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Research Article
Influence of Turmeric Based Diet on the Performance of Broiler Chicken

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Abstract

Background and Objective: Adverse effect of antibiotics is a major concern. On the other hand, the therapeutic properties of turmeric are well known, which are locally grown in the region and available in abundance. Hence, the present study was conducted to use turmeric as an alternative to antibiotics. The current study was designed to determine body weight, growth rate, feed intake, feed conversion efficiency, carcass traits and the economics of broiler chicken production as influenced by different levels of turmeric powder dietary supplementation. **Materials and Methods:** A total of 200 day-old commercial broiler chicks of the Cobb 430 Y strain were randomly divided into four treatments (T_1, T_2, T_3 and T_4) each consisting of five replications consisting of ten birds, each following a Randomized Block Design. The experimental birds were fed a standard broiler starter (0-21 days) and finisher ration (22-42 days). The birds were subjected to four dietary treatments containing 0, 0.4, 0.6 and 0.8 g kg^{-1} of feed, respectively. Body weight, weight gain and FCE were recorded weekly, while the total calorie intake was recorded daily. On the 42nd day, four birds from each treatment were sacrificed to study the carcass characteristics. **Results:** The dietary supplementation with turmeric powder did not significantly affect body weight or weight gain and feed intake had the best FCE recorded in T_4. Mortality was nil in turmeric supplemented group. Hence, livability was recorded as 100 percent. Carcass weight was unaffected by turmeric supplementation, but it showed a significant effect on dressing percentage and organ weights. The highest net profit per bird and BCR were observed in T_3. Hence, the performance index, net profit per bird and BCR were found to be best in T_3. **Conclusion:** As a result of the above findings, supplementation of turmeric powder at 0.6 g kg^{-1} of feed can be recommended under Nagaland's agro-climatic conditions.

Key words: Broiler chicken, turmeric powder, antibiotics, antimicrobial growth promoters, feed conversion efficiency, feed conversion ration

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

In India today, the poultry industry is one of the fastest-growing agricultural sectors. Raising livestock like chickens, ducks, turkeys and geese for meat or eggs is one type of animal husbandry. It finds its origin in the agricultural era. More than 60 billion chickens are killed each year for human consumption, most of which are raised as livestock in the poultry industry. Layers are birds raised for eggs while broilers are chickens raised for meat. Egg and broiler production is increasing by 8-10% per year, while crop production is increasing by 1.5-2% per year[1].

India is currently the fifth-largest egg producer in the world and the eighteenth-largest broiler chicken producer in the world. Rising per capita income, growing urban population and falling real poultry prices all contribute to the sector's potential. One of the fastest-growing segments of global meat demand is poultry and the Indian poultry industry is growing rapidly. The growth of the Indian poultry industry is contributing to rising incomes and rapidly growing middle-class incomes, with the emergence of vertically integrated poultry farmers who have lowered consumer prices by reducing expenditure on production and marketing.

Small poultry processing facilities are spread across the country and produce processed chicken. There are also five state-of-the-art integrated poultry processing facilities that produce skinless chicken, chicken parts and other chicken products. Globally, poultry meat is expected to account for 41% of all animal protein by the end of the decade, according to the OECD and FAO Agricultural Outlook 2030[2].

Poultry meat consumption is increasing as consumers are attracted not only by lower prices but also by the consistency and adaptability of the product, as well as higher protein and fat content. According to the 2019 Livestock Census, the total number of poultry flocks in 2019 increased by 16.81% to 851.81 million.

Antibiotics have been used in animal feed worldwide for many years as antimicrobial growth promoters (AGPs) to improve animal and human health and reduce or eliminate certain exogenous diseases. However, the use of antibiotics in poultry feed must be minimized to reduce the risk of resistant infections and to meet public demand for antibiotic-free animal products[3].

