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Effects of Dietary Supplementation of Banana Peel on Performance Traits, Carcass Characteristics and Serological Parameters in Broiler

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Abstract: The purpose of this research was to investigate the safe amounts of banana peel inclusion in chicken diets and to examine the impact on broiler performance, carcass features, and serological markers. A total of 400 Cobb500TM day-old broiler chicks were split among four treatments, each with 100 birds. Each group was then subdivided into five duplicates, each with 20 birds. T8 was given a normal control diet with antibiotics (Enramycine 0.3 grammes/Kg), T9 was given a baseline diet without antibiotics, T10 was given a basal diet with maize 2% replaced by banana peels, and T11 was given a basal diet with maize 4% replaced by banana peels. Data will be analyzed under a complete randomized design through one-way ANOVA using SPSS. The body weight, feed intake and FCR manifested significant improvement in the T11 group in comparison with the control. Moreover, serum HDL, dressed weight and giblet weight results were found significant in treatment groups as compared to the control. The serum LDL concentration and cholesterol were significantly lowered in T10 and T11 as compared to the control group. Hence, banana peel supplementation as a replacement for corn in a broiler diet can support normal broiler growth and performance and can also lower the cost of feed efficiently.

Keywords: Banana peel; carcass characteristics; Serological parameters; growth performance; Feed costs.

1. Introduction

The poultry industry is a significant supplier of white meat around the globe, and it plays a vital part in meeting the protein needs of the rising population [1]. The chicken business is experiencing several challenges, including rising feed prices, adverse climatic conditions caused by global warming, antibody residues in products, and infectious disease outbreaks [2]. As a result of nutritional, metabolic, managerial, and environmental concerns, poor growth performance and low feed conversion ratio are becoming increasingly apparent [3]. The cost of feeding accounts for almost 70% of the entire cost of chicken production. The demand for feed components is substantially larger than the supply, with a 19.4%, 37.2%, and 38.0% difference for dry biomass, crude protein, and energy, respectively. These components,

particularly maize, are also present in the human diet. As a result, the availability and price of the components vary throughout the year [4].

Corn incorporation in chicken feed might account for up to 50% of overall costs. As a result, the price of maize has a direct impact on the price of chicken feed [5]. Furthermore, the prices of additional raw materials utilised in feed formulation are rising daily [6]. For sustainable poultry production, non-traditional feed resources must be used to bridge the supply-demand gap while also lowering feed prices without compromising bird development performance [7]. Non-traditional feed supplies mostly consist of agro-industrial by-products such as cereal by-products and crop residues such as maize, wheat, sorghum, sugar cane, and fruit industry wastes [8]. Fruit industry wastes offer potential nutritious value and polyphenols with antibacterial and antioxidant properties [9]. However, owing to high fibre content and the presence of anti-nutritional components, their usage is restricted. Fruit wastes include peels, pulp, pods, skins, and hides [10]. Because these fruit wastes are not adequately recycled, they are substantial environmental contaminants. Orange and banana fruits have a high production yield in our climate, but their peels are discarded [11]. There have recently been verified reports on the use of peels in broiler diets after drying and grinding.

During the ripening process, large numbers of bananas are discarded, as are their peels, which account for 40% of the fruit [12]. Many bioactive chemicals, such as polyphenols, carotenoids, and other antioxidant compounds, are found in banana peel and are vital for human and animal metabolism [13]. Banana peel contains a lot of calories, minerals, fibre, protein, vitamins, and vital amino acids [14]. Antimicrobial activity against food-borne pathogens such as Staphylococcus aureus, Bacillus cereus, Salmonella enteritidis, and Escherichia coli has also been shown [15].

Despite their great nutritional value and availability, banana peels are restricted in the poultry diet owing to their high fibre content and the presence of several anti-nutritional elements like as saponins [16]. Peel at rates ranging from 7.5% to 10% is recommended as the highest safe level. More than 10% inclusion has a deleterious influence on bird weight increase [17]. According to current research, adequate drying or treatment of banana peels with an alkali such as sodium hydroxide may enhance the inclusion level of banana peels in the broiler diet. Sun-drying for 3-5 days or treating peels with 0.5% alkali makes it suitable to use in a grill diet [18].

