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Feasibility analysis of plantain herb supplementation on broiler production at farmer level

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ABSTRACT

Plantain (PL, Plantago lanceolata L.), a natural herb, benefits broiler performance when produced under research farming conditions. The study aimed to investigate the feasibility of PL supplementation on broiler production at the farmer level. A total of 4000 day-old broiler chicks (Cobb-500) were assigned randomly to four experimental groups with four replications each (250 chicks/replication). A commercial (C) ration having CP=23.1% and ME=3097 Kcal/kg and a formulated (F) ration (iso-nitrogenous and iso-energetic to C) were used as basal ration. The experimental groups were (i) C0: commercial ration without PL; ii) C10: commercial ration + 10g DM from fresh PL/kg ration; (iii) F0: formulated ration without PL; and (iv) F10: formulated ration + 10 g DM from fresh PL/kg ration. The sources of ration and PL supplementation independently had a significant effect on growth performance and the highest (p<0.05) growth performance was exhibited by the C10 group. Improved serum lipid profile and meat quality were found in the F10 group among the experimental groups. Besides, the improved drumstick and liver percentages were found only for ration variation, whereas PL supplementation alone improved thymus and heart percentages (p<0.05). The highest profit per bird was found in the C10 and F10 groups, twofold higher than the C0 and F0 groups. This study concluded that PL supplementation could increase broiler productivity and profitability by adjusting farmer-level ration variation.

Key Words: *Broiler, Meat quality, Production performance, Profitability and Serum lipid profile.*

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I. Introduction

The broiler industry is rapidly expanding throughout the globe because the meat is high in quality protein, vitamins and minerals, as well as its affordable price (Baéza et al., 2022). Antibiotics, antibiotic growth promoters, growth hormones and medicines were used inappropriately in the broiler industry to improve production efficiency (Chowdhury et al., 2015). However, some growth promoters are transferred to broiler meat and eventually humans, which causes antimicrobial resistance (AMR) in humans and also has a negative impact on the environment (Hoque et al., 2020). The prohibition of using antibiotics as growth promoters has prompted research into phytogenic feed additives, which are plant-derived compounds (Selaledi et al., 2020). These additives are safe, less hazardous and cost-effective in broiler production than synthetic growth promoters (Qureshi et al., 2016). The bioactive components of these additives have growth-promoting, immune-regulatory, anti-microbial, digestibility-improving and antioxidant properties in poultry (Murugesan et al., 2015; Liu et al., 2018).

Plantain (PL, *Plantago lanceolata* L.) is a potential herb used as a feed additive in ruminants and non-ruminants (Camy et al., 2019; Redoy et al., 2021; Rahman et al., 2021). It is a rich source of plant primary and secondary metabolites (PSM), of which acteoside, catalpol and aucubin are most abundant (Al-Mamun et al., 2017; Bahadoria et al., 2020; Redoy et al., 2021). These PSM have superoxide anion radical scavenging activities, which result in better animal efficiency and greater meat quality by positively influencing blood metabolites (Al-Mamun et al., 2008b; Al-Mamun et al., 2009; Camy et al., 2019; Redoy et al., 2021). Besides, PSM of PL has anti-microbial, anti-oxidative, anti-inflammatory and anti-parasitic effects in animals (Ferrazzano et al., 2015; Peña-Espinoza et al., 2018; Hammami et al., 2020; Reza et al., 2021). Moreover, PL supplementation in broiler reduced abdominal fat and provided better flavor, juiciness, tenderness and overall acceptability of meat (Chacrabati et al., 2013; Camy et al., 2019).

The response of PL in broiler performance is highly dependent on the rate of inclusion and the optimum growth performance was found by using 80 g of fresh plantain in laboratory farming conditions (Redoy et al., 2021). To the best of our knowledge, the effect of PL supplementation on broiler performance and profitability at the farmer level has not yet been assessed. Thus, an out-station broiler feeding trial using PL supplementation was conducted in Manikganj, Bangladesh, to assess broiler production efficiency regarding cost-effectiveness at the farmer level.

II. Materials and Methodology

Experimental birds, ration and management

Handling, blood collection and rearing procedure of broilers were approved by the Animal Welfare and Experimentation Ethics Committee, Bangladesh Agricultural University (AWEEC/BAU/2020(46)). Four thousand (4000) unsexed day-old broiler chicks (Cobb-500; initial body weight: 45.3±0.6 g) were randomly allocated to four experimental groups, each with four replications and 250 chicks per replication. This experiment was conducted using a completely randomized design for 28 days. The chicks were collected from a local hatchery and reared in an open-sided poultry shed in Manikganj, Dhaka. A commercial ration (C) was purchased from a local market having CP=23.12% and ME=3097 Kcal/kg. Another ration (F), which was iso-nitrogenous and iso-energetic to the former one, was formulated and prepared at the experiment site. The experimental groups were (i) C0: commercial ration without plantain (*Plantago lanceolata* L.) supplementation; (ii) C10: commercial ration + 10g DM from fresh plantain/kg ration; (iii) F0: formulated ration without plantain supplementation; and (iv) F10: formulated ration + 10 g DM from fresh plantain/kg ration. The ingredients and chemical composition of rations are presented in Table 01.

The Lancelot plantain (PL, *Plantago lanceolata* L) was grown near the experimental site, harvested at the pre-blooming stage, and chopped into approximately 0.5–1.5 cm for supplementation. From the 5th day, the birds were offered fresh PL as a supplement with a commercial and formulated ration. The fresh PL contained 12.51% dry matter and other chemical constitutes were crude protein–15.64%, crude fibre–14.07%, ether extract–3.12%, ash–14.07%, calcium–1.81%, phosphorus–0.41% and metabolizable energy–2018 kcal/kg of dry matter.