According to several reports by Amato and Castellini[4], when antibiotics are added to the daily feed, the overall development of broiler chickens, as well as their morbidity and mortality, are reduced. The use of these commercially available antibiotics can negatively impact public health by creating antibiotic resistant microbial communities. Given this negative impact, many wealthy countries have made the use of antibiotics in animal feed illegal. To increase productivity, the poultry industry needs to create an alternative technology that allows birds to access antibiotics. According to recent reports, turmeric is an herbal remedy that can be used as an alternative to natural antibiotics in poultry farms.

Turmeric is a spice extracted from *Curcuma longa* plant rhizomes, a component from Zingiberaceae. Rhizome, used in cooking. The plant is a perennial rhizomatous herb native to the Indian subcontinent and Southeast Asia that requires temperatures of 20-30°C (68-86°F) and plenty of annual rainfall to thrive. Plant rhizomes are harvested each year, some for propagation the following season and some for food. Other species can benefit from these anti-inflammatory qualities as well. The part of the plant used medicinally is the rhizome[5]. Bumbles foot is a staph infection that can cause foot and leg swelling and harsh landings from the roost can cause foot and leg injuries in chickens and ducks. By supplying vitamins B and E, turmeric is also thought to help in the treatment of young chickens or chicks suffering from wry necks, a condition that prevents the bird from being able to hold its head up. The primary component of turmeric, curcumin, which is used to colour the natural yellow pigment in the roots of turmeric, is a poly-phenolic compound that is isolated from the rhizomes of turmeric[6] and the flavor is in the rhizomes, which can be used fresh or boiled in water and dried before being ground into a rich orange-yellow powder. Curcumin is also used to dye and is a common coloring and flavoring agent in many Asian cuisines. The main objectives of this study were:

- To study the effect of dietary supplementation of turmeric powder on body weight and growth rate of broiler chicken
- To study the effect of dietary supplementation of turmeric powder on feed intake and feed conversion efficiency in broiler chicken
- To investigate the dietary supplementation of turmeric powder on carcass traits of broiler chicken
- To determine the dietary supplementation of turmeric powder on the economics of broiler chicken production

MATERIALS AND METHODS

Study area: The proposed work was carried out at an Instructional Farm (poultry unit) of the Department of Livestock Production and Management, SASRD-Nagaland University, Medziphema Campus, Nagaland in India. The study

as carried out from May, 2022 to June, 2022 in India. The farm is located at 93.20 to 95.15 E Longitude and Latitude between 25.6 N at an elevation of 310 m above mean sea level.

The present study was based on the growth pattern, feed intake, feed efficiency, mortality/livability, performance index, carcass yield and relative economics of broiler birds based on the performance of broiler chicken fed on a diet supplemented with turmeric (*Curcuma longa* L.) powder.

Experimental birds: For the present study, a total of 200 numbers of days old commercial broiler chicks of Cobb-430 Y strain were procured from S.K poultry shop Burma Camp, Dimapur, Nagaland, India.

Experimental diet: Both broiler starter and finisher feed were procured from a reputed commercial feed supplier, S.K poultry shop Burma Camp, Dimapur, Nagaland, India. This ensured standard quality without any compromising on the bird's health.

Turmeric powder: Organic turmeric powder was procured from the local farmers from the State of Meghalaya as the curcumin content is high because of favorable soil, climate and environmental condition.

The experimental animals grouped as T_1, T_2, T_3 and T_4 were allotted four dietary treatments by replacing 0, 0.4, 0.6 and 0.8% of turmeric powder with good-quality feed ingredients (Table 1).

Feed, watering and health: The chicks were given glucose water when they arrived to give them energy and lessen the stress from traveling. Each chick was required to consume the glucose water by dipping its beak in the glucose water. In the beginning, a small amount of feed was placed on the newspaper within the brooder to entice the chicks to eat. Additionally, there were enough feeders available to guarantee correct feeding by keeping them full until the chicks learned to eat and then reducing them to 3/4 of their capacity to avoid feed waste. There were access points to clean, fresh water. Throughout the testing period, the birds were given *ad libitum* access to food and water. For the 0-3 first 3 weeks' ration, the starter ration was incorporated and the duly finished ration was started. Daily morning and evening feedings included a set amount of feed. The following morning, the leftover feed was measured to determine the bird's daily feed intake. Standard practices for maintaining sanitation and hygiene were closely observed to maintain the health of the birds. Additionally, at the first and 2nd weeks of age, the chicks received vaccinations against Ranikhet disease and infectious bursal disease, respectively.

