



## Effect of Dietary Inclusion of Turmeric (*Curcuma longa*) and Garlic (*Allium sativum*) Powders as Feed additives on Performance of Broiler Chicken

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### ABSTRACT

The present study was conducted to evaluate the effect of dietary inclusion of garlic, turmeric and their combinations on performance of broilers (Cobb strain). Two hundred and forty day-old unsexed broiler chicks were procured and randomly divided into five dietary treatment groups (n=48). Birds in control (C) group were administered antibiotic levofloxacin at 2.5 g/l of drinking water, however, antibiotic was replaced with dietary inclusion of either 1% turmeric (T<sub>1</sub>), 1% garlic (T<sub>2</sub>), 0.6% turmeric+0.4% garlic (T<sub>3</sub>), or 0.6% garlic+0.4% turmeric (T<sub>4</sub>). The diets formulated were isocaloric and isonitrogenous. The feeding trial was conducted for 6 weeks. The results revealed significantly (P<0.05) higher cumulative feed intake in group T<sub>3</sub>, while body weight gain (g) showed no difference (P>0.05) among groups. Feed conversion ratio was found to be better in groups T<sub>2</sub> and T<sub>4</sub>. Protein efficiency ratio was found to be higher in group T<sub>2</sub> (P<0.05). The villi length of duodenum; epithelial and glandular epithelial height of jejunum, glandular epithelial height and diameter of glands of ileum were higher (P<0.05) in group T<sub>2</sub>. The 1% garlic supplemented group showed the best cost benefit ratio. It was concluded that 1% garlic powder supplementation in the diet may substitute antibiotics without any adverse effect in broilers.

**Key words:** Antibiotics, Broilers, Feed additives, Garlic, Turmeric

### INTRODUCTION

Antibiotic growth promoters (AGP) had been intensively used in broiler ration to improve productivity, because it stimulates favorable micro-organisms growth in gastro-intestinal tract and suppress harmful micro-organisms besides improving nutrient absorption. Antibiotics can be used successfully at sub-therapeutic doses in poultry ration to promote growth (Chattopadhyay, 2014). But residues of AGP may transmit to the products causing anti-bacterial resistance which is a serious public health concern. In response, many countries have banned the use of AGP in livestock and poultry feed. Under these circumstances, poultry nutritionist is looking for alternatives of AGP. Phyto-genic feed additives (PFA) are defined as group of natural growth promoters (NGPs) or non-antibiotic growth promoters used as feed additives, derived from herbs, spices or other plants (Yitbarek *et al.*, 2015).

Research on the topic done so far indicates that PFA can suitably replace AGP without any adverse impact on production performance of poultry. These additives contain numerous bio-active ingredients (alkaloids, glycosides, flavonoids, mucilage, etc) which have favorable effect on poultry performance mediated through stimulation of appetite, improvement of endogenous enzyme secretion and positive modulation of immune response (Toghyani *et al.*, 2011).

Turmeric (*Curcuma longa*) and garlic (*Allium sativum*) are universally accessible herbs having beneficial effects on broiler performance (Rajput *et al.*, 2012). Turmeric has antioxidant, anti-bacterial, anti-viral, anti-protozoal, anti-fungal, anti-inflammatory, anti-carcinogenic, anti-hypertensive and hypocholesteremic activities (Chen and Huang, 2009) and its active ingredients are curcumin, demethoxycurcumin, bisdemethoxycurcumin and tetrahydrocurcumin (Huang

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*et al.*, 1995). Earlier researchers have reported that supplementation of turmeric up to 1% in the diet positively affected the performance of broiler chickens (Singh *et al.*, 2018). Active principle present in garlic includes allicin, alliin, ajoene, diallylsulphide, dithiin and s-allylcysteine that renders it functional properties (Batiha *et al.*, 2020). Garlic has anti-bacterial, anti-inflammatory, antiseptic, anti-parasitic and immuno-modulatory properties. Its use in poultry diet up to 1% level improved body weight gain (BWG), digestibility of feed, decreased bad cholesterol and augmented meat quality parameters (Eltazi *et al.*, 2014).