The experimental birds were reared in an open-sided house on a floor littered with 1.5–2.0 inch sawdust. The total floor area was divided into sixteen equal pens separated by a wired net. Each bird was allotted a total of 1.08 ft^2 of floor space. For the first week, the brooding temperature was maintained at 34^{0}C, then decreased by 3^{0}C per week until it reached 21^{0}C. Feed was given at 0800 and 1600 h during the experiment. *Ad libitum* access to fresh and clean water was given to the experimental birds. Drinkers were cleaned twice daily, while feeders were cleaned weekly. The lighting schedule was followed by Cobb-500 commercial broiler management guidelines. Vaccines

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against new castle disease and infectious bursal disease were administered to the experimental birds on days 5 and 12. Strict biosecurity precautions were followed during the experiment.

Table 01. Ingredients and nutritional composition of experimental rations

Ingredients in formulated ration	Amounts (%)	
Corn	55.30	
Soybean meal	30.79	
Protein concentrate	5.30	
Rice polish	4.00	
Rice bran oil	2.50	
Limestone dust	0.44	
Sodium chloride	0.22	
Sodium bicarbonate	0.20	
DL- methionine 99%	0.53	
L-lysine 79%	0.42	
Threonine 98.5%	0.22	
Choline chloride 60%	0.20	
Vitamin-mineral premix[1]	0.08	
Chemical composition (g/100gm DM)	**Commercial ration (C)**	**Formulated ration (F)**
Dry matter	88.72	88.84
Crude protein	23.12	23.21
Crude fibre	3.78	3.92
Ether extract	3.93	3.96
Ash	8.52	8.66
Calcium	0.87	0.88
Available phosphorus	0.54	0.54
ME (Kcal/kg)[2]	3097	3109

[1]Each kg vitamin mineral premix contained=Vitamin A, 13.500 I.U; Vitamin D3, 1.500 I.U; a-DL-Tocopherolacetate, 50 mg; Menadion, 2 mg; Thiamine, 3 mg; Riboflavin, 5 mg; Pyridoxin, 4 mg; Cobalamine, 15pg; Folsaure, 200 pg; Nicotenic acid, 60 pg; Ca-pantothenate, 30mg; Cholin, 750 mg; Ascorbic acid, 150 mg. [2] Calculated value

Record keeping, sample collection and analysis

The body weight (BW) and feed intake (FI) of the birds were recorded weekly for each pen. The body weight gain (BWG) of each pen was calculated by subtracting the initial weight from the final weight. After adjusting the mortality, feed conversion ratio (FCR) was calculated by dividing the feed intake by the BWG. Every day, the mortality of the birds in each pen was registered. Furthermore, production efficiency factor (PEF) was calculated by using the formula (Marcu et al., 2013)

$$PEF = [\text{live weight (kg)} \times \text{survivability (\%)}] / [\text{age at depletion (d)} \times FCR] \times 100$$

On day 28, randomly forty birds from each treatment (ten birds from each replication) were sacrificed to collect blood, meat sample and carcass evaluation. Using a centrifuge machine (Hermle Z 306, Germany), the blood sample was centrifuged at 3421×*g* RCF for 15 min for serum separation and then stored at -20°C until analysis. The carcass evisceration was performed according to Ziołecki and Doruchowskin (1989).

The proximate composition of commercial and formulated feed samples was analysed according to AOAC (2005). The feed, meat and blood samples were analysed in triplicate. The breast muscle was used for the determination of proximate components in accordance with AOAC (2005). The serum was analysed for determination of triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL) using different enzymatic kits from HUMAN company (USA) in a chemistry analyser (Urit-810, Germany) according to the manufacturer's instructions.

The sensory evaluation of meat quality was carried out using the scaling method described by Barylko-Pikielna and Matuszewska (2009). The meat's aroma, flavour, juiciness, brittleness, and general appearance were assessed on a five-point scale (1 point being the lowest score and 5 points being the highest). The thermally treated samples were cooled to 20±2°C and placed in plastic

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containers for sensory evaluation. The samples were randomly assessed by a 5-members assessment team with proven sensory sensitivity trained according to ISO standards. The cooled meat samples were assessed in triplicate.

Statistical analysis

The raw data was structured using the Microsoft Excel program and then analysed using IBM SPSS (Version 23.0, IBM Crop., USA). All parameters were subjected to two-way analysis of variance (ANOVA), where the type of ration and doses of PL were considered fixed factors. Duncan multiple range test (DMRT) was conducted to find the difference among the experimental groups, and the differences at p <0.001 and p <0.05 were considered statistically significant.

The model used in this experiment was- $Y_{i,j,k} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{i,j} + \varepsilon_{i,j,k.}$

Where $Y_{i.j.k.}$ was the overall response of broiler; μ was the overall mean; α_i was the effect of ration (commercial and formulated rations); β_j was the effect of PL supplementation; $(\alpha\beta)_{i,j}$ was the interaction effect of ration and PL supplementation; $\varepsilon_{i,j,k.}$ was the error.

III. Results

Production performance

Broiler production performances fed commercial and formulated feed with or without fresh PL supplementation are shown in Table 02. Both ration and PL supplementation significantly affected growth performance except for survivability, which was only influenced (p<0.05) by supplementation. Among the experimental groups, the highest growth performance (p<0.05) was exhibited by the C10 group.

Table 02. Influence of two sources of ration and plantain (PL; *Plantago lanceolata* L.) supplementation on growth performance of commercial broiler[1] at farmer level

Variables	Ration[2]		PL supplementation (g DM /kg ration)		Experimental groups[3]				SEM	*p* value[4]		
	C	F	0	10	C0	C10	F0	F10		R	P	R×P
Final BW (g)	1612	1556	1559	1609	1603^{b}	1622^{a}	1516^{c}	1597^{b}	12.48	<0.001	<0.001	0.001
BW gain (g)	1568	1511	1514	1564	1557^{b}	1577^{a}	1470^{c}	1552^{b}	12.55	<0.001	<0.001	<0.001
FI (g)	2570	2536	2553	2554	2588^{a}	2552^{b}	2517^{c}	2555^{b}	8.240	0.002	0.904	0.001
FCR (FI/BWG)	1.64	1.68	1.69	1.63	1.66^{b}	1.62^{d}	1.71^{a}	1.64^{c}	0.010	<0.001	<0.001	0.014
Survivability (%)	95	94.5	93	96.5	94.0^{ab}	96.0^{a}	92.0^{b}	97.0^{a}	0.719	0.631	0.008	0.172
PEF (%)	324.3	304.3	298.3	330.2	314.6^{b}	334.1^{a}	282.1^{c}	326.5^{a}	6.162	<0.001	<0.001	0.007