Feed intake and feed conversion efficiency: Every day, the amount of meal given to the birds was recorded and the following morning and feed leftovers were noted. In that research, I used a knife, scissors, eye or nasal dropper, test tube, rack, burner, shovel, etc. By providing a weighted quantity of feeds in accordance with the treatments and expressing the results in grams, a precise digital weighing balance was used to calculate feed intake. To determine the precise amount of feed consumed by the birds each day, the leftover feed was deducted from the total amount of feed delivered the previous day. These figures were used to compute the average daily and weekly feed consumption in grams for each bird in each group. The feed conversion efficiency (FCE) of different experimental groups was calculated by adopting the following formula:

$$\text{Feed conversion efficiency (FCE)} = \frac{\text{Total body weight gain (g)}}{\text{Quantity of feed consumed (g)}}$$

Mortality/livability and performance index: Mortality was noted as and when occurred during the period of investigation and was expressed in percentage. Mortality was calculated by using the following formula:

$$\text{Mortality (M)} = \frac{\text{Total no.of birds died}}{\text{Total no.of live birds}} \times 100$$

The livability percentage was calculated by subtracting the mortality percentage from 100 while the performance index (PI) was calculated by adopting the formula of[7]:

$$\text{PI} = \frac{\text{Average body weight (g)} \times \text{Livability (\%)}}{\text{Cumulative FCE} \times \text{Number of days}} \div 100$$

Dressing percentage, carcass yield and organ weight: Four birds from each group were randomly chosen after the trial to be used in carcass evaluation tests. Before being killed, the live

Table 1: Experimental turmeric powder in different treatment groups of broiler chicken

Group	Total number of birds	Rate of turmeric powder per kg feed
T_1	50	0 g kg^{-1} of feed
T_2	50	0.4 g kg^{-1} of feed
T_3	50	0.6 g kg^{-1} of feed
T_4	50	0.8 g kg^{-1} of feed

weight of each bird was recorded. Using the Kosher Method, slaughtering was carried out[8]. After evisceration, thorough bleeding and feather removal, the bird's dressed weight was determined. Additionally, the weights of the heart, liver, spleen and empty gizzard were measured individually and the average weights of each of these organs were noted for the four different groups.

Ethical consideration: Animals were sacrificed by the Humane Method as per the norms laid down by "Statement of human and animal rights, Statement of informed consent and ethical approval".

Statistical analysis: For the purpose of drawing a reliable conclusion and examining the impacts of various treatments, the experimental data that were acquired were statistically analyzed. In accordance with Snedecor and Cochran's[9] description, the recorded data were analyzed using Microsoft Excel's One-way Analysis of Variance (ANOVA) in a randomized block design. All statistical analysis was performed using Microsoft Excel. The level of statistical analysis was defined at (5%) level of significance.

RESULTS AND DISCUSSION

Body weight: Table 2 displayed the findings on the variation in body weight in the various treatment groups from day one to 42 days of age. A graphic depiction of the average body weight of the various experimental groups at weekly intervals of up to 6 weeks was shown in the appendix contains a statistical analysis of the average body weight from the 4th week to the 6th week. In Table 2, the day-old chicks' average body weight and heights for the control group (T_1) and the three treatment groups (T_2, T_3 and T_4) were 30.72, 31.6, 30.08 and 29.40 per bird, respectively. The graph representing the average body weight in various groups up to six weeks of age were plotted in Fig. 1. The equivalent body weight for the various treatment groups was 2446.92, 2492.54, 2510.52 and 2493.72 g per bird after the 6 week. The overall means of body weight were1050, 1013.54, 1029.48 and 1019.74, respectively, for T_1, T_2, T_3 and T_4.