As garlic and turmeric own different active principles, their combination may have synergistic effect on the performance of broiler chicken. Therefore, the present study was undertaken to ascertain the effect of turmeric and garlic powders supplementation either alone or in combinations as feed additives.

## MATERIALS AND METHODS

Present study was conducted at Division of Animal Nutrition, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Jammu, India. Two hundred and forty day-old, unsexed broiler chicks (Cobb

strain) were randomly distributed into five treatment groups (n=48) in an experiment based on completely randomized design (CRD). Each group had four replicates *i.e.*, twelve birds per replicate. Iso-caloric and iso-nitrogenous diets (maize-soya based basal diet) were formulated to meet nutrient requirement as per ICAR (2013). Birds of the control (C) group were administered antibiotic (Levofloxacin at 2.5 g/l drinking water). However, antibiotic was replaced with dietary inclusion of either 1% turmeric (T<sub>1</sub>), 1% garlic (T<sub>2</sub>), 0.6% turmeric+0.4% garlic (T<sub>3</sub>), or 0.6% garlic+0.4% turmeric (T<sub>4</sub>). All chicks were brooded on partitioned deep litter house. The day old chicks procured were pre-vaccinated against Marek's disease and were vaccinated as per standard vaccination schedule. Entire experiment lasted for six weeks under scientific management system and *ad libitum* water was offered.

Turmeric and garlic were purchased from local market and were dried and grinded to be used in powdered form. The ingredient composition for broiler pre-starter, starter and finisher feed and their chemical composition is presented in Table 1, 2 and 3, respectively. The birds were weighed periodically (0,

**Table 1. Ingredient composition (%) of basal diet**

Ingredients	Experimental Diets		
	Pre-starter	Starter	Finisher
Maize	60.5	60.88	67.5
Meat-bone meal	5	5	5
Soya bean meal	31.08	30.36	24.5
Salt	0.25	0.25	0.25
Sodium bicarbonate	0.01	0.01	0.01
Soya bean oil	2	2.6	2.2
DL-Methionine	0.17	0.13	0.09
Lysine	0.12	0	0
Di-calcium phosphate	0.13	0	0
Lime stone powder	0.59	0.54	0.29
Vitamin supplement <sup>1</sup>	0.05	0.05	0.05
Trace minerals <sup>2</sup>	0.1	0.1	0.1

<sup>1</sup>Each kg of premix contains vitamin A- 50m IU, vitamin D<sub>3</sub>- 14m IU, vitamin E- 20 g, vitamin K<sub>3</sub>-8g, vitamin B<sub>1</sub>- 3.2 g, vitamin B<sub>2</sub>-32g, vitamin B<sub>12</sub>-0.024g, calcium D pantothenate- 16 g, niacin- 28g, vitamin B<sub>6</sub>- 3.6 g, folic acid- 5.6 g, biotin- 0.2g; <sup>2</sup>Each kg contains copper-15 g, iodine-2 g, iron-90 g, manganese-100 g, selenium-0.3 g, zinc-80 g

**Table 2. Proximate composition of feed ingredients and additives (on % dry matter basis)**

Ingredients	Crude protein	Ether extract	Crude fibre	Total ash	Nitrogen free extract
Maize	9.15	4.01	2.11	1.51	83.22
Soybean meal	45.5	5.4	7.58	8.09	33.43
Meat bone meal	47.79	7.71	9.05	21.41	14.04
Turmeric powder	9.14	5.59	4.32	3.82	77.13
Garlic powder	18.48	0.57	3.22	4.74	72.99

