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Effect of Feeding Graded Levels of Guava Leaf Meal on Performance and Economics of Broiler Chicks

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ABSTRACT

Present study was undertaken on 120-day-old unsexed broiler chicks to study the effect of dietary guava leaf meal (GLM) on performance of broilers. They were randomly distributed into 4 dietary treatment groups of 30 birds per group, each having 3 replicates (10 birds per replicate) in a completely randomized block design (CRD). All the birds were fed standard starter and finisher ration to meet their nutrient requirements. Diets of the birds in groups T_1, T_2, T_3 and T_4 were supplemented with guava leaf meal at 0, 1, 2 and 4 % of diet. Cumulative feed intake during 0-3, 0-6 and 4-6 weeks of broiler chicks were significantly ($P<0.05$) higher in T_1 followed by T_2, T_3 and lowest in T_4 groups. FCR of 0-3 weeks among groups was found to be statistically non-significant ($P<0.05$), whereas, at 0-6 weeks better FCR was observed in T_3 followed by T_4 and poor FCR was recorded in T_1 and T_2. Similarly, FCR during 4-6 weeks was significantly ($P<0.05$) better in T_3 followed by T_4, T_2, and lower FCR was recorded in T_1. GLM incorporation did not exert any adverse effect on carcass characteristics, even though, significantly decreased abdominal fat content and improved lymphoid organ weight was noted in gram and percent of live weight. GLM supplementation significantly ($P<0.001$) increased net profit per bird and benefit: cost ratio in T_2, T_3 and T_4 groups as compared to T_1 group. It may be concluded that GLM supplementation at 2 % improved body weight gain, FCR, lymphoid organs weights and reduced feed intake and abdominal fat content. Thus, supplementation of guava leaf meal at 2% in the broiler ration could be a better alternative in terms of producing healthy low fat broiler meat.

Key words: Broilers, Carcass characteristics, Economics, Feed conversion ratio, Guava leaf meal

INTRODUCTION

The synthetic drugs as feed additives in broiler diets are primarily included to improve efficiency of broiler's growth, prevent diseases and improve feed utilization. This leads to improve production, and have been used extensively in intensive broiler farming in order to minimize diseases, and to improve growth and feed utilization. But the prophylactic use of synthetic drugs as feed additives/ growth promoters in broiler production have been banned because of harmful effects (microorganisms resistance against chemical drugs and their residual effect on meat products) on human health. In this context, condensed tannin containing leaf meals (CTLM) could serve as suitable alternatives to synthetic products.

One such CTLM source is *Psidium guajava,* commonly known as guava, which is used as a traditional medicine. Its primary traditional uses include the alleviation of diarrhoea and dehydration. Other uses include treatment of gastroenteritis, dysentery, stomach pain, diabetes mellitus, and wounds. In addition, it is known for its anthelmintic (Pathak *et al.,* 2013a; Pathak *et al.,* 2013b; Pathak *et al.,* 2013c; Pathak *et al.,* 2016) antioxidant (Daing *et al.,* 2017a; Daing *et al.,* 2017b; Pathak *et al.,* 2017; Zargar *et al.,* 2016; Zargar *et al.,* 2017), antibacterial (Daing *et al.,* 2017a; Daing *et al.,* 2017b), anticoccidial (Zargar *et al.,* 2016; Zargar *et al.,* 2017) and anti-inflammatory properties (Qian and Nihorimbere, 2004; Cheng *et al.,* 2009; Han *et al.,* 2011). Guava leaves have CTs with high antioxidant activity, growth promoting and functional feed properties besides playing important role in lowering abdominal fat content and improve broiler performance. Most of its biological activities have been accredited to the presence of CT at lower level. Keeping all these point in view, the present study was planned to assess

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the effect of graded levels of dietary GLM on feed intake, FCR, carcass characteristics and economics of broiler chicks production.

MATERIALS AND METHODS

The experimental was carried out in the Division of Animal Nutrition, Faculty of Veterinary Sciences and Animal Husbandry, R.S. Pura, SKUAST-Jammu. Fresh guava (*Psidium guajava*) leaves were collected from Faculty premises, R.S. Pura, Jammu. They were shed dried to dry matter content of more than 90 percent and stored in a cool, dark and dry place. Dried guava leaves were milled in the laboratory hammer mill.