BW=body weight; FI=feed intake; BWG=body weight gain; FCR=feed conversion ratio; PEF=production efficiency factor

[1] COBB 500 commercial broiler; n=4000; Initial body weight= 45.3±0.6 g;

[2]Ration– (C) Commercial: CP=23.12% and ME=3097 Kcal/kg; (F) Formulated: CP=23.21% and ME=3109 Kcal/kg;

[3]C0= Commercial ration without plantain (*Plantago lanceolata* L.) supplementation; C10=Commercial ration + 10g DM from fresh plantain/kg ration; F0= Formulated ration without plantain supplementation; and F10= Formulated ration + 10 g DM from fresh plantain /kg ration;

[4]R=Ration effect; P=Plantain supplementation effect; R×P=Interaction effect of ration and plantain supplementation;

[abc], mean values with dissimilar superscripts differ significantly (p<0.05).

Serum lipid profile

As stated in Table 03, feeding PL to broilers with commercial and formulated feed has positively influenced serum TC and HDL-C concentration (p<0.05). However, the TG concentration was only influenced (p<0.05) by ration rather than PL supplementation and/or their interaction. Overall, the F10 group had an improved serum lipid profile compared to other experimental groups.

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Table 03. Influence of two sources of ration and plantain (PL; *Plantago lanceolata* L.) supplementation on serum lipid profile of commercial broiler[1] at farmer level

Variables	Ration[2]		PL supplementation (g DM /kg ration)		Experimental groups[3]				SEM	*p* value[4]		
	C	F	0	10	C0	C10	F0	F10		R	P	R×P
TG (mg/dl)	59.91	54.77	58.19	56.48	61.27[a]	58.54[ab]	55.11[b]	54.43[b]	0.995	0.004	0.222	0.449
TC (mg/dl)	85.39	81.79	84.53	82.65	86.45[a]	84.33[ab]	82.60[bc]	80.98[c]	0.690	0.001	0.037	0.746
HDL-C (mg/dl)	49.07	51.93	48.95	52.05	47.34[b]	50.79[a]	50.56[a]	53.30[a]	0.752	0.016	0.011	0.714
LDL-C (mg/dl)	21.25	19.01	21.43	18.82	22.85	19.65	20.01	17.99	0.842	0.182	0.128	0.711

TG= triglycerides; TC= total cholesterol; HDL-C=high density lipoprotein cholesterol; LDL-C=low density lipoprotein cholesterol

[1] COBB 500 commercial broiler; n=4000; Initial body weight= 45.3±0.6 g;

[2]Ration– (C) Commercial: CP=23.12% and ME=3097 Kcal/kg; (F) Formulated: CP=23.21% and ME=3109 Kcal/kg;

[3]C0: Commercial ration without plantain (*Plantago lanceolata* L.) supplementation; C10: Commercial ration + 10g DM from fresh plantain/kg ration; F0: Formulated ration without plantain supplementation; and F10: Formulated ration + 10 g DM from fresh plantain /kg ration;

[4]R: Ration effect; P: Plantain supplementation effect; R×P: Interaction effect of ration and plantain supplementation;

[abc], mean values with dissimilar superscripts differ significantly (p <0.05).

Carcass composition

Both the sources of ration and supplementation had a similar response in carcass composition except for some variables (Table 04). The improved drumstick and liver percentages were found only for ration variation, whereas supplementation alone improved thymus and heart percentages (p<0.05). Among the experimental groups, the F10 group had a 2–7% higher dressing percentage and a 9–17% lower abdominal fat percentage.

Table 04. Influence of two sources of ration and plantain (PL; *Plantago lanceolata* L.) supplementation on carcass characteristics of commercial broiler[1] at farmer level

Variables	Ration[2]		PL supplementation (g DM /kg ration)		Experimental groups[3]				SEM	*p* value[4]		
	C	F	0	10	C0	C10	F0	F10		R	P	R×P
Dressing P. (%)	60.98	61.92	59.89	63.02	59.45[b]	62.53[a]	60.33[b]	63.50[a]	0.527	0.049	<0.001	0.916
Breast (%)	18.58	17.12	17.44	18.26	18.36[b]	18.80[a]	16.52[d]	17.71[c]	0.264	<0.001	<0.001	0.019
Thigh (%)	8.31	7.85	8.04	8.12	8.27[a]	8.33[a]	7.80[c]	7.90[b]	0.070	<0.001	0.046	0.649
Drumstick (%)	4.29	4.19	4.22	4.27	4.30[a]	4.29[a]	4.13[b]	4.31[a]	0.026	0.037	0.219	0.134
Shank (%)	4.63	4.76	4.65	4.75	4.52	4.75	4.77	4.74	0.041	0.089	0.166	0.082
Bursa (%)	0.20	0.23	0.19	0.23	0.19[c]	0.22[b]	0.21[b]	0.24[a]	0.006	0.003	<0.001	0.760
Thymus (%)	0.25	0.25	0.23	0.27	0.23[b]	0.26[a]	0.23[b]	0.27[a]	0.005	0.545	<0.001	0.242
Liver (%)	3.30	3.64	3.50	3.44	3.22[c]	3.39[b]	3.61[a]	3.67[a]	0.056	<0.001	0.194	0.025
Heart (%)	0.62	0.62	0.61	0.64	0.61	0.64	0.61	0.63	0.006	0.631	0.034	0.757
Kidney (%)	0.22	0.20	0.21	0.21	0.22	0.22	0.19	0.20	0.005	0.015	0.464	0.282
Abd. fat (%)	1.34	1.20	1.29	1.24	1.35[a]	1.33[a]	1.25[b]	1.15[c]	0.024	<0.001	0.001	0.006

Dressing P=dressing percentage; Abd. Fat=abdominal fat

[1] COBB 500 commercial broiler; n=4000; Initial body weight= 45.3±0.6 g;

