone, whether they are consumers or farmers. When live broilers were sold at market price, all treated groups were profitable, with the synbiotic fed group having the highest value among the supplemented groups. This is in line with the findings of Salah *et al*. (2019), who showed that synbiotic supplementation had significantly higher net profit and the profit to cost ratio compared to control. Probiotic feeding group showed more profitable compared to the antibiotic and control groups. This result was particularly similar to the findings of Roy *et al.* (2013) who reported that feeding probiotic to broiler was either similar or more profitable than combination of probiotic+AGP while better than AGP alone. NLP supplemented group was economically more profitable when compared with the control. These results are supported by the results of Mostofa *et al.* (2013) who reported that neem leave extract supplementation in the broiler diets may be useful for the safe, economical and efficient production of broiler and this formulation could be employed as an alternative to commercial growth promoters.

Furthermore, as we know, synbiotic, probiotic, and NLP supplemented groups are safer and more beneficial to consumer health than antibiotic treated group, yet individuals are unwilling to pay a premium for this safe food. As a result, increased prices might be predicted from the synbiotic, probiotic and NLP groups.

Conclusion

Based on the results, it could be concluded that addition of synbiotic, probiotic and neem leaf powder to the broiler diet has positive impact on growth parameters. However synbiotic could be employed as the best alternative among the other alternatives (NLP, probiotic) for broiler production. Synbiotic can also be used for more economical and profitable broiler production. Thus antibiotic free broiler meat may be produced which will be safe for human and develops related industry in Bangladesh.

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Conflicts of interest

The Authors ensured that there is no conflict of interest regarding this article.

Author's contributions

The corresponding author directly supervised and guided the research activities and prepared the manuscript. The co-author accomplished the research and also helped in script preparation.

References

Abdel-Hafeez HM, Saleh ES, Tawfeek SS, Youssef IM, Abdel-Daim AS (2017). Effects of probiotic, prebiotic, and synbiotic with and without feed restriction on performance, hematological indices and carcass characteristics of broiler chickens. *Asian-Australas Journal of Animal Science* 30: 672-682. https://doi.org/10.5713/ajas.16.0535 PMid: 27620891 PMCid: PMC5411827

Abdel-Raheem SM, Abd-Allah SM, Hassanein KM (2012). The effects of prebiotic, probiotic and synbiotic supplementation on intestinal microbial ecology and histomorphologyof broiler chickens. *International Journal of Agronomy and Veterinary Medicine Science* 6: 277-289. https://doi.org/10.5455/ijavms.156

Al-Sultan SI, Abdel-Raheem SM, El-Ghareeb WR, Mohamed MH (2016). Comparative effects of using prebiotic, probiotic, synbiotic and acidifier on growth performance, intestinal microbiology and histomorphology of broiler chicks. *Japanese Journal of Veterinary Research* 64: 187-195.

Ashayerizadeh A, Dabiri N, Ashayrizadeh O, Mizadeh KH, Roshanfekr H and Mamooee M (2009). Effects of dietary antibiotic, probiotic and prebiotic as growth promoter on growth

performance, carcass characteristics and hematological indices of broiler chickens. *Pakistan Journal of Biological Sciences* 12: 52-57.
https://doi.org/10.3923/pjbs.2009.52.57
PMid: 19579918

Awad WA, Ghareeb K, Raheem AS, Böhm J (2009). Effects of dietary inclusion of probiotic and symbiotic on growth performance, organ weights and intestinal histomorphology of broiler chickens. *Poultry Science* 88: 49-56.
https://doi.org/10.3382/ps.2008-00244
PMid: 19096056

Awad WA, Ghareeb K, Boehm J (2008). Intestinal structure and function of broiler chickens on diets supplemented with a synbiotic containing *Enterococcus faecium* and oligosaccharides. *International Journal of Molecular Sciences* 9: 2205- 2216.
https://doi.org/10.3390/ijms9112205
PMid: 19330069 PMCid: PMC2635618