A total of 120 day-old unsexed and healthy commercial broiler chicks of Cobb-K strains were purchased from Kashmir Valley Poultry Breeding Farm and Hatchery, Jammu. They were randomly distributed into 4 dietary treatment (T_1, T_2, T_3 and T_4) groups of 30 chicks per group, each having 3 replicates of 10 chicks per replicate in an experiment based on CRD. Electric bulbs and gas brooders were used as source of light and heat. On arrival, chicks were given water and feed *ad libitum* but with small amount of feed sprinkled on papers inside brooding area for easier consumption and recognition of feed by chicks up to ten days of age. Temperatures were kept at 32°C for first 7 days and monitored frequently for about 3 times/day *i.e.* in the morning, during the day, and at night. Brooding house and its environments was thoroughly cleaned, washed with detergent, disinfected and fumigated by using standard protocol. After 10 days, they were shifted in 12 deep litter pens. Rice husk was spread on the floor to serve as litter material. All the birds were fed to meet their nutrient requirements as per BIS (1992). Diets of the birds in groups T_1, T_2, T_3 and T_4 were supplemented with guava leaf meal at 0, 1, 2 and 4 % of diet.

The parameters measured were feed intake, body weight, body weight gain, FCR, carcass characteristics and benefit: cost ratio of broiler birds. Average daily feed intake per bird was calculated every morning by subtracting the amount of feed left in feeding trough from what was offered previous day and then dividing it by the number of birds in the replicate. Chicks were weighed at the start of the experiment and weekly thereafter. Chicks in a pen were weighed individually with a digital weighing scale and previous weight was subtracted from the current weight to determine the body weight gain per bird for the week. The FCR was calculated by dividing the feed consumed by the live weight gain.

Samples of GLM, feed offered, residue left and faeces voided were analyzed for proximate composition *viz.* dry matter (DM), organic matter (OM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) as per standard protocol (AOAC, 1995). Samples were also subjected to analysis of calcium (Ca) and phosphorus (P) as per methods described by Talpatra *et al.* (1940) and AOAC (2000), respectively. A representative sample of GLM was analyzed for CT content as per butanol HCl method (Makkar, 2000). The metabolizable energy (ME) content (kcal/Kg) of GLM and experimental broiler diets was calculated according to the formula of Pauzenga (1985).

$$ME = 37 \times \%\ CP + 81 \times \%\ EE + 35.5 \times \%\ NFE$$

Carcass evaluation was done at the end of experimental feeding trial of 42 days. Two birds from each replicate were randomly selected for carcass evaluation. The birds were starved overnight to empty the crop and were put in slaughtering trough and the head cut. The following measurements were taken for the carcass analysis *viz.* live weight, slaughtered weight, de-feathered weight, eviscerated weight, shank, head, neck, heart, liver, lungs, empty gizzard, thymus, bursa, spleen and empty intestine weights *etc.* All these were calculated as such (in grams) and as percent of the live weight of the bird. The economics of broiler chicks with and without GLM supplemented diets was calculated at the end of feeding trial of 6 weeks as per standard protocol.

The data obtained were subjected to analysis of variance and treatment means were ranked using Duncan's multiple range tests (Snedecor and Cochran, 2004) using SPSS version 16.0 for windows. Significance was declared at P<0.05 unless otherwise stated.

RESULTS AND DISCUSSION

The ingredients and chemical composition of experimental broiler (starter and finisher) diets have been presented in Table 1. The CT content of GLM was 83.4 g/kg DM, which is confirmatory with the findings of previous workers (Khan *et al.,* 2019; Pathak *et al.,* 2015; Singh *et al.,* 2015). Birds of T_1 group were fed with basal diet (Control: GLM 0 % of diet) while T_2, T_3 and T_4 groups were fed by replacing crushed maize with GLM @ 1, 2 and 4 percent of diet or 10, 20 and 40 g/kg of diet, respectively. Dietary incorporation of GLM @ 0, 1, 2 and 4 % by replacing maize slightly changed the nutrient values of experimental diets of T_1, T_2, T_3 and T_4. As the level of GLM in the diet increased the concentration of CT increased and nutrient composition very slightly decline in T_2, T_3 and T_4 groups compared to T_1 group but they remained within the permissible range (BIS, 1992).