[2]Ration– (C) Commercial: CP=23.12% and ME=3097 Kcal/kg; (F) Formulated: CP=23.21% and ME=3109 Kcal/kg;

[3]C0= Commercial ration without plantain (Plantago lanceolata L.) supplementation; C10=Commercial ration + 10g DM from fresh plantain/kg ration; F0= Formulated ration without plantain supplementation; and F10= Formulated ration + 10 g DM from fresh plantain /kg ration;

[4] R= Ration effect; P= Plantain supplementation effect; R×P= Interaction effect of ration and plantain supplementation;

[abc], mean values with dissimilar superscripts differ significantly (p <0.05)

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Meat quality

Based on the result presented in Table 05, the meat proximate components, except for crude protein and ether extract, were not influenced by either ration, supplementation, or their combined interaction. However, the crude protein content of broiler meat was improved by PL supplementation, whereas both the ration and supplementation significantly changed the ether extract among the experimental groups. The result linked to sensory evaluation of broiler meat is represented in Figure 01. Incorporation of PL had a strong influence ($p<0.05$) on meat sensory quality and the F10 group showed the highest result of general appearance, aroma, flavour, juiciness and brittleness.

Table 05. Influence of two sources of ration and plantain (PL; *Plantago lanceolata* L.) supplementation on meat composition of commercial broiler[1] at farmer level

Variables	Ration[2]		PL supplementation (g DM /kg ration)		Experimental groups[3]				SEM	*p* value[4]		
	C	F	0	10	C0	C10	F0	F10		R	P	R×P
Dry matter (%)	26.48	26.13	25.97	26.64	25.64	27.32	26.30	25.96	0.389	0.671	0.424	0.239
Crude protein (%)	22.32	22.59	21.64	23.27	21.90[ab]	23.37[a]	21.38[b]	23.26[a]	0.315	0.568	0.006	0.582
Ether extract (%)	1.65	1.43	1.68	1.39	1.87[a]	1.42[b]	1.49[b]	1.36[b]	0.066	0.010	0.002	0.042
Ash (%)	1.21	1.13	1.18	1.15	1.20	1.21	1.16	1.09	0.021	0.067	0.450	0.320
NFE (%)	73.97	74.11	73.82	74.26	73.84	74.10	73.80	74.41	0.224	0.792	0.406	0.733

NFE=nitrogen free extract

[1] COBB 500 commercial broiler; n=4000; Initial body weight= 45.3±0.6 g

[2] Ration– (C) Commercial: CP=23.12% and ME=3097 Kcal/kg; (F) Formulated: CP=23.21% and ME=3109 Kcal/kg

[3] C0= Commercial ration without plantain (*Plantago lanceolata* L.) supplementation; C10= Commercial ration + 10g DM from fresh plantain/kg ration; F0= Formulated ration without plantain supplementation; and F10= Formulated ration + 10 g DM from fresh plantain /kg ration

[4] R=Ration effect; P=Plantain supplementation effect; R×P= Interaction effect of ration and plantain supplementation

[abc], mean values with dissimilar superscripts differ significantly ($p<0.05$).

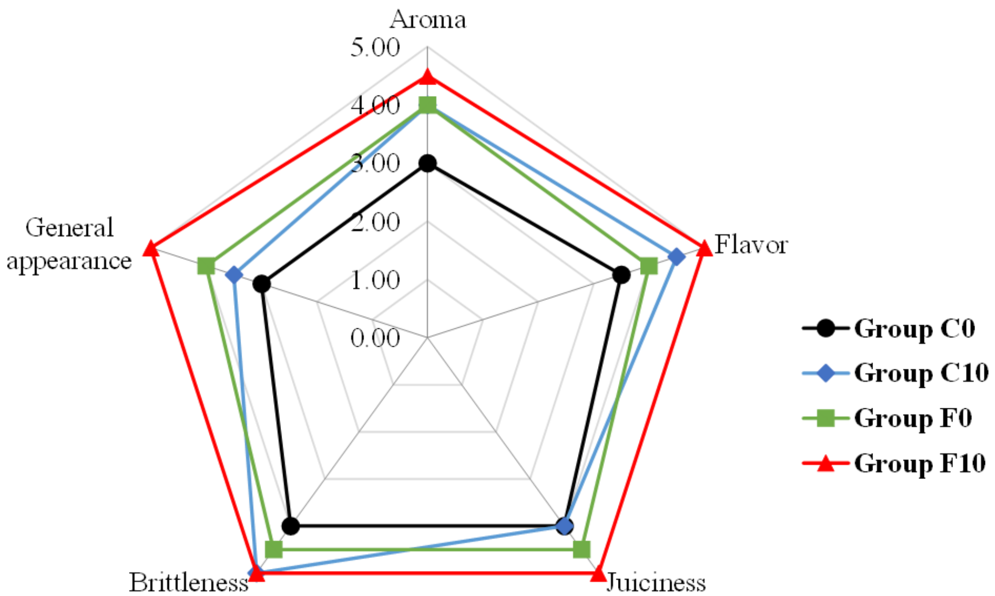

Figure 01. Influence of two sources of ration and plantain (PL; *Plantago lanceolata* L.) supplementation on sensory properties of commercial broiler meat

[2] C0= Commercial ration without plantain (*Plantago lanceolata* L.) supplementation; C10= Commercial ration + 10g DM from fresh plantain/kg ration; F0= Formulated ration without plantain supplementation; and F10= Formulated ration + 10 g DM from fresh plantain /kg ration

Profitability Analysis

The data relating to the profitability of broiler production are stated in Table 06. The cost of commercial feed per kg was BDT 44.0, which was higher than the cost of formulated feed (BDT 41.8). The highest benefit (BDT/bird) was found in the C10 and F10 groups, two times higher than in the C0 and F0 groups. Consequently, the C10 and F10 groups had higher profitability than other groups.