From the above perspectives, the objective of this study is to utilize the waste banana peels in a broiler diet hence improving production performance and also lowering the cost of feed. In this study, we observed banana peel effects on feed intake, weight gain, carcass characteristics and serum metabolites. The safe inclusion rate was still not determined for the broiler, so there was a need to evaluate the safe limit. This study ultimately gave a good non-conventional resource for the chicken diet and also is helpful in the least cost feed formulation. A detailed discussion of this introduction is explained in Part I sections; Part II contains descriptive materials and methods that define the explained experimental layout. Part III is the core of this study which describes the experimental results. In the last section Part IV, we conclude this paper with its major findings.

2. Materials and Methods

From a nearby hatchery, 400 Cobb500TM day-old broiler chicks were obtained [19]. T8 was given a normal control diet with antibiotics (Enramycine 0.3 grammes/Kg), T9 was given a baseline diet without antibiotics. T10 was given a baseline diet with corn 2% replaced by banana peels, whereas T11 was given a basal diet with corn 4% replaced by banana peels. Each group had 100 birds, which were split into five duplicates. Each replication had 20 birds. From day 1 to 35, groups T10 and T11 were given experimental

diets. Banana peels were collected from the banana waste at the local market. To lower enzymatic degradation, peels were washed thoroughly with distilled water. After that peels were cut to make chips and sun-dried for 4 days. Then the dried sample was ground to make fine powder and added to the broiler diet. A commercial broiler diet was given to experimental birds (CP: 20% and ME: 3000 Kcal) including banana peels as a replacement for corn. All of the diets were isocaloric and nitrogenous. Weekly growth performance criteria were computed. (Table 1) shows the whole experimental design.

Table 1. Experimental layout

Diet group	Treatment	Dose rate	Number of birds	Replicates	Number of birds per replicate	
T_8	Basal diet (Formulated according to standards) + antibiotic (Positive control)	As recommended	100	5	20	**Total groups: 4 Replicate/group: 5 Birds/replicate: 20 Total birds: 20×5×4 =400**
T_9	Only basal diet (Negative control)	As recommended	100	5	20	
T_{10}	2% Banana Peel		100	5	20	
T_{11}	4% Banana Peel		100	5	20	

Feed was offered in two phases, starter and finisher only. Feed formulation of starter diet (percentages) is explain in (table 2).

Table 2. Feed formulation of starter diet (percentages)

Ingredients (%)	Diet group T_8	Diet group T_9	Diet group T_{10}	Diet group T_{11}
MCP*	0.2	0.2	0.2	0.2
Lysine HCL	0.22	0.22	0.22	0.22
DLM**	0.345	0. 345	0. 345	0. 345
Threonine	0.2	0.2	0.2	0.2
Salt	0.33	0.33	0.33	0.33
Soda	0.2	0.2	0.2	0.2
Betain HCL	0.063	0.063	0.063	0.063
Phytase	0.05	0.05	0.05	0.05
Coxiril®***	0.03	0.03	0.03	0.03
Enramycine	0.05	0.05	0.05	0.05
Vitamin premix	0.064	0.064	0.064	0.064
Mineral premix	0.064	0.064	0.064	0.064
Trial product	0.01	0.01	0.01	0.01
Rice polish	0.156	0.231	0. 231	0. 231
Limestone	1.02	1.02	1.02	1.02
Total	3.6	3.6	3.6	3.6

Raw material				
Maize	53.8	53.8	51.8	49.8
Banana peel	0	0	2	4
Soya bean Meal	28	28	28	28
Canola meal	4.4	4.4	4.4	4.4
Poultry by-product meal	3	3	3	3
Rice Polish	8	8	8	8

*MCP= Mono calcium phosphate **DL-Methionine

*** Coxiril®= Coccidiostat containing 0.5% Diclazuril as an active ingredient

Feed formulation of finisher diet (percentages) is explain in (table 3).

Table 3. Feed formulation of finisher diet (percentages)

Ingredients (%)	**Diet group T_8**	**Diet group T_9**	**Diet group T_{10}**	**Diet group T_{11}**
MCP*	0.2	0.2	0.2	0.2
Lysine HCL	0.333	0.333	0.333	0.333
DL-Methionine	0.224	0.224	0.224	0.224
Threonine	0.09	0.09	0.09	0.09
Salt	0.22	0.22	0.22	0.22
Soda	0.1	0.1	0.1	0.1
Betain HCL	0.05	0.05	0.05	0.05
Phytase	0.01	0.01	0.01	0.01
Coxiril**	0.01	0	0	0
Enramycine	0.03	0	0	0
Vitamin Premix	0.055	0.055	0.055	0.055
Mineral Premix	0.055	0.055	0.055	0.055
Trial product	0	0	0	0
Rice polish	0.2	0.3	0.3	0.3
Limestone	0.8	0.8	0.8	0.8
Total	2.4	2.4	2.4	2.4
Raw material				
Maize	63	63	61	57
Banana peel	0	0	2	4
Soybean Meal	25	25	25	25
Rapeseed meal	5	5	5	5
Poultry by-product meal	3	3	3	3
Corn gluten 60%	1.6	1.6	1.6	1.6