Growth pattern (average body weights) of experimental broiler chicks of various groups (T_1, T_2, T_3 and T_4) at weekly interval is depicted in figure 1. Average body weights among groups were statistically

Table 1. Ingredients and chemical composition of experimental broiler diets

Attributes	Experimental diets							
	Broiler Starter				Broiler finisher			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Ingredient composition (g/kg)								
Crushed Maize	500	490	480	460	540	530	520	500
Rice polish	45	45	45	45	80	80	80	80
Soybean meal	400	400	400	400	315	315	315	315
Soybean oil	15	15	15	15	25	25	25	25
DCP	15	15	15	15	15	15	15	15
LSP	10	10	10	10	10	10	10	10
Common salt	5	5	5	5	5	5	5	5
*Premix	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
L-Lysine	3.6	3.6	3.6	3.6	3.3	3.3	3.3	3.3
DL-Methionine	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6
GLM % of diet	0	1	2	4	0	1	2	4
Chemical composition (g/kg)								
OM	929.7	929.2	924.8	920.7	924.8	921.7	924.0	919.7
CP	229.2	229.7	227.1	226.6	200.4	199.1	199.5	198.9
EE	44.4	42.3	44.3	44.0	60.2	60.0	59.3	58.4
CF	39.6	40.3	43.2	46.9	47.4	49.3	46.0	52.6
NFE	616.5	616.9	610.2	603.2	616.8	613.3	619.2	609.8
TA	70.3	70.8	75.2	79.3	75.2	78.3	76.0	80.3
AIA	26.2	23.7	25.2	27.7	25.3	24.9	25.8	27.0
Ca	15.1	15.8	16.4	17.6	15.6	15.2	16.5	18.4
P	6.9	6.7	6.0	5.8	6.3	6.4	5.9	5.6
ME (kcal/kg)	2803	2799	2795	2787	2907	2894	2882	2866
CT (g/kg)	0.0	0.80	1.62	3.23	0.0	0.83	1.65	3.30

*Per kg diet provide Manganese, 90 mg; zinc, 80 mg; iron, 90 mg; iodine, 2 mg; copper, 15 mg; selenium, 0.3 mg; vitamin A, 10,000 IU; vitamin D_3, 2500 IU; vitamin K_3, 1 mg; vitamin E, 8 mg; vitamin B_1, 8 mg; vitamin B_2, 5 mg; vitamin B_6, 1.6 mg; vitamin B_{12}, 20.5 mcg; niacin, 12 mg; folic acid, 0.8 mg and calcium pantothenate, 8 mg

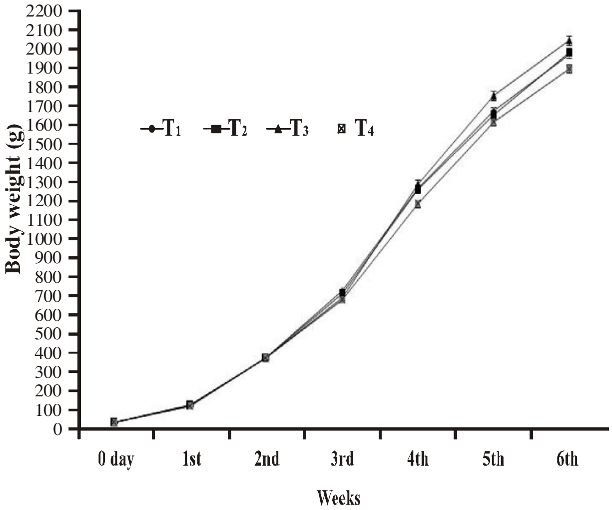

Fig. 1. Growth pattern of broiler chicks fed with and without GLM supplemented diets

similar up to 3rd weeks of age. However, body weight differed significantly (P<0.05) irrespective of groups after 3rd weeks onwards. Furthermore, significantly (P<0.05) higher mean body weight was obtained in T_3 followed by T_1 and T_2 and minimum body weight was observed in T_4, while, body weight of birds of groups T_1 and T_2 did not differ significantly.