Bai SP, Wu AM, Ding XM, Lei Y, Bai J and Chio JS (2013). Effects of probiotic-supplemented diets on growth performance and intestinal immune characteristics of broiler chickens. *Journal of Poultry Science* 92: 633-670.
https://doi.org/10.3382/ps.2012-02813
PMid: 23436517

Bhowmik S, Chowdhury SD, Kabir MH and Ali MA (2008). Chemical composition of some medicinal plant products of indigenous origin. *The Bangladesh Veterinarian* 25:32 – 39.
https://doi.org/10.3329/bvet.v25i1.4616

Bishnu J, Sunil L, Anuja S (2009). Antibacterial property of different medicinal plants: *Azadirachta indica*, *Cinnamomum zeylanicum*, *Xanthoxylum armatum* and *Origanum majorana*. *Journal of Science, Engineering and Technology* 5: 143- 150.
https://doi.org/10.3126/kuset.v5i1.2854

Bitterncourt LC, CC Da Silva, PDSR Garcia, DCZ Donato, R De Albuquerque and LF Araujo (2011). Influence of a probiotic on broiler performance. *Revista Brasileira de Zootecnia* 40: 2739–2743.
https://doi.org/10.1590/S1516-35982011001200018

Buenrostro JL, and FH Kratzer(1983). Effect of *Lactobacillus* inoculation and antibiotic feeding of chickens on availability of dietary biotin. *Poultry Science* 62: 2022– 2029.
https://doi.org/10.3382/ps.0622022
PMid: 6415640

Cardozo PW, Calsamiglia S, Ferret A, Kamel C 2004: Effect of natural plant extracts on ruminal protein degradation and fermentation profiles in continuous culture. *Journal of Animal Science* 82: 3230-3236.

Casewell M, Christian F, Marco F, McMullin P and Phillips I (2003). The European ban on growth-promoting antibiotics and emerging consequences for human and animal health. *Journal of Antimicrobial Chemotherapy* 52: 159–161.
https://doi.org/10.1093/jac/dkg313
PMid: 12837737

Edens FW (2003). An alternative for antibiotic use in poultry probiotics. Brazilian Journal of *Poultry Science* 5: 75–97.
https://doi.org/10.1590/S1516-635X2003000200001

Faria DE, Henrique APF and Franzolin R (2009). Alternatives to the use of antibiotic growth promoter for broiler chickens. *Probiotic Ciencia Animal Brasileira*10: 18-28.

Fuller R (1989). Probiotics in man and animals. *Journal of Biotechnology* 66: 365-378.
https://doi.org/10.1111/j.1365-2672.1989.tb05105.x

Gaggia F, Mattarelli P, and Biavati B (2010). Probiotics and prebiotics in animal feeding for safe food production. *International Journal of Food Microbiology* 141: S15–S28.
https://doi.org/10.1016/j.ijfoodmicro.2010.02.031
PMid: 20382438

Greko C (2001). Safety aspects on non-use of antimicrobials as growth promoters. In Gut Environment of Pigs. A. Piva, K. E. Bach Knudsen. Journal of E. Lindberg, ed. Nottingham University Press, Nottingham, UK. 219–230.

HassanpourH, Moghaddam AK, Zamani KM (2013). Effects of synbiotic on the intestinal morphology and humoral immune response in broiler chickens. *Livestock Science* 153: 116–122.
https://doi.org/10.1016/j.livsci.2013.02.004

Kale BP, Kothekar MA, Tayade HP, Jaju JB, Mateeddin M (2003): Effect of neem (*Azadirachta indica*) leaf powder supplementation on growth in broilers. *Indian Journal of Pharmacology* 35: 177.

Khatun S, Mostofa M, Alom F, Uddin J, Alam MN, Moitry NF (2013). Efficacy of tulsi and neem leaves extract in broiler production. *Bangladesh Journal of Veterinary Medicine* 11: 1- 5.
https://doi.org/10.3329/bjvm.v11i1.17728

Laboni S, Chowdhury SD (2007). Efficacy of neem (*Azadirachta indica*) leaf meal as a dietary additive in commercial broiler chickens. *Bangladesh Veterinarian* 24: 120-129.