So from the Table 2 numerically it can be seen that in T_3 the average body weight was highest compared to other treatments[5,7] also observed an increase in body weight when

Table 2: Average body weight (kg/bird/week) of broiler birds in different treatment groups

Treatment	1day old	1st week	2nd week	3rd week	4th week	5th week	6th week	Over all mean
T_1	30.72	154.60	399.68	1050.00	1352.60	1883.31	2446.92	1050
T_2	31.60	156.38	416.70	1013.54	1345.60	1866.90	2492.54	1013.54
T_3	30.08	159.72	430.98	1029.48	1419.60	1909.18	2510.52	1029.48
T_4	29.40	160.20	415.20	1019.74	1357.20	1812.90	2493.72	1019.74
SEM±	-	-	-	-	46.79	20.87	83.21	-
CD (p = 0.05)	-	-	-	-	NS	93.92	NS	-

Mean bearing different superscripts differ significantly (p<0.05)

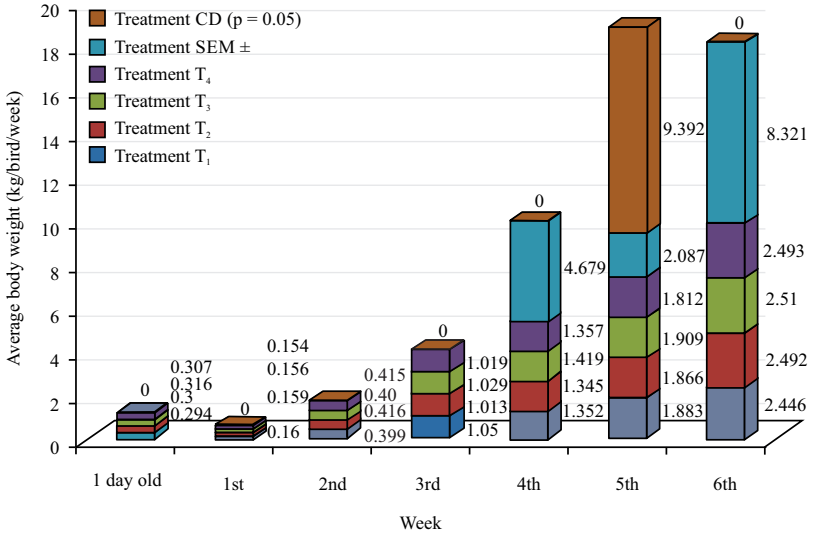

Fig. 1: Average body weight (kg/bird/week) of broiler chicken body weight performance