Cumulative feed intakes during 0-3, 0-6 and 4-6 weeks of broiler chicks were significantly (P<0.05) higher in T_1 followed by T_2, T_3 and lowest feed intake was recorded in T_4 groups (Table 2). Reduction in feed intake may be due to the GLM used in this study that contained high concentration (3.23-3.33 g/ kg diet) of CT. The CT having astringent property, at higher level it bind with glycol-proteins of the saliva and other nutrients, such complex causes a sensation in the oral cavity, which greatly reduced palatability and hence tends to depress the feed intake in broiler birds. Similar results have been reported before (Douglas *et al.,* 1993; Hassan *et al.,* 2003). However, present results are contradictory to the findings of Rahman *et al.* (2013) who found that GLM up to 4.5% dietary level had no detrimental effect on feed consumption.

Cumulative weight gains during 0-3, 0-6 and 4-6 weeks were found to be highest in T_3 followed by T_1, T_2 and lowest in T_4 (Table 2). The present findings showed that up to 2 % of GLM inclusion in the diets of broiler chicks had no adverse effect on body weight gain even though the feed intake was lower in this group, indicating that CT containing GLM act as natural feed additives and showed beneficial effects on body weight gain. The present results are in agreement with the findings of Rahman *et al.* (2013). They reported no deleterious effect of guava leaf meal on body weight gain up to 4.5 % level of dietary inclusion in broiler chicks.

Table 2. Effect of GLM supplementation on cumulative feed intake, body weight gain and FCR

Age	Group				SEM	P Value
	T_1	T_2	T_3	T_4		
Feed intake						
0-3 weeks	1084^{d}	1068^{c}	1016^{b}	983^{a}	3.70	0.001
4-6 weeks	2690^{d}	2668^{c}	2580^{b}	2477^{a}	7.70	0. 001
0-6 weeks	3774^{d}	3736^{c}	3596^{b}	3460^{a}	11.37	0.001
Body weight gain						
0-3 weeks	685^{b}	671^{ab}	654^{ab}	637^{a}	5.94	0.025
4-6 weeks	1230^{a}	1255^{a}	1337	1206^{a}	12.10	0.001
0-6 weeks	1916^{b}	1926^{b}	1991^{c}	1844^{a}	11.06	0.001
Feed conversion ratio (FCR)						
0-3 weeks	1.59	1.61	1.57	1.56	0.01	0.627
4-6 weeks	2.21^{c}	2.14^{bc}	1.95^{a}	2.08^{b}	0.02	0.001
0-6 weeks	1.97^{c}	1.95^{c}	1.81^{a}	1.88^{b}	0.01	0.001

^{a,b,c,d} Means with different superscripts within a row differ significantly (P<0.05)

However, El-Deek *et al.* (2009) reported that broiler body weight gain at 8 weeks showed non-significant difference at 2 or 4% levels of guava by-products, raw or treated, in comparison with control.

The cumulative FCR of 0-3 weeks among groups was found to be statistically non- significant (P<0.05), whereas, FCR of 4-6 was found to be better in T_3 followed by T_4, T_2 and worse FCR was recorded in T_1, while T_2 has an intermediate value between T_1 and T_4. Similarly, FCR at 0-6 weeks was better in T_3 followed

Table 3. Effect on carcass characteristics of broiler chicks fed GLM supplemented diets