Mahejabin N, Mostofa M, Akter F, Das S, Alam M (2015). Effects of neem, turmeric and papaya

leaf extract mixture on growth performance of broilers. *International Journal of Natural and Social Sciences* 2: 17-21.

Midilli M, M Kocabach, N Alp, OH Muglah, N Turan, H Yilmaz and S Cakir (2008). Effects of dietary probiotic and prebiotic supplementation on growth performance and serum IgG concentration of broilers. *South African Journal of Science* 38: 21–27. https://doi.org/10.4314/sajas.v38i1.4104

Min YN, HL Yang, YX Xu and YP Gao (2016). Effects of dietary supplementation of synbiotics on growth performance, intestinal morphology, sIgA content and antioxidant capacities of broilers. *Journal of Animal Physiology and Animal Nutrition* 100: 1073–1080. https://doi.org/10.1111/jpn.12479 PMid: 27018493

Moreira J, Mendes AA, Garcia EA, Garcia RG, Almeida ICL, JR and JGC (2001).Efeito do uso do probióticosobre o desempenho e rendimento de carcaçaemfrangos de corte. In:XXXVIIIReuniãoAnual da SBZ, Piracicaba. *Anais Piracicaba* 852-854.

Mostofa M, Khatun S, Alom F, Uddin J, Alam MN, Moitry NF (2013). Efficacy of tulsi and neem leaves extract in broiler production. *Bangladesh Journal of Veterinary Medicine* 11: 1- 5. https://doi.org/10.3329/bjvm.v11i1.17728

Mountzouris KC, Tsirtsikos P, Kalamara E, Nitsch S, Schatzmayr G, Fegeros K (2007). Evaluation of the efficacy of a probiotics containing *Lactobacillus, Bacillus, Bifidobacterium, Enterococcus* and *Pediococcus*strains in promoting broiler performance and modulating cecalmicroflora composition and metabolic activities. *Journal of Poultry Science* 86: 309-317. https://doi.org/10.1093/ps/86.2.309 PMid: 17234844

O'Dea E, Fasenko GM, Allison GE, Korver DR and Guan LL (2006): Investigating the effects of commercial probiotics on broiler chick quality and production efficiency. *Journal of Poultry Science* 85: 1855-1863. https://doi.org/10.1093/ps/85.10.1855 PMid: 17012181

Panda AK, Reddy MR, Rao SVR, Raju, MVL, Praharaj NK (2000). Growth, carcass characteristics, immune competence and response to Escherichia coli of broilers fed diets with various levels of probiotic. *Archiv fur Geflugelkunde* 64: 152-156.

Rada, Foltyn M, Lichovnikova M and Musilova A (2013). Effects of protease supplementation of low protein diets on growth parameters and carcass characteristics. *Mendel Net* pp: 268-272.

Rahman MA, Ali MA, Saha BK, Hasan MA, Rahman MA, Mostofa M (2015). Use of neem leaf and ginger extracts for cost effective broiler production. *International Journal of Natural and Social Sciences* 2: 11-16.

Raksasiri BV, Paengkoum P, Paengkoum S and Poonsuk K (2018). The effect of supplementation of synbiotic in broiler diets on production performance, intestinal histomorphology and carcass quality. *International Journal of Agricultural Technology* 14: 1743-1754.

Roy BC and Chowdhury SD (2013). Effect of dietary probiotic and antibiotic growth promoter either alone or in combination on the growth performance of broilers during summer. *Eighth International Poultry Show and Seminar (7-9 March), WPSA-BB* 153-158.