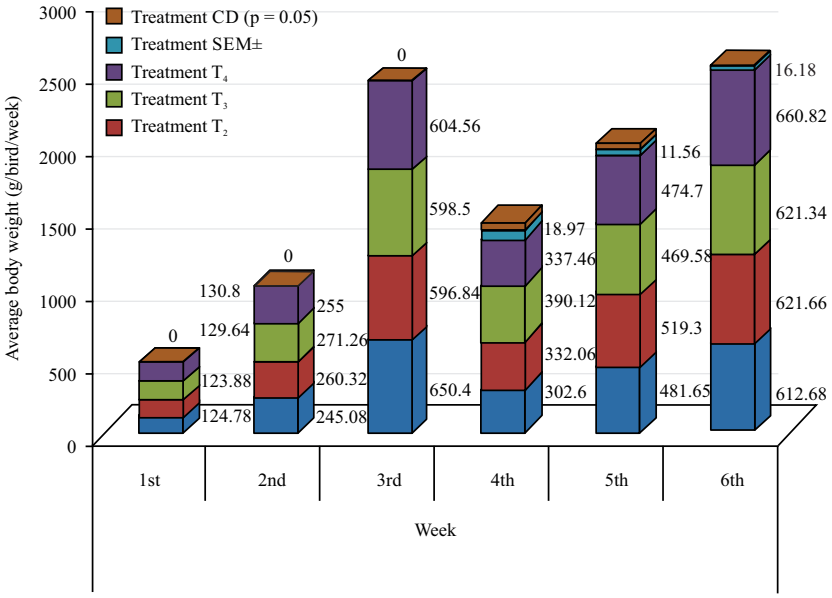

Fig. 2: Average gain in body weight (g/bird/week) of body weight gain in different treatment groups of broiler birds

Table 3: Average gain in body weight (g/bird/week) of broiler birds in different treatment groups

	Body weight gain (g)					
Treatment	1st week	2nd week	3rd week	4th week	5th week	6th week
T_1	123.88	245.08	650.40	302.60	481.65	612.68
T_2	124.78	260.32	596.84	332.06	519.30	621.66
T_3	129.64	271.26	598.50	390.12	469.58	621.34
T_4	130.80	255.00	604.56	337.46	474.70	660.82
SEM±	-	-	-	18.97	11.56	16.18
CD (p = 0.05)	-	-	-	85.38	52.05	NS

Mean bearing different superscripts in a table differ significantly (p<0.05)

supplemented with turmeric powder and the least was observed in T_2. However, statistical analysis reveals that the use of turmeric powder had a non-significant effect on body weight between the treatments. The findings of the study were in agreement with the findings of those who[2,10] also reported a non-significant effect of turmeric powder on the body weight of birds. However, on the contrary, researchers[11-13] observed a significant increase in body weight by incorporating turmeric powder into the diet of birds.

Body weight gain: The first week's average weight growth for broiler chicks was 123.88, 124.78, 129.64 and 130.80 g/bird for T_1, T_2, T_3 and T_4, respectively as shown in Table 3. The graph representing the average body weight gain in various groups up to (Fig. 2) 6th week, the corresponding mean weight gain was 612.68, 621.66, 621.34 and 660.82 g/bird for T_1, T_2, T_3 and T_4. Numerically, the highest body weight gain was observed in T_4 with turmeric supplementation and this can be close agreement[14,15], who observed higher body weight gain when turmeric powder was used.

Statistical analysis showed that there was significant body weight gain among the treatments in the 4th and 5th weeks. It was found that there was a significant difference between T_1 and T_3 in the fourth week however, in the sixth week the body weight gain was non-significant among the treatments using turmeric powder. Similar findings were observed by researchers[11,12,16-19], who also reported significant body weight gain when they incorporated turmeric on a bird's diet. However, had a non-significant effect of Turmeric powder on the body weight gain of the bird?[20]

Feed intake: The data are given in Table 4 and Fig. 3 shows the overall mean of feed intake during the entire trial period for the treatment groups T_1, T_2, T_3 and T_4 groups were 644.10,

637.27, 646.11 and 646.2. So, numerically the highest feed intake was observed in T_4 followed by T_3, T_1 and T_2, respectively[15]. Also observed higher feed intake when turmeric powder was incorporated with the feed.

Statistical analysis revealed that the use of turmeric powder had a non-significant impact on the feed intake of the birds and this can be corroborated with the findings of reporters[18,21,22] who also reported that the use of TP had a non-significant effect on the feed intake. Whereas, the present findings were contradictory to the observation of researchers[12,23] who found a significant difference in feed intake in supplementing turmeric powder in broiler birds.

Feed conversion efficiency: The average weekly feed conversion efficiency and mean feed efficiency of the different experimental groups up to 8 weeks of age were depicted in Table 5 and their mean statistical analysis. The graph representing the average weekly feed conversion efficiency in various groups up to 6 weeks of age was plotted in Fig. 4. As per the data given in Table 5, the overall mean feed conversion efficiency (FCE) of Broiler birds was in the range of 1.52, 1.42, 1.39 and 1.31 for T_1, T_2, T_3 and T_4, respectively.