*MCP= Mono-calcium phosphate

** Coxiril®= Coccidiostat containing 0.5% Diclazuril as the active ingredient.

As well as chemical analysis of basal diets of banana peel is given in (Table 4).

Table 4. Chemical analysis of basal diets

Ingredients	Starter	Finisher
Moisture (%)	12.6	12.6
CP (%)	26	21
Ash (%)	3	4
Crude Fat (%)	5	5.5
Crude Fiber (%)	4	5
Metabolizable Energy (Kcal/Kg)	2800	2950

Proximate analysis of banana peel in comparison with corn is given in (Table 5).

Table 5. Proximate analysis of Banana peel and Corn

Ingredients	Corn	Banana peel
Moisture (%)	10.9	9.8
CP (%)	8.1	8.12
Ash (%)	1.5	16.26
Crude Fat (%)	2.4	4.84
Crude Fiber (%)	2.75	11.60
Metabolizable Energy (Kcal/Kg)	3200	2860

Weekly body weight data was meticulously documented. Feed intake was determined by deducting the rejected feed from the total offered feed. The FCR was calculated by dividing body weight (grams) by feed intake (grams). It was carried out to assess the ability of birds to convert meals into body weight.

Triglyceride and total cholesterol (HDL and LDL) values were assessed for the serum investigation. After the trial, blood samples were obtained at random from one pigeon per replication in non-heparinized tubes on day 35. Following centrifugation (3000 rpm for 15 minutes), the samples were kept at -200 degrees Celsius for subsequent analysis. Commercial laboratories were used to analyses serum metabolites such as triglycerides, cholesterol levels, HDL-cholesterol, and LDL-cholesterol.

After the time, data for carcass features, dressing %, dressed weight, and weight of giblets (heart, gizzard, liver, and kidney) were gathered by randomly choosing and killing 1 bird for each duplicate. Following the sacrifice and removal of blood, feathers, and internal organs, the corpse was weighed to determine the dressed weight. The eviscerated weight was determined after removing all internal organs except the giblet. After sacrifice, the weight of three organs, including the liver, heart, and gizzard, was determined and referred to as giblet weight. The weight of giblets (g) was calculated per 100 g of live weights.

At the end of the trial, the net returns of using banana peel were calculated on basis of production cost per bird. It gave an idea about net profit or loss. Data were analyzed under a completely randomized design through one-way ANOVA using SPSS. Multiple comparisons of different means were done through Tuckey's test and Duncan's test. P≤ 0.05 was considered a significant value.

3. Results and Discussion

This study revealed that the weekly body weight of the broilers increased significantly in treatment groups as compared to control groups as shown in (Table 6). There was a remarkable improvement noticed in the body weight of the birds fed with 4% banana peels (T11) in comparison with the positive control. This study follows the observed improved weight gain and final body weight with a 3% inclusion level of banana peel in broilers with no harmful effects. Described significant differences in weight gain among treatment groups (5%, 10%, and 15%). Concluded that the inclusion of 20% banana peel in heat stressed broiler can support the final body weight. Observation was made that the highest daily weight gain of (37.56 ± 4.52 g) on day 10 in one of his treatments. His experiment used plantain peel meal (PPM) differentially treated as sun-dried; sun-dried-lye treated and sun-dried phytase (1g/kg diet) with 25, 50 and 75% replacement for maize. The inclusion of peels greatly affects the final body weight as higher inclusion levels may retard the final body weight of the birds. It is due to the presence of high fiber content and some ANF which reduce weight gain.