Parameters	Groups				SEM	P Value
	T_1	T_2	T_3	T_4		
Live weight (g)	1724	1776	1890	1846	32.59	0.293
De-feathered weight (g)	1315	1372	1466	1426	26.68	0.210
% of live weight	76.29	77.25	77.53	77.27	0.24	0.280
Slaughter weight (g)	1645	1708	1820	1743	31.55	0.268
% of live weight	95.42^b	96.19^c	96.29^c	94.44^a	0.24	0.014
Eviscerated weight (g)	1146	1195	1345	1212	34.87	0.219
% of live weight	66.40	67.30	71.12	65.54	1.27	0.442
			Carcass			
Feather (g)	228.00	239.50	243.17	231.17	3.64	0.441
% of live weight	13.28	13.49	12.94	12.59	0.23	0.545
Head (g)	35.00	42.67	43.17	41.17	1.46	0.173
% of live weight	2.03	2.41	2.26	2.25	0.07	0.273
Neck (g)	52.17	55.00	54.17	52.00	1.58	0.897
% of live weight	3.03	3.09	2.88	2.84	0.09	0.756
Thigh (g)	83.67	90.33	91.67	82.17	2.59	0.500
% of live weight	4.84	5.08	4.84	4.44	0.11	0.196
Shank (g)	32.00	32.67	34.67	27.83	1.32	0.329
% of live weight	1.86	1.84	1.82	1.52	0.07	0.220
Breast (g)	430.67	450.33	479.67	456.67	12.07	0.580
% of live weight	24.94	25.36	25.33	24.69	0.35	0.904
Drumstick (g)	75.00	81.17	85.00	78.50	2.09	0.403
% of live weight	4.35	4.57	4.51	4.23	0.08	0.420
Wings (g)	48.67	51.17	55.33	51.00	1.53	0.505
% of live weight	2.82	2.89	2.94	2.75	0.07	0.815
Abdominal fat (g)	8.00^c	5.50^b	4.33^a	5.50^b	0.38	0.001
% of live weight	0.47^c	0.31^b	0.23^a	0.30^b	0.02	0.001
Organs						
Gizzard (g)	31.50	34.50	34.33	35.67	1.57	0.832
% of live weight	1.83	1.94	1.81	1.91	0.07	0.910
Heart (g)	6.50	7.17	7.33	8.50	0.37	0.297
% of live weight	0.38	0.40	0.40	0.46	0.02	0.563
Liver (g)	28.50	29.33	29.67	30.00	0.93	0.956
% of live weight	1.65	1.65	1.57	1.63	0.05	0.941
Intestine (g)	48.33^a	56.33^b	62.83^c	74.17^d	2.69	0.001
% of live weight	2.82^a	3.17^b	3.32^c	4.06^d	0.14	0.008

^{a,b,c}Means with different superscripts within a row differ significantly (P<0.05)

Table 4. Effect of GLM supplementation on lymphoid organs weight

Parameters	Group				SEM	P Value
	T_1	T_2	T_3	T_4		
Live weight (g)	1914	1864	2147	1934	46.03	0.080
Thymus (g)	6.65^a	7.56^a	11.37^c	9.68^b	0.57	0.001
% live weight	0.35^a	0.41^b	0.53^c	0.50^c	0.02	0.001
Spleen (g)	5.67^a	6.33^{ab}	7.67^b	7.33^b	0.30	0.043
% live weight	0.29^a	0.34^{ab}	0.36^b	0.38^b	0.01	0.032
Bursa (g)	5.78	7.16	7.45	7.03	0.26	0.069
% live weight	0.30^a	0.38^b	0.35^{ab}	0.36^b	0.01	0.043

^{a,b,c}Means with different superscripts within a row differ significantly (P<0.05)

by T_4 and worse FCR was obtained in T_1 and T_2, however, differences between T_1 and T_2 were statistically non-significant (Table 2). The results indicate that there was no detrimental effect on mean FCR after feeding up to 4 percent level of GLM. Present results are similar to the findings of Rahman *et al.* (2013). They observed that the broiler fed diet with 4.5 % guava leaf meal utilized their diet efficiently and maintained FCR that was comparable to control. It is clearly indicated that the broiler production was more profitable and economical in GLM supplemented diets.

Data on carcass characteristics of experimental broiler chicks are presented in the Tables 3 and 4. Dietary supplementation of GLM at 0, 1, 2 and 4% level did not exert any adverse effect on carcass characteristics measurements of broiler chicks except slaughter weight in percent of live weight.