The feed conversion efficiency for the 1st week was 1.26, 1.10, 1.17 and 0.85 for T_1, T_2, T_3 and T_4 and on the 6th week which is the last week it was 2.26, 1.96, 1.87 and 1.83, respectively for T_1, T_2, T_3 and T_4. The best FCE was observed in T_4 with supplementation of turmeric powder and this was with a close agreement with[18,23,24] who observed the best FCE when turmeric powder was included in the broiler chicken's diet.

Mortality, livability (%) and performance index of broiler birds in different treatment groups : The mortality, livability and performance index (PI) from day old to 6 weeks of age for the treatment groups were shown in Table 6.

Table 4: Average feed intake (g/bird/week) of broiler birds in different treatment groups

	Daily feed intake (g)							
Treatments	1st week	2nd week	3rd week	4th week	5th week	6th week	Total	Overall mean
T_1	156.54	375.00	659.96	598.64	900.48	1173.96	3864.58	644.10
T_2	137.34	385.74	675.88	560.84	892.20	1171.63	3823.63	637.27
T_3	151.42	385.98	652.68	615.68	908.34	1162.58	3876.68	646.11
T_4	110.78	381.90	658.74	593.22	953.04	1179.52	3877.2	646.2
SEM±	-	-	-	19.69	14.26	21.87	-	-
CD (p = 0.05)	-	-	-	NS	64.19	NS	-	-

Mean bearing different superscripts in a table differ significantly (p<0.05)

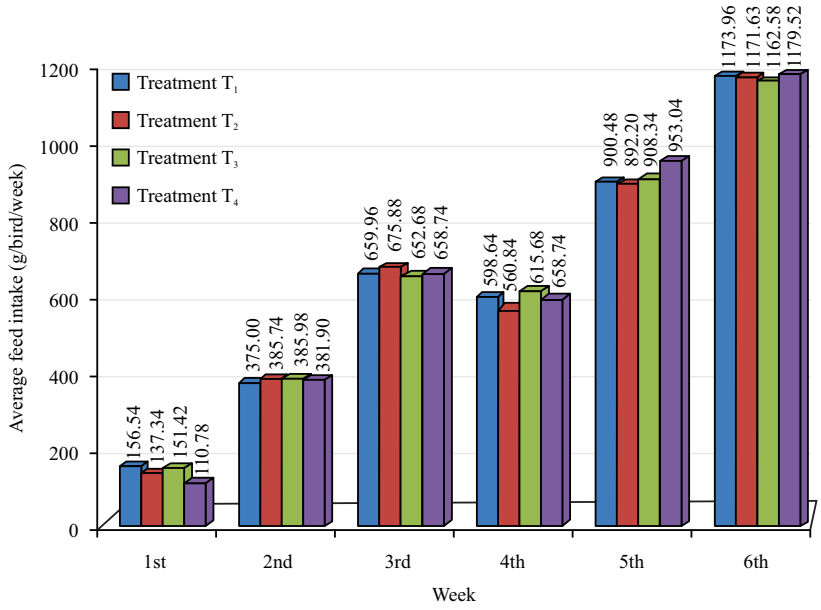

Fig. 3: Average feed intake (g/bird/week) of feed intake in different treatment groups of broiler chicken