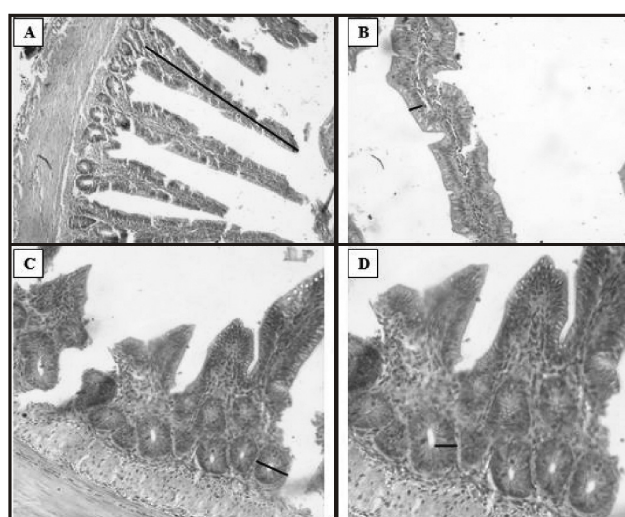
14, 21 and 42 days of age) and average feed intake was calculated. Feed samples were analyzed for proximate principles as per AOAC (2012). At the end of trial, eight birds per group (two birds/replicate) were randomly picked up, slaughtered, and tissues were collected from intestines for histology and micrometry. The tissue samples collected upon slaughter were fixed in 10% neutral buffered formalin solution for histomorphological processes (Luna, 1968). The micrometrical observations were recorded on haematoxylin and eosin stained sections. The micrometrical observations were epithelial height ( $\mu\text{m}$ ), glandular epithelial height ( $\mu\text{m}$ ), diameter of gland ( $\mu\text{m}$ ) and length of villi ( $\mu\text{m}$ ) (Fig. 1). Statistical analysis was done as per Snedecor and Cochran (1994). The means in different treatments were subjected to Duncan's multiple range test (1995) for ranking ( $P < 0.05$ ).

## RESULTS AND DISCUSSION

Results revealed that cumulative feed intake (g) of pre-starter phase (0-14 days) showed non-significant difference among different experimental groups (Table 4). But the cumulative feed intake of starter phase (15-21 days) was significantly higher ( $P < 0.05$ ) in control group and was least in groups  $T_2$  and  $T_4$ . However, during finisher phase (22-42 days), feed intake was found to be significantly ( $P < 0.05$ ) higher in group  $T_3$  than C and  $T_2$ , but  $T_1$  and  $T_4$  were statistically similar to  $T_3$ . Also feed intake of  $T_1$  was higher ( $P < 0.05$ ) than C. Likewise, the total feed intake during the entire experimental trial (0-6 weeks) was higher ( $P < 0.05$ ) in group  $T_3$  than C and  $T_2$ , with intermediate values in rest of the groups, suggesting the positive role of turmeric in promoting feed intake. This may be explained in the light of fact that turmeric possesses appetite

stimulant, stomachic and carminative properties, which might be responsible for improved feed intake (Chakraborty *et al.*, 2011). Similar results were reported by earlier researchers on supplementing turmeric in graded levels (Kanani *et al.*, 2016, Ratika *et al.*, 2018). On the contrary, some researchers found no difference in feed intake on turmeric supplementation (Singh *et al.*, 2018). The difference found in the above studies might be due to different dosage of turmeric supplementation, different AGP used in addition to difference of feed ingredients.

Body weight gain (BWG) of pre-starter phase, starter phase as well as for entire trial was statistically similar irrespective of different dietary treatments (Table 4). But during finisher phase, it was higher ( $P < 0.05$ ) in group  $T_3$  as compared to groups  $T_1$  and C with

**Fig. 1. Micrometrical measurements**

- A: Villus height
- B: Luminal epithelial height
- C: Glandular diameter
- D: Glandular epithelial height