The slaughter weight (% of live weight) was significantly (P<0.05) higher in T_2 and T_3 followed by T_1, while the least slaughter weight was observed in T_4. However, the slaughter weight between T_2 and T_3 was statistically similar. Other carcass characteristics *viz.* feathers weight, head, neck, thigh, shank, breast, drumstick, wings, gizzard, heart and liver weights in gram as well as in percent of their live weights did not differ significantly (P<0.05) among groups.

Dietary supplementation of CT containing GLM significantly (P<0.05) reduced abdominal fat weight in

Table 5. Economics of broiler chickens fed CT containing guava leaf meal based diets

Parameters	Group				SEM	P Value
	T_1	T_2	T_3	T_4		
Total body weight (kg)	1.96^b	1.97^b	2.04^c	1.89^a	0.09	0.001
Total feed intake (kg)	3.773^c	3.736^c	3.596^b	3.460^a	0.04	0.001
Feed cost (₹) / kg diet	29.05	28.89	28.73	28.41	1.18	0.194
Total feed cost (₹)/ bird	109.61^d	107.93^c	103.31^b	98.30^a	0.07	0.001
Cost of chicks (₹)	15	15	15	15	-	-
Bird selling rate (₹) / kg	89	89	89	89	-	-
Revenue ₹ / bird	174.44^b	175.33^b	181.56^c	168.21^a	1.05	0.001
Investment ₹ / bird	124.61^c	122.93^c	118.31^b	113.30^a	0.16	0.001
Net return/ profit (₹) / bird	49.83^a	52.40^{ab}	63.25^c	54.91^b	0.05	0.001
% Profit from GLM	0.00^a	5.16^b	26.93^d	10.19^c	1.02	0.004
Benefit: cost ratio	1.40:1^a	1.43:1^{ab}	1.53:1^c	1.48:1^b	0.01	0.001

^{a,b,c,d} Means with different superscripts within a row differ significantly (P<0.001) treatment groups as compared to control group. The lowest abdominal fat contents were obtained in T_3 followed by $T_2$and T_4, whereas, the highest abdominal fat content was recorded in T_1 group. Hafeni (2013) also reported similar results related to fat content and concluded that more than 5 g/kg of CT containing *A. karroo* leaf meal should be supplemented in order to achieve a significant reduction of fat deposition in Cobb 500 broiler chickens. The reduction of fatness has been associated with lower concentration of growth hormone (GH) when the diets were sprayed with polyethylene glycol. The GH increase nitrogen retention and reduce fat deposition, with an increase in fat turn over. The reason for the higher level in plasma GH has been explained with a possible inactivation of gut wall proteins by CT. The intestine weight in grams and percent of live weight increased significantly ($P<0.05$) as the GLM levels increased in the diets of broiler chicks.

The intestine weights were significantly ($P<0.05$) higher in T_2, T_3 and T_4 groups than that of T_1 group. It might be due to GLM supplemented diets takes more time for digestion of feed as well as increase the length of intestine compared to control group, therefore, increase the weight of intestine in supplemented groups. Comparable mean live weight and significantly ($P<0.05$) higher lymphoid organs (thymus, bursa and spleen) weights and their size were recorded in GLM supplemented groups as compared to their counterpart control group. Thus, the supplementation of GLM in broiler diets significantly ($P<0.05$) increased lymphoid organ weight and their size which might be due to immune modulating properties of CT.

Data related to feed cost are presented in Table 5. At the end of feeding trial of 6 weeks, final body weight (kg) was found to be highest in T_3 group followed by T_1 and T_2 groups and the least final body weight was recorded inT_4 group, while final body weights between T_1 and T_2 groups were statistically similar. However, GLM supplementation significantly ($P<0.05$) reduced total feed intake and total feed cost per bird in T_3 and T_4 groups as compared to un-supplemented T_1 group, while, total feed intake was statistically non-significant between T_1 and T_2 groups.