Table 6. Effect of dietary supplementation of a banana peel on weekly body weight of broilers

Group	Week 0 (Mean± S.E)	1st Week	2nd week	3rd week	4th week	5th week
T_8	43.73±0.20	162.59^{a}±1.52	405.36^{ab}±6.52	816.96^{ab}±3.96	1351.47^{ab}±18.21	1998.73^{a}±31.66
T_9	43.70±0.18	164.33^{a}±1.36	402.18^{a}±5.63	806.80^{a}±2.83	1327.41^{a}±7.40	1943.79^{a}±17.92
T_{10}	43.71±0.21	172.06^{b}±3.73	424.48^{b}±9.20	830.42^{b}±5.49	1371.75^{bc}±13.58	2017.20^{a}±45.13
T_{11}	43.85±0.14	181.02^{c}±1.45	449.11^{c}±5.36	849.37^{c}±6.29	1397.80^{c}±7.65	2168.34^{b}±12.27
P-Value	0.93	0.00	0.003	0.00	0.012	0.001

Within a column, values with distinct superscripts vary statistically at P<0.05, whilst the standard error for a specific group was put after the mean value.

In the case of feed intake, a noticeable increase in feed intake and appetite of the birds supplemented with a banana peel was observed and listed in (Table 7). The highest recorded significant intake was observed in the T11 group supplemented with 4% banana peel. Hence, the 4% banana peel supplementation improved feed intake significantly as compared to other groups.

These results are similar to the trial study of resulting in a 3% inclusion of banana peel increased feed intake of birds. Stated increase in feed intake when the inclusion of banana meal was linearly increased from 10 to 30% in the chicken diet. Low inclusion levels of peels gradually increased feed intake in broilers. Higher inclusions of BP need heat, chemical and enzymatic treatments, to lower tannin content, enzymatic

degradation of peels and improve digestibility. In the case of BP, supplementation tannin was greatly lower by treatment of peels with 1.04, 0.59 and 0.46 g/100g for autoclaving, oven heating and soaking in boiling water, respectively.

Table 7. Effect of dietary supplementation of a banana peel on feed intake of broilers

Group	1st Week (Mean± S.E)	2nd week	3rd week	4th week	5th week
T8	152.90ab±2.19	578.30ab±10.59	1094.70ab±6.15	1867.07a±25.39	3048.12a±24.96
T9	141.07a±3.49	561.39a±6.08	1058.56a±9.72	1856.84a±11.37	3027.27a±19.76
T10	153.83ab±3.93	579.90ab±4.02	1108.46b±13.60	1938.50b±26.52	3073.79a±19.33
T11	165.80b±6.22	607.11b±15.06	1146.59c±17.06	2018.51c±16.42	3149.04b±19.38
P-Value	0.11	0.044	0.022	0.00	0.008

This study manifested that the feed conversion ratio was improved significantly ($P<0.05$) starting from week 1st till the termination of the trial as can be clearly seen from (Table 8). The lowest and best mean FCR value was recorded in group T11 followed by T10. The feed conversion ratio was improved to a remarkable extent due to the supplementation of the banana peel at the rate of 4% in feed. Hence, show higher inclusion levels did not support the standard FCR values, as the tannin and fiber content of the diet increased at higher levels.

Stated no significant difference in replacing corn with banana peel up to 45% on FCR of broiler diet. When compared to the control group, the incorporation of banana peel in the chicken diet was greater than 20%. There was a significant difference in FCR value between treatment groups that were lower than the control group, and it was determined that 20% inclusion of banana peel may promote growth performance in heat-stressed chickens. Hence, higher inclusion levels did not support the standard FCR values, as the tannin and fiber content of the diet increased at higher levels.

Table 8. Effect of dietary supplementation of banana peels on weekly FCR in broilers

Group	1st week (Mean± S.E)	2nd week	3rd week	4th week	5th week
T8	0.95^{b}±0.03	1.43^{b}±0.02	1.35^{bc}±0.006	1.41^{b}±0.006	1.58^{bc}±0.03
T9	0.99^{b}±0.03	1.47^{b}±0.02	1.36^{c}±0.007	1.44^{c}±0.017	1.62^{c}±0.02
T10	0.88^{ab}±0.04	1.36^{a}±0.02	1.33^{b}±0.01	1.40^{ab}±0.011	1.54^{ab}±0.03
T11	0.82^{a}±0.03	1.33^{a}±0.02	1.30^{a}±0.009	1.37^{a}±0.007	1.49^{a}±0.02
P-Value	0.013	0.001	0.001	0.004	0.008

Within a column, values with distinct superscripts vary statistically at $P<0.05$, whilst the standard error for a specific group was put after the mean value.