**Table 3. Chemical composition of broiler pre-starter, starter and finisher diet (on % dry matter basis)**

Attributes	Pre-starter					Starter					Finisher				
	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
Organic matter	94.86	94.47	94.29	94.02	93.78	95.37	95.29	95.14	95.11	94.87	96.5	94.89	95.76	94.08	94.82
Crude protein	21.64	21.76	21.89	21.79	21.86	21.67	21.75	21.99	21.58	21.84	19.16	19.51	19.67	19.42	19.87
Ether extract	3.19	3.29	3.34	3.41	3.56	4.23	4.32	4.37	4.48	4.59	5.01	5.00	5.03	5.02	5.04
Crude fibre	4.08	4.04	4.07	4.06	4.09	4.2	4.26	4.19	4.32	4.21	4.14	4.17	4.05	4.12	4.30
Total ash	5.14	5.53	5.41	5.98	5.62	4.63	4.71	4.56	4.69	5.63	4.12	4.61	4.24	4.52	4.31
Nitrogen free extract	65.95	65.38	65.29	64.76	64.87	65.27	64.96	64.89	64.93	63.73	67.57	66.68	67.01	66.92	66.48
Ca	1.17	1.15	1.17	1.13	1.2	1.02	1.04	1.09	1.02	1.06	0.98	0.95	0.9	0.92	0.95
P	0.85	0.84	0.82	0.87	0.85	0.8	0.78	0.74	0.76	0.8	0.76	0.73	0.75	0.74	0.78
Metabolizable energy (kcal/kg) calculated	3000	3000	3000	3000	3000	3050	3050	3050	3050	3050	3100	3100	3100	3100	3100

intermediate values for rest of the groups. The above results signified that garlic either alone or in combination with turmeric improves BWG, which may be attributed to active principle allicin (present in garlic). Allicin is responsible for promoting useful intestinal flora. These results are in line with the findings of earlier researchers who reported that garlic supplementation resulted in higher body weight and BWG in broilers (Borgohain *et al.*, 2017). In contrast to our results, Issa and Omer (2012) found no difference in body weight of broilers on garlic supplementation. The differences found might be due to different dosage of garlic supplementation (0.4% vs. 1.0% of basal diet in the current study).

The average FCR of pre-starter and starter phase were similar ( $P>0.05$ ), but during finisher phase and for entire trial, FCR was significantly higher ( $P<0.05$ ) in group T<sub>1</sub> in comparison to rest of the treatments (Table 4). The higher body weight gain and better utilization of feed may be the probable reason for better FCR in garlic supplemented groups. It can be inferred that garlic alone or in combination with turmeric may substitute AGP. But turmeric supplementation alone is not effective. The present results corroborate with the findings of Brzoska *et al.* (2015) and Ratika *et al.* (2018), who too found improved FCR on garlic supplementation. Whereas, some researchers found no difference in FCR while supplementing garlic, turmeric

or their combinations (Choudhury *et al.*, 2018). Contrary to our results, Singh *et al.* (2018) reported comparable FCR in 1% turmeric and AGP fed groups in broilers. In the present study, antibiotic was given through drinking water whereas in the cited study AGP was provided with basal diet, which may be the probable reason for the difference.

Protein efficiency ratio (PER) values of pre-starter and starter phase showed no significant difference among different treatments (Table 4). But during finisher phase PER was found lower ( $P<0.05$ ) in T<sub>1</sub> (2.39) in comparison to rest of the groups (2.49, 2.67, 2.53 and 2.58 in C, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively). However, the PER of entire trial was found higher ( $P<0.05$ ) in T<sub>2</sub> (3.39) than T<sub>1</sub> (3.05) with intermediate values for rest of the groups (2.89, 3.07 and 3.16 in C, T<sub>3</sub> and T<sub>4</sub>, respectively). These results further strengthen the positive role of garlic powder (alone and in combination with turmeric powder (TP)) on growth performance, suggesting that it may substitute AGP. Likewise, Ratika *et al.* (2018) found no significant difference in PER during the first four weeks while supplementing turmeric powder, garlic powder and their combination in basal ration of broilers, but at 5<sup>th</sup> and 6<sup>th</sup> week, PER was higher in 0.5% turmeric powder and 1.5% garlic powder + 0.25% turmeric powder supplemented diet.

Data pertaining to the effect of dietary inclusion

**Table 4. Effect of supplementation of turmeric and garlic powder on cumulative feed intake, body weight gain, feed conversion ratio and protein efficiency ratio of broiler chicken**