Although, feed cost (₹) per kg diet among groups did not differ significantly. As the level of GLM supplementation increased the total feed intake and total feed cost per bird decreased significantly ($P<0.001$). The degree of reduction in the cost of total feed consumed at the end of feeding trial of 6 weeks was proportional to the amount of GLM in broiler diets. The price of day-old chick was ₹ 15 per chick and the selling rate of bird at the end of experiment of 6-weeks was ₹ 89 per kg bird. Furthermore, revenue generated in ₹ per bird as well as investment in ₹ per bird were significantly ($P<0.001$) lower in GLM supplemented (T_3 and T_4) groups as compared to T_1 and T_2 groups, but the revenue generated and investment were statistically similar between T_1 and T_2 groups. Dietary supplementation of GLM significantly ($P<0.001$) increased net return or profit per bird and benefit: cost ratio in T_2, T_3 and T_4 groups as compared to un-supplemented T_1 group. The net profit per bird and benefit: cost ratio was found maximum in T_3 followed by T_4, while, minimum net profit per bird and benefit: cost ratio was recorded in T_1 group, whereas T_2 has an intermediate value between T_1 and T_4 groups.

The net profit made in the present study ranged from ₹ 49.83 to 63.25 per bird. As the level of GLM increased percent profit increased significantly ($P<0.004$) and the highest profit was obtained in T_3 group which clearly indicated that dietary supplementation of GLM (2% of diet) improved productive performance and cost effective partial replacer of costlier maize without any deleterious effect on broiler production.

CONCLUSION

It may be concluded that dietary incorporation of guava leaf meal (2 %) in broiler diet improved body weight gain, FCR, lymphoid organs weights, and reduced feed intake and abdominal fat content. Thus, supplementation of guava leaf meal at 2% in the broiler ration could be a better alternative in terms of producing healthy low fat broiler meat.

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REFERENCES

AOAC. 1995. *Official Methods of Analysis* (16th edn.). Association of Official Analytical Chemists. Washington, DC.

AOAC. 2000. *Official Methods of Analysis* (16th edn.). Association of Official Analytical Chemists. Washington, DC.

BIS. 1992. Bureau of Indian Standards. *Requirements for Chicken Feeds*. IS 1374-1992. Manak Bhavan, 9, Bhadursha Zafar Marg, New Delhi. pp. 1-3.

Cheng, F.C., Shen, S.C. and Wu, J.S.B. 2009. Effect of guava (*Psidium guajava L.*) leaf extract on glucose uptake in rat hepatocytes. *J. Food Sci*. 74: 132-138.

Daing, Mohd. Iqbal, Pathak, A.K., Bhat, Mohd. Altaf, and Zargar and Mohd. Aqib 2017a. Antioxidant and antibacterial potential of condensed tannins containing tree leaves extract. *Vet. Pract.*18: 118-121.

Daing, Mohd. Iqbal, Pathak, A.K., Bhat, Mohd. Altaf, Sharma, R. K. and Zargar, Mohd. Aqib 2017b. *In vitro* antioxidant and antibacterial efficacy of condensed tannins containing tree leaves extract of Jammu Province. *J. Anim. Res.*7: 165-174.

Douglas, J.H., Gonzalez, N.J. and Beck, M.M. 1993. Differential age response of turkeys to protein and sorghum tannin levels. *Poult. Sci.* 72: 1944-1951.

El-Deek, A.A., Asar, M.A., Hamdy, S.M. and Abdalla, A.A. 2009. Utilization of guava by-products in broiler finisher diets. *Poultry Prod. Dept., Fac. of Agric. Alexandria University, Alex. Egypt. Poult. Sci.*29: 53-75.

Hafeni, S. 2013. *Performance of broiler chickens fed pearl millet as an energy source and Acacia karroo leaf meal as an additive*. M.Sc. Thesis, University of Namibia.

Han, E.H., Hwang, Y.P., Choi, J.H., Yang, J. H. and Seo, J. K. 2011. *Psidium guajava* extract inhibits thymus and activation-regulated chemokine (TARC/CCL17) production in human keratinocytes by inducing heme oxygenase-1 and blocking NF-κB and STAT1 activation. *Environ. Toxicol. Pharmacol.*32: 136-145.

Hassan, I.A., Elzuber, E.A. and Tinay, H.A. 2003. Growth and apparent absorption of minerals in broiler chicks fed diets with low or high tannins content. *Trop. Anim. Hlth. Prod*. 35: 189-196.