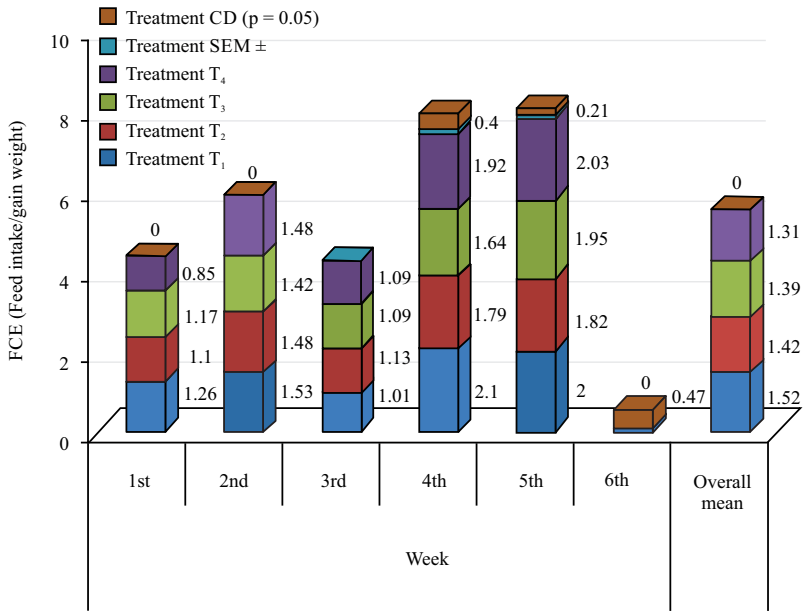

Fig. 4: Feed conversion efficiency on different treatment groups of broiler chicken

Table 5: Average feed conversion efficiency of broiler birds in different treatment groups

Treatments	1st week	2nd week	3rd week	4th week	5th week	6th week	Overall mean
T_1	1.26	1.53	1.01	2.10	2.00	2.26[a]	1.52
T_2	1.10	1.48	1.13	1.79	1.82	1.96[ab]	1.42
T_3	1.17	1.42	1.09	1.64	1.95	1.87[b]	1.39
T_4	0.85	1.48	1.09	1.92	2.03	1.83[b]	1.31
Sem±	-	-	-	0.09	0.05	0.10	-
CD (p = 0.05)	-	-	-	0.40	0.21	0.47	-

[a,b]Mean bearing different superscripts in a table differ significantly (p<0.05)

Table 6: Mortality, livability (%) and performance index of broiler birds in different treatment groups of broiler chicken

Group	Mortality (%)	Livability (%)	Performance index
T_1	1.01	98.99	336.57
T_2	0	100.00	379.25
T_3	0	100.00	386.76
T_4	0	100.00	382.5

From the above table, it can be illustrated that the mortality rate was 1.01 in T_1 and the following treatments have zero (0) mortality. As evident, we can state that the treatment groups which were supplemented with turmeric powder on their diet had no mortality, although the cause of mortality is unknown but based on the observation it was possibly because of transportation stress.

The performance index for each group was 336.57, 379.25, 386.76 and 382.5 i.e. for T_1, T_2, T_3 and T_4. So, here the performance index was highest in T_3 followed by T_4 and T_2 and the least was observed in T_1 similar finding was observed[25] who stated a higher performance index with turmeric powder.

Dressing percentage, carcass yield and organ weight: The average dressing percentage, carcass yield and organ weight in different treatment groups was illustrated in Table 7.

The average dressing percentages of broiler birds at the end of 6 weeks of age for T_1, T_2, T_3 and T_4 are 73.44, 74.09, 73.19 and 74.70%, respectively. The average carcass weight was 1.96, 2.02, 2.06 and 1.96 kg/bird in T_1, T_2, T_3 and T_4 groups, respectively. For ages T_1, T_2, T_3 and T_4, respectively, the average gizzard weight was 50.86, 43.78, 45.58 and 44.62 g. The average heart weight was 12.14, 13.36, 14.32 and 13.46 g for T_1, T_2, T_3 and T_4, respectively. The average liver weight was 64.26, 66.68, 68.92 and 56.12 g for T_1, T_2, T_3 and T_4, respectively. The average spleen weight was 4.46, 5.90, 6.16 and 5.52 g

Table 7: Average dressing percentage, carcass yield and organ weight in different treatment of broiler chicken