Days	Group				
	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
<b>Feed intake (g)</b>					
0-2 weeks	370.37±9.04	369.29±11.35	361.12±13.75	377.51±15.98	339.15±14.30
2-3 weeks	684.24 <sup>b</sup> ±14.48	656.09 <sup>ab</sup> ±16.57	611.41 <sup>a</sup> ±17.54	641.30 <sup>ab</sup> ±13.61	622.31 <sup>a</sup> ±28.16
3-6 weeks	3392.61 <sup>a</sup> ±69.16	3582.43 <sup>bc</sup> ±17.16	3437.61 <sup>ab</sup> ±30.01	3655.85 <sup>c</sup> ±96.09	3525.31 <sup>abc</sup> ±23.02
0-6 weeks	4447.23 <sup>a</sup> ±72.22	4607.83 <sup>ab</sup> ±26.00	4410.15 <sup>a</sup> ±15.32	4674.66 <sup>b</sup> ±50.51	4486.76 <sup>ab</sup> ±53.34
<b>Body weight gain (g)</b>					
0-2 weeks	286.35±7.92	286.43±7.16	290.75±11.21	278.25±12.03	269.00±6.37
2-3 weeks	424.20±9.98	428.65±11.62	443.67±10.23	422.80±3.61	418.55±16.62
3-6 weeks	1506.51 <sup>ab</sup> ±32.84	1482.14 <sup>a</sup> ±27.93	1617.42 <sup>bc</sup> ±56.87	1661.17 <sup>c</sup> ±48.38	1609.47 <sup>abc</sup> ±31.86
0-6 weeks	2217.05±33.17	2197.05±44.05	2351.85±71.79	2362.22±45.90	2307.02±46.30
<b>Feed conversion ratio</b>					
0-2 weeks	1.30±0.06	1.29±0.06	1.25±0.07	1.36±0.08	1.23±0.07
2-3 weeks	1.61±0.05	1.53±0.08	1.38±0.07	1.51±0.04	1.50±0.13
3-6 weeks	2.25 <sup>a</sup> ±0.02	2.42 <sup>b</sup> ±0.05	2.13 <sup>a</sup> ±0.06	2.20 <sup>a</sup> ±0.06	2.19 <sup>a</sup> ±0.04
0-6 weeks	2.00 <sup>ab</sup> ±0.01	2.10 <sup>b</sup> ±0.05	1.88 <sup>a</sup> ±0.01	1.98 <sup>ab</sup> ±0.03	1.95 <sup>a</sup> ±0.06
<b>Protein efficiency ratio</b>					
0-2 weeks	3.53±0.17	3.54±0.16	3.67±0.22	3.37±0.18	3.76±0.22
2-3 weeks	2.89±0.09	2.12±0.05	2.42±0.07	2.33±0.06	2.34±0.04
-6 weeks	2.49 <sup>b</sup> ±0.02	2.39 <sup>a</sup> ±0.06	2.67 <sup>b</sup> ±0.08	2.53 <sup>b</sup> ±0.04	2.58 <sup>b</sup> ±0.07
0-6 weeks	2.89 <sup>ab</sup> ±0.09	3.05 <sup>a</sup> ±0.15	3.39 <sup>b</sup> ±0.17	3.07 <sup>ab</sup> ±0.08	3.16 <sup>ab</sup> ±0.24

<sup>a,b,c</sup>Mean with different superscript within a row differ significantly (P<0.05)

of turmeric and garlic on the micrometry of different components of small intestine *viz.* duodenum, jejunum and ileum are presented in Table 6. In the duodenum,

epithelial height (µm), glandular epithelial height (µm) and diameter of glands (µm) were similar (P>0.05), but the length of villi (µm) of duodenum was higher (P<0.05)

**Table 5. Effect of supplementation of turmeric and garlic powder nutrient intake (g) during metabolism trial of broiler chicken**