Khan, Muzaffer, Pathak, A.K. and Singh, Surender 2019. Nutrient metabolism, blood Indices and Immunity in *Haemonchus contortus* infected goats fed condensed tannins enriched densified complete feed blocks. *Anim. Nutr. Feed Technol.* 19: 417-430.

Makkar, H.P.S. 2000. Quantification of tannins in tree foliage. Joint FAO/IAEA working document, IAEA, Viena. Pp 1-26.

Pathak, A.K., Dutta, N., Banerjee, P.S. and Sharma, K. 2013b. Effect of tannin extracts from tropical tree leaves on larvae and adult *Haemonchus contortus*. *Indian Vet. J.* 90: 32-34.

Pathak, A.K., Dutta, N., Banerjee, P.S., Pattanaik, A.K. and Sharma, K. 2013a. Influence of dietary supplementation of condensed tannins through leaf meal mixture on nutrient intake, utilization and performance of *Haemonchus contortus* infected sheep. *Asian-Australas. J. Anim. Sci.*26: 1446-1458.

Pathak, A.K., Dutta, N., Pattanaik, A.K., Sharma, K., Banerjee, P.S. and Goswami, T.K. 2017. Effect of condensed tannins supplementation through *Ficus infectoria* and *Psidium guajava* leaf meal mixture on erythrocytic antioxidant status, immune response and gastro-intestinal nematodes in lambs (*Ovis aries*). *Vet. Archiv.*87: 139-156.

Pathak, A.K., Dutta, Narayan, Banerjee, P.S., Sharma, K. and Pattanaik, A.K. 2013c. Efficacy of various condensed tannins extracts from tanniferous tree leaves on egg hatching inhibition of *Haemonchus contortus*. *Vet. Pract.*14: 127-129.

Pathak, A.K., Dutta, Narayan., Banerjee, P.S., Goswami, T.K. and Sharma, K. 2016. Effect of condensed tannins supplementation through leaf meal mixture on voluntary feed intake, immune response and worm burden in *Haemonchus contortus* infected sheep. *J. Parasitic Dis.*40: 100-105.

Pathak, A.K., Dutta, N., Pattanaik, A. K., Singh, A., Narang, A. and Sharma, K. 2015. Effect of condensed tannins supplementation from tanniferous tree leaves on methane production and efficiency of biomass production *in vitro*. *Anim. Nutr. Feed Technol.* 15: 91-100.

Pauzenga, U. 1985. Feeding Parent Stock. *Zootec. Int.,* pp. 22-24.

Qian, H., and Nihorimbere, V. 2004. Antioxidant power ofphytochemicals from Psidium guajava. *J. Zhejiang Univ. Sci.*5:676-683.

Rahman, Z., Siddique, M.N., Khatun, M.A., Kamruzzaman,

M. 2013. Effect of Guava *(Psidium guajava)* leaf meal on production performances and antimicrobial sensitivity in commercial broiler. *J. Nat. Prod.*6: 177-187.

Singh, S., Pathak, A.K., Sharma, R.K. and Khan, M. 2015. Effect of tanniferous leaf meal based multi nutrient blocks on feed intake, haematological profile, immune response and body weight changes in *Haemonchus contortus* infected goats. *Vet. World* 8: 572-579.

Snedecor, G.W. and Cochran, W.G. 2004. *Statistical Methods*. 8th edn. East West Press Pvt. Ltd., New Delhi.

Talpatra, S.K., Ray, S.C. and Sen, K.C. 1940. Estimation of phosphorus, chlorine, calcium, magnesium, sodium and potassium in foodstuffs. *Indian J. Vet. Sci. Anim. Husb.*10: 243-258.

Zargar Mohd. Aqib, Pathak, A.K. and Daing, Mohd. Iqbal 2017. Screening and evaluation of antioxidants and anticoccidial properties of condensed tannins containing tree leaves of Jammu province. *Indian J. Anim. Res.*51: 1105-1112.

Zargar, Mohd. Aqib, Pathak, A.K., Sharma, R.K. and Daing, Mohd. Iqbal 2016. Antioxidants and Anticoccidial potential of aqueous extract from various tree leaves containing condensed tannins. *J. Anim. Res.*6: 563-570.

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