Table 06. Influence of two sources of ration and plantain (PL; *Plantago lanceolata* L.) supplementation on profitability of commercial broiler[1] production at farmer level

Variables	Experimental groups[2]				SEM	*p* value
	C0	C10	F0	F10		
(i) Total feed cost (BDT/bird)	113.89[a]	112.29[b]	110.75[c]	112.43[b]	0.362	0.001
(ii) Medication cost (BDT/bird)	6.09[a]	3.71[b]	0.54[c]	0.54[c]	0.719	<0.001
(iii) Feed additive cost (BDT/bird)	0.00[b]	2.21[a]	0.00[b]	2.21[a]	0.333	<0.001
(iv) Chick cost (BDT/bird)	35.00	35.00	35.00	35.00	0.000	1.000
(A) Total prod. cost (BDT/bird) (i + ii + iii + iv)	154.98[a]	153.21[b]	146.29[d]	150.18[c]	2.092	<0.001
(B) Meat price (BDT/bird)	166.75[b]	177.49[a]	160.04[c]	177.46[a]	2.343	<0.001
(C) Benefit (BDT/bird) (B-A)	11.77[b]	24.28[a]	13.75[b]	27.28[a]	2.116	<0.001
Profitability (%) (C/A)	7.59[b]	15.85[a]	9.39[b]	18.16[a]	1.403	<0.001

BDT=Bangladeshi Taka which is equal to 0.012 United States Dollar (USD)
[1] COBB 500 commercial broiler; n=4000; Initial body weight= 45.3±0.6 g
[2] C0= Commercial ration without plantain (*Plantago lanceolata* L.) supplementation; C10= Commercial ration + 10g DM from fresh plantain/kg ration; F0= Formulated ration without plantain supplementation; and F10= Formulated ration + 10 g DM from fresh plantain /kg ration
[abc], mean values with dissimilar superscripts differ significantly (p <0.05).

IV. Discussion

Production Performance

Present research revealed that the production performance of broiler-fed commercial ration outweighed the formulated ration though both the rations were iso-nitrogenous and iso-energetic (Table 01). Generally, commercial rations are fortified with a variety of non-nutritive feed additives in order to maximize broiler growth efficiency (Chowdhury et al., 2015), which may explain why commercial ration fed broilers performed better in this experiment. However, the PL supplementation had a significant influence on broiler's growth both in commercial and formulated rations, which revealed that PL had an independent effect beyond the nature of ration. This result was justified by the finding of Camy et al. (2019), who illustrated PL extract had a significant effect on weight gain in the commercial broiler. The bioactive components of PL, particularly acteoside, act as a powerful antioxidant, which may help to reduce oxidative stress in broilers, thereby promoting growth (De Marco et al., 2015). Chacrabati et al. (2013) reported that PL was comparable with synthetic antioxidants, which might improve serum antioxidants' levels in the broiler, resulting in better growth. Additionally, PL has a higher free radical scavenging activity, which reduces free radicals, resulting in less oxidation and increased whole-body protein synthesis in animals, supporting the current research (Al-Mamun et al., 2007; Al-Mamun et al., 2008b).

Serum Lipid Profile

PL supplementation did not affect (p<0.05) TG concentration under the present experiment condition, which was in line with the findings of Mazhari et al. (2016) and Camy et al. (2019). Moreover, the earlier literature revealed that dietary PL supplementation did not affect TC levels, which contradicts our findings of lower TC levels in the C10 and F10 groups (Mazhari et al. 2016; Camy et al. 2019). However, some researchers found reduced TG levels in broiler fed pomegranate pulp and garlic powder (Karim et al., 2017; Hosseini-Vashan & Raei-Moghadam, 2019). In addition, the increased HDL-C concentration in PL supplemented groups was supported by Redoy et al. (2021). PL can increase lipoprotein lipase activity in the broiler, which facilitates the breakdown of triglycerides into fatty acids and glycerol, resulting in a lower triglyceride concentration (Adiputro et al., 2013), but we were unable to replicate this impact. Besides, the essential oil extracted from PL effectively induced hypocholesterolemic effects in mice by inhibiting the enzyme HMG-CoA reductase, which is involved in cholesterol biosynthesis, and this finding is consistent with the current research (Najafian et al., 2018).

Furthermore, broilers supplemented with PL increased serum antioxidant levels, explaining how serum HDL-C levels increased in C10 and F10 groups.

Carcass Composition

The PL supplemented groups had higher breast and thigh meat percentages, consistent with Mazhari et al. (2016) and Camy et al. (2019). The percentage of immune organs (bursa and thymus) was higher in PL supplemented groups, which was supported by Kim et al. (2013) and Lee et al. (2017). Moreover, Narimani-Rad et al. (2011) and Kusmayadi et al. (2019) demonstrated that combining herbs or a single herb decreased abdominal fat content in broilers, which aligns with the current study. Besides, PL increases whole-body protein synthesis by limiting nitrogen losses (Al-Mamun et al., 2008b), which might lead to a rise in breast and thigh meat percentages in the PL supplemented groups. Besides, the iridoid glycosides, commonly aucubin and catalpol in PL, induced hypocholesterolemic effects in mice (Chung et al., 2008), which might lead to lower abdominal fat in PL supplemented groups.

Meat Quality

Response of PL in broiler meat composition yielded inconsistent findings. Camy et al. (2019) reported that PL extract had no influence on protein content in broiler meat, whereas positive response was highlighted by Redoy et al. (2021). However, both researchers found that meat extract content was significantly reduced by PL supplementation, which supports our results. The main reasons for increased CP in breast muscle might be due to (i) a reduction in pathogenic bacteria and an increase in the height of villi of the gut wall, resulting in more effective nutrient absorption (Shokryazdan et al., 2017**)** and (ii) an increase in nitrogen retention and a decrease in nitrogen excretion, allowing for the deposit of more protein in the body (Lin et al., 2013). In addition, PL can reduce the pathogenic microbiome and competition for nutrients between host and bacteria, thus facilitating better nutrient turnover in animals (Al-Mamun et al., 2008b; Lin et al., 2013; Hammami et al., 2020). Besides, the lower serum cholesterol levels in PL supplemented groups (Table 03) might be responsible for getting lower ether extract in broiler meat in respected group (Najafian et al., 2018).