Attributes	Groups				
	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
<b>Nutrient intake</b>					
Dry matter	1267.49 <sup>bc</sup> ±13.76	1331.09 <sup>d</sup> ±12.54	1182.69 <sup>a</sup> ±11.90	1292.30 <sup>cd</sup> ±12.39	1246.13 <sup>b</sup> ±20.35
Crude protein	262.82 <sup>abc</sup> ±4.74	272.02 <sup>c</sup> ±5.74	249.67 <sup>a</sup> ±3.45	267.20 <sup>bc</sup> ±3.89	255.78 <sup>ab</sup> ±5.49
Ether extract	68.49 <sup>a</sup> ±2.10	72.32 <sup>c</sup> ±1.19	64.77 <sup>a</sup> ±0.39	70.13 <sup>bc</sup> ±0.56	67.99 <sup>ab</sup> ±0.26
Crude fibre	56.59±2.52	60.39±2.17	52.24±7.68	57.57±6.78	57.68±4.44
Total ash	205.13±2.74	223.99±5.76	200.43±6.55	218.41±13.32	215.35±14.54
Organic matter	1161.98 <sup>bc</sup> ±2.74	1222.57 <sup>d</sup> ±5.76	1088.00 <sup>a</sup> ±6.55	1176.56 <sup>c</sup> ±13.32	1136.38 <sup>b</sup> ±14.54
Nitrogen free extract	888.96 <sup>ab</sup> ±22.47	949.02 <sup>b</sup> ±32.27	823.11 <sup>a</sup> ±26.01	894.80 <sup>ab</sup> ±36.08	803.31 <sup>a</sup> ±41.96

<sup>a,b,c,d</sup>Mean with different superscript within a row differ significantly (P<0.05)

in group T<sub>2</sub> than the rest of the groups. The longer and slender villi lead to an increased surface area which leads to better absorption of nutrients. These results are in line with the findings of earlier researchers, who also found increased villi length on garlic powder supplementation (Purwanti *et al.*, 2014).

While in jejunum, the epithelial height (µm) was observed to be significantly higher (P>0.05) in groups T<sub>2</sub> than T<sub>3</sub> and C. The length of villi showed no significant difference (P>0.05) among different treatments, however glandular epithelial height (µm) was found to be significantly higher (P<0.05) in groups T<sub>2</sub> and T<sub>4</sub> than groups C and T<sub>1</sub>, with intermediate value for group T<sub>3</sub>. But, diameter of gland (µm) was significantly higher (P<0.05) in groups T<sub>4</sub>, T<sub>3</sub> and T<sub>2</sub> than in T<sub>1</sub> and C.

In ileum, epithelial height (µm) and length of villi (µm) showed no significant difference among groups. Glandular epithelial height (µm) was lower in C than

rest of the groups. But, the diameter of gland (µm) was significantly higher in groups T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> as compared C. Adibmoradi *et al.* (2006) observed that feeding of garlic meal significantly decreased epithelial thickness in different sections of small intestine. The above differences may be owed to the fact that garlic meal was used in the study by the above researcher whilst garlic powder was being used in the current study. Also, Rajput *et al.* (2012) reported that the dietary supplementation of turmeric powder at the rate of 0.2 g/kg increased villus length of broiler chicken at 42 days of age. It has also been found that above mentioned micrometrical parameters were better in duodenum than jejunum and ileum. The diameter of glands in different sections of small intestine was higher in garlic powder fed groups which signifies increased activity of these glands *i.e.*, increased secretion of mucin which is essential for integrity of mucinous lining of intestinal epithelium and easy passage of the ingesta (Schneeman, 1982). Thus,

**Table 6. Effect of supplementation of turmeric and garlic powder on micrometry of different components of small intestine of broiler chicken**