This research showed a significant positive and beneficial improvement in serum chemistry profile as compared to the positive and negative control. Statistically and as per data presented in (Table 9) concludes that T11 group had the lowest cholesterol, followed by T10, indicating that the banana has a hypolipidemic impact. The highest statistical, as well as numerical cholesterol reading (of about 75.25 mg/dl), was recorded in the negative control. The concentration of Low-density lipoprotein also manifested a remarkable improvement in its profile due to the feeding of banana peel. T11 had the greatest and lowest mean reported value of LDL (38.252.56), followed by T10. In the case of good cholesterol, known as HDL (high-density lipoprotein), treatment groups showed a considerable increase in concentration when compared to control groups. T11 had the greatest numerical HDL concentration, followed by T10.

Table 9. Effect of banana peels on serological parameters of broilers

Group	Cholesterol (Mean± S.E)	LDL	HDL
T8	59.75^{bc}±8.52	44.0^{bc}±2.16	47.75^{a}±2.06
T9	75.25^{c}±5.72	48.50^{c}±0.87	45.0^{a}±1.35
T10	43.50^{ab}±4.66	37.75^{ab}±2.29	51.75^{ab}±2.78
T11	38.25^{a}±2.56	34.25^{a}±3.14	56.75^{b}±3.52
P-Value	0.003	0.004	0.035

Values with distinct superscripts within a column vary statistically at P≤0.05, whereas the standard error of a specific group was put after the mean value.

This study relates to stated that all treatment groups have low blood cholesterol and triglyceride levels. They replaced yellow corn with BP (with or without enzymes) up to 45% in a broiler diet. These results are evident for the strong antioxidant activity of BP due to the presence of polyphenols and flavonoid compounds. This study also used banana peel meal with inclusions of 10, 20, 30 and 40% and evaluate blood lipid profile (HDL, LDL and total Cholesterol). The results showed no significant difference by replacing maize with banana peel meal.

Final results after statistical analysis manifested that broiler fed with banana peel had significant improvement in the case of carcass parameters. The dressed weight was the highest and best in the treatment groups. Both groups (T10 and T11) showed statistically similar and excellent improvement in dressing percentage. Moreover, giblet weight was also improved significantly ($p<0.05$) in treatment groups as compared to the control. The highest giblet weight was measured in the T11 group followed by T10. Hence, banana peel supplementation gave an optimum improvement in carcass characteristics as compared to antibiotics-fed groups.

Reported improved dressing percentage and carcass weight of chicken with 3% dietary inclusion of banana peel as presented in (Table 10).

Table 10. Effect of banana peels on carcass characteristics of broiler

Group	Dressed weight (Mean± S.E)	Giblet weight*
T8	1237.75^{a}±24.75	106.5^{ab}±5.58
T9	1145.25^{a}±32.58	83.75^{a}±17.16
T10	1405^{b}±43.75	126^{bc}±3.03

T11	1419.75^{b}±39.71	142^{c}±11.67
P-Value	0.00	0.014

*Giblet weight = weight of three organs including the liver, heart and Gizzard.

Broiler-fed diets having more than 10% BP cannot follow the above trend but still can support the broiler growth and helpful in lowering the cost of feed observed improved crop and liver weights in birds feed cooked banana meal and no significant difference in carcass parameters as compared to the control group when the uncooked banana meal was fed up to 30%. Observed no significant difference in dressing percentage and carcass characters by using treated banana peel in broiler diet up to 25%. Stated that in broiler finisher diets, some replacement of corn with banana peel has no significant difference in carcass characteristics. However, net profit can be maximize using this strategy and it is conclusive in (Table 11).

Table 11. Effect of banana peels on the economics of feed

Particulars (Rs/Broilers)	**Groups**			
	T_8	**T_9**	**T_{10}**	**T_{11}**
Cost of day-old chick	70	70	70	70
The total cost of feed	216	210	216	216
Cost of banana peel	0	0	0	0
Misc. Expenditure	100	100	100	100
Total production cost	316	310	316	316
Final live body weight	1.998	1.943	2.017	2.168
Broiler sale rate (Rs/Kg)	210	210	210	210
Total income	419.58	408.3	423.57	455.28
Net profit	103.58	98.3	107.57	139.28

4. Conclusion and Future Work

We can conclude as a result of this trial and previous studies that banana peel supplementation as a replacement for corn in a broiler diet can support normal broiler growth and performance. It has good crude protein, carbohydrates and mineral content which make BP fit for a broiler diet. Also, due to the presence of polyphenols and flavonoids, it can improve the gut health of birds. It can also lower the cost of feed efficiently. Hence this study supports the use of BP as a replacement for corn in broiler diets at low inclusion levels to improve broiler performance and lower the feed cost.

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