Toghyani et al. (2011) reported that adding garlic and cinnamon to broiler diets did not affect meat olfactory parameters. However, PL supplementation in drinking water improved the aroma, flavor, juiciness, tenderness, and overall acceptability of broiler meat, confirmed by Camy et al. (2019), consistent with the current research. The primary explanation for the improvement in meat quality in PL fed broilers might be due to antioxidant action of this herb (Al-Mamun et al., 2008a). The presence of phenolic components, especially acteosides, in PL contributes to the broiler's antioxidant status, which may help prevent lipid auto-oxidation and reduce the concentration of free radicals, thereby improving the meat's quality (Al-Mamun et al., 2007; Redoy et al., 2021).

Profitability Analysis

In this experiment, the higher profitability of PL supplemented groups was in accordance with the findings of El-Faham et al. (2014) and Puvaca et al. (2016). Regardless of the housing system (open-sided vs. controlled), feed type (mash vs. pellet), or management system (automation vs. manual), the use of herbs in commercial broiler diets led to increased profitability in the majority of studies (Abdel-Latif et al., 2002; Moustafa, 2006; Abaza et al., 2008; Issa & Abo Omar, 2012; Abo Omar et al., 2016). Some reasons might be responsible for getting better profitability in PL supplemented groups in this study, including- (i) higher body weight gain, (ii) lower production cost, (iii) greater dressing percentage and (iv) better price of value-added safe meat. Increased body weight gain was observed in PL supplemented groups compared to respective controls, which resulted in a higher return on broiler production. Besides, the total production cost was the lowest in the F0 group and then in the F10, C10 and C0 groups, respectively. Moreover, PL supplementation significantly increased the dressing percentage, which positively triggered the profitability of respected groups. Furthermore, PL improves the fatty acid profile and meat antioxidant level in commercial broilers, producing functional meat (Redoy et al., 2021). Since the price of value-added functional and conventional meats in the experimental site was comparable, this aspect had no effect on profitability. Developing a value-added broiler chain may assist in obtaining a higher price for safe and value-added broiler meat, thus increasing the economic efficiency of broiler production using PL herb, which we recommend here.

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V. Conclusion

Overall, the data indicated that PL supplementation enhanced broiler production performance at farmer level, including weight gain, feed conversion ratio, and production quality, regardless of ration difference. The dressed yield, abdominal fat content and meat quality were more influenced by ration variation, even though PL supplementation had a significant independent effect. Most importantly, PL supplementation resulted in a twofold increase in profit for both the ration groups compared to their respective un-supplemented groups. Thus, PL could be supplemented to facilitate cost-effective broiler production adjusting farmer-level ration variation. Different forms of PL, such as sun-dried, oven-dried or shade-dried, may be added to broiler rations to assess growth performance and determine the best form of plantain to use as a sustainable supplement in commercial feed formulation.

VI. References

[1]. Abaza, I. M., Shehata, M. A., Shoieb, M. S. and Hassan I. I. (2008). Evaluation of some natural feed additive in growing chicks diets. International Journal of Poultry Science, 7, 872-879. https://dx.doi.org/10.3923/ijps.2008.872.879

[2]. Abdel, El-Latif, S. A., Faten A. A. and El-Kaiaty A. M. (2002). Effect of feeding dietary thyme, black cumin, Dianthus and fennel on productive and some metabolic responses of growing Japanese quail. Egyptian Poultry Science Journal, 22, 109-125.

[3]. Adiputro, D. L., Widodo, M. A., Romdoni, R. and Sargowo. D. (2013). Extract of mangosteen increases high density lipoprotein levels in rats fed high lipid. Universal Medicine, 32, 37-43. https://doi.org/10.18051/UnivMed.2013.v32

[4]. Al-Mamun, M., Abe, D., Kofujita, H., Tamura, Y. and Sano, H. (2008a). Comparison of the bioactive components of the ecotypes and cultivars of plantain (*Plantago lanceolata* L.) herbs. Animal Science Journal, 79, 83-88. https://doi.org/10.1111/j.1740-0929.2007.00501.x

[5]. Al-Mamun, M., Goto, K., Chiba, S. and Sano, H. (2009). Responses of plasma acetate metabolism to hop (*Humulus lupulus* L.) in sheep. International Journal of Biological Science, 5(3), 287-292. https://dx.doi.org/10.7150/ijbs.5.287

[6]. Al-Mamun, M., Hanai, Y., Tanaka, C., Tamura, Y. and Sano, H. (2008b). Responses of whole body protein synthesis and degradation to plantain herb in sheep exposed to heat. Archives of Animal Nutrition, 62, 219-229. http://dx.doi.org/10.1080/17450390801892633

[7]. Al-Mamun, M., Ito, C., Fujita, T., Sano, H. and Sato, A. (2007). Comparison of the [$^ 2H_5 $] Phenylalanine Model with the [1-$^{13} C $] Leucine Method to Determine Whole Body Protein Synthesis and Degradation in Sheep Fed at Two Levels. Asian-Aust. Journal of Animal Science, 20, 1517-1524. https://doi.org/10.5713/ajas.2007.1517

[8]. Al-Mamun, M., Shibuya, K., Kajita, M., Tamura, Y. and Sano, H. (2017). Responses of plasma glucose metabolism to exogenous insulin infusion in sheep-fed forage herb plantain and exposed to heat. Animal, 11, 1287-1294. https://doi.org/10.1017/S1751731116002846

[9]. Andrew Selaledi, L., Mohammed Hassan, Z., Manyelo, T. G. and Mabelebele, M. (2020). The current status of the alternative use to antibiotics in poultry production: An African perspective. Antibiotics, 9, 594-612. https://doi.org/10.3390/antibiotics9090594

[10]. AOAC. (2005). Official Methods of Analysis of AOAC International. 18th ed. Assoc. Off. Anal. Chem., Arlington.