Sabatkova J, Kumprecht I and Zobac P (2008). The probiotic Bio plus 2B as an alternative of antibiotic in diets for broiler chickens. *Acta Veterinaria Brno* 77: 569-574. https://doi.org/10.2754/avb200877040569

Salah SA, Ayman S, El-Tarabany, Mahmoud S, Ali, Mohamed A (2019). Impact of dietary supplementation with a synbiotic, organic acids or their combination on growth performance, carcass traits, economic efficiency, jejunum histomorphometry and some blood indices of broiler chickens. *Animal Production Science* 59: 1318-1326. https://doi.org/10.1071/AN18156

Salehi-manesh A, M Mohammadi, and MM Roostaei-Ali (2016). Effect of dietary probiotic, prebiotic and synbiotic supplementation on performance, immune responses, intestinal morphology and bacterial populations in broilers. *Journal of Animal Physiology and Animal Nutrition* 100: 694–700. https://doi.org/10.1111/jpn.12431 PMid: 26847817

Salim HM, Kang KH, Akter N, Kim DW, Na JC, Jong HB, Choi HC and Kim WK (2013). Supplementation of direct-fed microbials as an alternative to antibiotic on growth performance, immune response, cecal microbial population, and ileal morphology of broiler chickens. *Journal of Poultry Science* 92: 2084-2090. https://doi.org/10.3382/ps.2012-02947 PMid: 23873556

Sarangi NR, LK Babu, A Kumar, CR Pradhan, PK Pati and JP Mishra (2016). Effect of dietary supplementation of prebiotic, probiotic, and synbiotic on growth performance and carcass

characteristics of broiler chickens. *Veterinary World* 9: 313–319. https://doi.org/10.14202/vetworld.2016.313-319 PMid: 27057118 PMCid: PMC4823295

SAS. 2002. SAS User's guide. Statistics Version 8e. SAS Institute Inc, Cary, NC, USA.

Shim YH, Ingali SL, Kim JS, Seo DK, Lee SC and Kwon IK (2012). A multi microbe probiotic formulation processed at low and high drying temperatures: effects on growth performance, nutrient retention and caecal microbiology of broilers. *Journal of British Poultry Science* 53: 482-490. https://doi.org/10.1080/00071668.2012.690508 PMid: 23130583

Smith DL, Harris AD, Johnson JA, Silbergeld EK, Morris Jr JG (2003). Animal antibiotic use has an early but important impact on the emergence of antibiotic resistance in human commensal bacteria. *National Academy of Science*. 99:6434–6439. https://doi.org/10.1073/pnas.082188899 PMid: 11972035 PMCid: PMC122966

Suparom W, Chumpawadee S, Santaweesuk N and Khajarern J (2013). Efficacy of symbiotic in broiler die. *KhonKaen Agricultural Journal* 41: 381-387.

Tannock GW (1999). What we know and need to know. *Journal of Advance Biotechnology* 17: 691-693. https://doi.org/10.1016/S0734-9750(99)00021-X

Tomasik PJ and Tomasik P (2003). Probiotics and prebiotics. Cereal Chemistry 80: 113-117. https://doi.org/10.1094/CCHEM.2003.80.2.113

Uddin J, Alam MA, Akter MTD, Moni MIZ, Alom F, Rahman A, Noman MAA (2014). Broiler production by using polyherbal medication (neem, nishyinda, tulsi and turmeric extract). *International Journal of Innovation and Applied Studies* 1161-1175.

Valarmathy K, Gokulakrishnan, Salma KM, Kusum DP (2010). A study of antimicrobial activity of ethanolic extracts of various plant leaves against selected microbial species. *International Journal of Pharm Sciences and Research*. 1: 293–295.

Wankar AK, Shirbhate RN, Bahiram KB, Dhenge SA, Jasutkar RA (2009). Effect of Neem (*Azadirachta indica*) leaf powder supplementation on growth in broilers. *Veterinary World* 2: 396-397

Yang Y, Iji PA, Choct M (2009). Dietary modulation of gut micro flora in broiler chickens: a review of the role of six kinds of alternatives to in-feed antibiotics. *World's Poultry Science Journal* 65: 97-114. https://doi.org/10.1017/S0043933909000087

Zhou X, Wang Y, Wu RJ and Zhang B (2010). Effect of dietary probiotic on growth performance, chemical composition and meat quality of Guangxi Yellow chicken. *Journal of Poultry Science* 89: 588-593. https://doi.org/10.3382/ps.2009-00319 PMid: 20181878