Treatments	Carcass weight (kg)	Dressing percentage (%)	Liver weight (g)	Spleen weight(g)	Gizzard weight (g)	Heart weight (g)
T_1	1.96[a]	73.44[a]	64.26[a]	4.46[a]	50.86[a]	12.14[b]
T_2	2.02[a]	74.09[a]	66.68[a]	5.90[a]	43.78[b]	13.36[ab]
T_3	2.06[a]	73.19[a]	68.92[a]	6.16[a]	45.58[b]	14.32[a]
T_4	1.96[a]	74.70[a]	56.12[b]	5.52[a]	44.62[b]	13.46[ab]
SEM±	0.07	0.67	2.57	0.29	1.63	0.46
CD(p = 0.05)	NS	3.52	7.92	0.88	5.01	1.40

[a,b]Mean bearing different superscripts in a table differ significantly (p<0.05)

for T_1, T_2, T_3 and T_4, respectively. From the above data, we can see that numerically, T_4 has the highest dressing percentage, which was in agreement with[18,26] while T_3 has the highest carcass weight, which is in agreement with Samarasinghe *et al.*[27] who observed improved carcass quality of broiler chickens by supplementing turmeric powder. The lowest dressing percentage was found in T_3 and the lowest carcass weight was found in T_1 and T_4. So, statistically, there was a significant effect of turmeric powder on the dressing percentage, the result was in close agreement with the findings of researchers[16,17,28] who reported a significant higher dressing percentage when turmeric powder was supplemented in broiler diets. The turmeric powder had a significant effect on the organ weights (liver, spleen, gizzard and heart weight), the findings were in close agreement[29]. Contrary to the present findings by reporters[16,18] did not have any significant effect on the weight of the organs?

Different levels of turmeric powder content and their efficiency should be evaluated, as the turmeric powder content can differ based on soil fertility and agro-climatic conditions. The effect of turmeric powder should be investigated on different locally available feeds and also to determine the efficacy of turmeric powder on various bird strains. Some farmers rarely use turmeric powder in poultry feeds and turmeric is not available in some pockets of the tribal belts of the state. Since turmeric powder possesses natural antiseptic and antibiotic properties, it can preserve feeds for a longer duration and also reduce the morbidity and mortality of poultry birds at a low cost.

CONCLUSION

Dietary supplementation with turmeric powder had a non-significant effect on the body weight of broiler chickens. It was revealed that dietary supplementation with turmeric powder did not have a significant effect on body weight gain. There was a non-significant difference in feed intake among the treatment groups. The feed conversion efficiency was best in T_4. Turmeric powder supplementation had a significant effect on the dressing percentage and organ weights but did 3not affect the carcass weight. There was 1.01% mortality observed in T_1 while the other treatments remained 100% livability. On T_3 the performance index remained the highest, followed by T_4, T_2 and T_1. The cost of production was lowest in T_2, while profit per bird was highest in T_3 and BCR was highest in T_2 and T_3. From the result of the present study, it may be concluded that supplementing turmeric powder with 0.6 g kg^{-1} feeds birds in terms of growth, performance index, profit per bird and benefit-cost ratio. Therefore, turmeric powder at 0.6 g kg^{-1} was found to be favorable. Turmeric is effective against the common intestinal nematode (roundworm) and helps reduce the adult worm's length and width on vital organisms found in chicken digestive systems. Turmeric also has healing properties and restores the integrity of intestinal mucosa in the gastrointestinal tract.

SIGNIFICANCE STATEMENT

When antibiotics are added to the daily feed, the overall development of broiler chickens improved. To increase productivity, the poultry industry needs to create an alternative technology that allows birds to access antibiotics. Turmeric is an herbal remedy that can be used as an alternative to natural antibiotics in poultry farms. The purpose of the study was to see the impact of turmeric as dietary supplementation in broiler chicken production. Turmeric powder consumption is determined by the body weight of the broiler chicken. It has a significant effect on the dressing percentage and organ weights but did not affect the carcass weight. Turmeric is effective against the common intestinal nematode. Turmeric also has healing properties and restores the integrity of intestinal mucosa in the gastrointestinal tract.

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