[11]. Baéza, E., Guillier, L. and Petracci, M. (2022). Production factors affecting poultry carcass and meat quality attributes. Animal, 16, 100331. https://doi.org/10.1016/j.animal.2021.100331

[12]. Bahadori, M. B., Sarikurkcu, C., Kocak, M. S., Calapoglu, M., Uren, M. C. and Ceylan, O. (2020). Plantago lanceolata as a source of health-beneficial phytochemicals: Phenolics profile and antioxidant capacity. Food Bioscience, 34, 100536. http://doi.org/10.1016/j.fbio.2020.100536

[13]. Baryłko-Pikielna, N. and Matuszewska, I. (2009). Sensory Testing of Food. Basics-Methods-Application. Wroclaw, Poland; Polish Society of Food Technologists.

[14]. Camy, M. L. Y., Redoy, M. R. A., Shuvo, A. A. S., Ray, B. C., Rahman, M. A. and Al-Mamun, M. (2019). Effect of aqueous herbal extracts on growth, plasma metabolites and meat characteristics of broiler. Bangladesh Journal of Animal Science, 48, 108-115. https://doi.org/10.3329/bjas.v48i2.46764

[15]. Chacrabati, R., Chowdhury, R., Yesmin, S., Sano, H. and Al-Mamun M. (2013). Comparison of broiler performance using Plantain (*Plantago lanceolata* L.), Bio-Sel-E and commercial diet. Bangladesh Journal of Animal Science, 42, 123-130. https://doi.org/10.3329/bjas.v42i2.18492

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EISSN 2709-8516

[16]. Chowdhury, S., Hassan, M. M., Alam, M., Sattar, S., Bari, M. S., Saifuddin, A. K. M. and Hoque, M. A. (2015). Antibiotic residues in milk and eggs of commercial and local farms at Chittagong, Bangladesh. Veterinary World, 8, 467-471. https://doi.org/10.14202%2Fvetworld.2015.467-471

[17]. Chung, M. J., Park, K. W., Kim, K. H., Kim, C. T., Baek, J. P., Bang, K. H., Choi, Y. and Lee, S. J. (2008). Asian plantain (Plantago asiatica) essential oils suppress 3-hydroxy-3-methyl-glutaryl-co-enzyme a reductase expression in vitro and in vivo and show hypocholesterolemic properties in mice. British Journal of Nutrition, 99, 67-75. https://doi.org/10.1017/s0007114507798926

[18]. De Marco, M., Salcedo, W. L., Pastorelli, G., Rossi, R., Corino, C., Bergagna, S., Mellia, E., Gennero, M. S., Biasibetti, E., Capucchio, M. and Nurisso. T. (2015). Effects of verbascoside supplemented diets on growth performance, blood traits, meat quality, lipid oxidation and histological features in broiler chickens. Ital. Journal of Animal Science, 14, 172-178. http://dx.doi.org/10.4081/ijas.2015.3712

[19]. El-Faham, A. I., Ali, N. and El-Maaty, H. M. (2014). Effect of using some natural feed additives to substitute antibiotic growth promoters on performance and blood parameters of broilers. Egyptian Poultry Science Journal, 34, 735-750.

[20]. Ferrazzano, G. F., T. Cantile, T., Roberto, L., Ingenito, A., Catania, M. R., Roscetto, E., Palumbo, G., Zarrelli, A. and Pollio. A. (2015). Determination of the in vitro and in vivo antimicrobial activity on salivary Streptococci and Lactobacilli and chemical characterization of the phenolic content of a Plantago lanceolata infusion. BioMed Research International, 2015, 286817. https://doi.org/10.1155/2015/286817

[21]. Hammami, S., Debbabi, H., Jlassi, I., Joshi, R. K. and Mokni. R. E. 2020. Chemical composition and antimicrobial activity of essential oil from the aerial parts of Plantago afra L. (Plantaginaceae) growing wild in Tunisia. South African Journal of Botany, 132, 410–414. https://doi.org/10.1016/j.sajb.2020.05.012

[22]. Hoque, R., Ahmed, S. M., Naher, N., Islam, M. A., Rousham, E. K., Islam, B. Z. and Hassan. S. (2020). Tackling antimicrobial resistance in Bangladesh: A scoping review of policy and practice in human, animal and environment sectors. PLOS ONE, 15, e0227947. https://doi.org/10.1371%2Fjournal.pone.0227947

[23]. Hosseini-Vashan, S. J. and Raei-Moghadam, M. S. (2019). Antioxidant and immune system status, plasma lipid, abdominal fat, and growth performance of broilers exposed to heat stress and fed diets supplemented with pomegranate pulp (*Punica granatum* L.). Journal of Applied Animal Research, 47, 521-531. https://doi.org/10.1080/09712119.2019.1676756

[24]. Issa, K. J. and Omar. J. A. (2012). Effect of garlic powder on performance and lipid profile of broilers. Open Journal of Animal Science, 2, 62-68. http://dx.doi.org/10.4236/ojas.2012.22010

[25]. Karim, M. B., Hossain, M. E., Ali, M. S. and Hossain, A. (2017). Effect of garlic powder (*Allium sativum*) on growth, dressing parameters, serum biochemical contents and profitability of broiler. Bangladesh Journal of Animal Science, 46, 215-224. https://doi.org/10.3329/bjas.v46i4.36961

[26]. Kim, D. K., Lillehoj, H. S., Lee, S. H., Jang, S. I., Lillehoj, E. P. and Bravo. D. (2013). Dietary Curcuma longa enhances resistance against Eimeria maxima and Eimeria tenella infections in chickens. Poultry Science, 92, 2635-2643. https://doi.org/10.3382/ps.2013-03095

[27]. Kusmayadi, A., Bachtiar, K. R. and Prayitno, C. H. (2019). The effects of mangosteen peel (*Garcinia mangostana* L.) and Turmeric (*Curcuma domestica* Val) flour dietary supplementation on the growth performance, lipid profile, and abdominal fat content in Cihateup ducks. Veterinary World, 12, 402-408. https://doi.org/10.14202/vetworld.2019.402-408

[28]. Lee, Y., Lee, S. H., Gadde, U. D., Oh, S. T., Lee, S. J. and Lillehoj, H. S. (2017). Dietary Allium hookeri reduces inflammatory response and increases expression of intestinal tight junction proteins in LPS-induced young broiler chicken. Research in Veterinary Science, 112, 149-155. https://doi.org/10.1016/j.rvsc.2017.03.019