Attributes	Groups				
	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
<b>Duodenum</b>					
Epithelial height (µm)	28.33±2.00	31.78±2.09	32.24±1.38	32.02±2.24	31.97±1.44
Length of villi (µm)	1116.38±25.61	1138.53±15.66	1224.85±18.41	1146.47±32.50	1157.28±29.84
Glandular epithelial height (µm)	23.23±1.24	23.68±0.87	25.65±1.15	25.37±0.93	24.04±1.12
Diameter of glands (µm)	71.67±5.85	70.04±4.12	96.54±7.66	84.12±6.35	82.15±6.15
<b>Jejunum</b>					
Epithelial height (µm)	21.60 <sup>a</sup> ±1.32	23.79 <sup>ab</sup> ±1.67	26.67 <sup>b</sup> ±1.46	21.85 <sup>a</sup> ±0.63	23.60 <sup>ab</sup> ±1.28
Length of villi (µm)	630.51±16.98	618.61±14.27	652.88±17.69	632.57±10.63	659.12±15.49
Glandular epithelial height (µm)	19.74 <sup>a</sup> ±0.74	20.81 <sup>a</sup> ±0.48	23.83 <sup>b</sup> ±1.81	21.50 <sup>ab</sup> ±0.90	23.40 <sup>b</sup> ±0.42
Diameter of glands (µm)	65.09 <sup>a</sup> ±4.52	62.48 <sup>a</sup> ±2.99	76.77 <sup>b</sup> ±4.00	77.19 <sup>b</sup> ±5.80	78.77 <sup>b</sup> ±1.64
<b>Ileum</b>					
Epithelial height (µm)	21.00±0.87	22.25±0.99	24.08±1.47	22.76±0.72	23.73±0.93
Length of villi (µm)	201.93±19.45	215.50±18.10	226.08±15.41	212.60±13.01	207.90±14.52
Glandular epithelial height (µm)	16.57 <sup>a</sup> ±0.98	19.71 <sup>b</sup> ±0.75	20.90 <sup>b</sup> ±1.40	21.25 <sup>b</sup> ±1.67	20.34 <sup>b</sup> ±1.23
Diameter of glands (µm)	51.19 <sup>a</sup> ±5.09	60.33 <sup>ab</sup> ±6.32	73.27 <sup>b</sup> ±7.16	71.48 <sup>b</sup> ±7.55	66.93 <sup>b</sup> ±4.69

<sup>a,b</sup>Mean with different superscript within a row differ significantly (P<0.05)

**Table 7. Effect of supplementation of turmeric and garlic powder on feed cost**

Attributes	Groups				
	C	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>
No of chicks	48	48	48	48	48
Cost of chicks at ₹ 41.00/ chick	1968	1968	1968	1968	1968
Cost of litter (₹)	300	300	300	300	300
Cost of feed including additive (₹)	8645	6302	6053	6401.42	6145
Miscellaneous cost (₹)	100	100	100	100	100
Mortality	0	0	0	0	0
Total live birds	48	48	48	48	48
Total input cost (in ₹)	11109	8766	8517	8865.42	8609
Mean slaughter body weight (kg)	2.22	2.19	2.35	2.36	2.3
Income from birds (atRs 100 per kg live weight)	10656	10512	11280	11328	11040
Total difference over control (₹)		-144	624	672	384
Difference over control/bird (₹)		-3	13	14	8
Cost Benefit ratio	0.96	1.2	1.32	1.28	1.28

supplementation garlic powder at 1% in basal diet of broiler could activate absorptive process and may act as a viable alternative to AGP.

Data on the cost benefit ratio of different groups is presented in Table 7. The total input cost was lower in garlic powder supplemented group followed by group fed turmeric and garlic powder at 40:60 and was higher in AGP fed group. The lower feed consumption and higher FCR in addition to lower cost of garlic were the probable reason for lower input cost as cost of garlic (raw) is ₹ 100/kg, whereas per kg cost of turmeric powder was ₹ 120 and that of antibiotic was ₹ 300 per 200 g, respectively. Due to better nutritional attribute and lower cost of garlic powder, highest income was achieved in group T<sub>3</sub> followed by groups T<sub>2</sub>, T<sub>4</sub> and C, but lowest income was recorded in group T<sub>1</sub>. The cost benefit ratio was highest in group T<sub>2</sub> (1.32) followed by T<sub>3</sub> (1.28), T<sub>4</sub> (1.28), T<sub>1</sub> (1.20) and least in C (0.96). The highest cost benefit ratio in T<sub>2</sub> may be attributed to less feed consumption, better FCR and better utilization of nutrients. The present results corroborate the findings of Borgohain *et al.* (2017) who found that garlic supplementation showed the highest gross profit per broiler. However, Karangiya *et al.* (2016) reported that

garlic supplementation did not affect the return over feed cost. This difference in the response may be due to various factors like strain of the broilers used, season of the trial, varying basal diet *etc.*

## CONCLUSIONS

Garlic supplementation at 1% resulted in improved growth and performance of the broilers as evident by superior FCR and better gut micrometry in comparison to the rest of groups.

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Received on 08-06-2021 and accepted on 02-07-2021