[29]. Lin, J., Hunkapiller, A. A., Layton, A. C., Chang, Y. J. and Robbins, K. R. (2013). Response of intestinal microbiota to antibiotic growth promoters in chickens. Foodborne Pathogens and Disease, 10, 331-337. https://doi.org/10.1089/fpd.2012.1348

[30]. Liu, N., Wang, J. Q., Liu, Z. Y., Chen, Y. K. and Wang, J. P. (2008). Tetramethylpyrazine attenuates necrotic enteritis by reducing gut oxidative stress, inflammation, opportunistic bacteria and endotoxins in broilers. European Poultry Science, 82, 233. https://doi.org/10.1399/eps.2018.233

[31]. Marcu, A., Vacaru-Opriş, I., Dumitrescu, G., Ciochina, L. P., Marcu, A., Nicula, M., Peţ, I., Dronca, D., Kelciov, B. and Mariş. C. (2013). The influence of the genotype on economic efficiency of broiler chickens growth. Scientific Papers Animal Science and Biotechnology, 46, 339-346.

[32]. Mazhari, M., Esmaeilipour, O., Mirmahmoudi, R. and Badakhshan. Y. (2016). Comparison of antibiotic, probiotic and great plantain (*Plantago major* L.) on growth performance, serum metabolites, immune response and ileal microbial population of broilers. Poultry Science Journal, 4, 97-105. http://dx.doi.org/10.22069/PSJ.2016.10041.1164

[33]. Moustafa, K. K. (2006). Effect of using commercial and natural growth promoters on the performance of commercial laying hens. Egyptian Journal of Poultry Science, 26, 941-965.

[34]. Murugesan, G. R., Syed, B., Haldar, S. and Pender, C. (2015). Phytogenic feed additives as an alternative to antibiotic growth promoters in broiler chickens. Frontier in Veterinary Science, 2, 21. https://doi.org/10.3389/fvets.2015.00021

[35]. Najafian, Y., Hamedi, S. S., Farshchi, M. K. and Feyzabadi, Z. (2018). Plantago major in traditional persian medicine and modern phytotherapy: a narrative review. Electronic Physician Journal, 10, 6390-6399. https://doi.org/10.19082/6390

[36]. Narimani-Rad, M., Nobakht, A., Shahryar, H. A., Kamani and J.and Lotfi, A. (2011). Influence of dietary supplemented medicinal plants mixture (Ziziphora, Oregano and Peppermint) on performance and carcass characterization of broiler chickens. Journal of Medicinal Plants Research, 5, 5626-5629. https://doi.org/10.5897/JMPR.9000790

[37]. Omar, J. A., Hejazi, A. and Badran. R. (2016). Performance of broilers supplemented with natural herb extract. Open Journal of Animal Science, 6, 68-74. http://dx.doi.org/10.4236/ojas.2016.61009

[38]. Peña-Espinoza, M., Valente, A. H. Thamsborg, S. M., Simonsen, H. T., Boas, U., Enemark, H. L., López-Muñoz, R. and Williams, A. R. (2018). Antiparasitic activity of chicory (Cichorium intybus) and its natural bioactive compounds in livestock: a review. Parasites and Vectors, 11, 1-14. https://doi.org/10.1186/s13071-018-3012-4

[39]. Puvaca, N., Simin, M. T., Kostadinovic, L., Lukac, D., Ljubojevic, D., Popovic, S. and Tasic, T. (2016). Economic efficiency coasts of broiler chicken production fed dietary garlic, black pepper and hot red pepper supplements. Custos e Agronegocio, 11, 422-436.

[40]. Qureshi, S., Banday, M. T., Shakeel, I., Adil, S., Mir, M. S., Beigh, Y. A. and Amin. U. (2016). Histomorphological studies of broiler chicken fed diets supplemented with either raw or enzyme treated dandelion leaves and fenugreek seeds. Veterinary World, 9, 269-275. https://doi.org/10.14202/vetworld.2016.269-275

[41]. Rahman, M. A., Ray, D., Redoy, M. R. A. and Al-Mamun, M. (2021). Dose titration of herbs mixture powder supplementation on laying performance and egg quality in commercial layer chicken. Livestock Research for Rural Development, 33,

[42]. Redoy, M. R. A., Rahman, M. A., Atikuzzaman, M., Shuvo, A. A. S., Hossain, E., Khan, M. J. and Al-Mamun M. (2021). Dose titration of plantain herb (*Plantago lanceolata* L.) supplementation on growth performance, serum antioxidants status, liver enzymatic activity and meat quality in broiler chickens. Italian Journal of Animal Science, 20, 1244-1255. https://doi.org/10.1080/1828051X.2021.1952114

[43]. Reza, M. M., Redoy, M. R. A., Rahman, M. A., Ety, S. Alim, M. A., Cheng, L. and Al-Mamun, M. (2021). Response of plantain (Plantago lanceolata L.) supplementation on nutritional, endo-parasitic, and endocrine status in lambs. Tropical Animal Health and Production, 53, 82-89. https://link.springer.com/article/10.1007/s11250-020-02514-0

[44]. Shokryazdan, P., Faseleh Jahromi, M., Liang, J. B., Ramasamy, K., Sieo, C. C. and Ho, Y. W. (2017). Effects of a Lactobacillus salivarius mixture on performance, intestinal health and serum lipids of broiler chickens. PloS one, 12, e0175959. https://doi.org/10.1371/journal.pone.0175959

[45]. Toghyani, M., Toghyani, M., Gheisari, A., Ghalamkari, G. and Eghbalsaied, S. (2011). Evaluation of cinnamon and garlic as antibiotic growth promoter substitutions on performance, immune responses, serum biochemical and haematological parameters in broiler chicks. Livestock Science, 138, 167-173. https://doi.org/10.1016/j.livsci.2010.12.018

[46]. Ziołecki, J. and Doruchowskin, W. (1989). Evaluation Methods of Poultry Slaughter Value. Poultry Research Center, Poznań, Poland.