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Performance of broiler birds fed diets supplemented with turmeric powder

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ABSTRACT

Performance of broiler chicken on diet supplemented with turmeric powder as reviewed have comprehensive works done on inclusion of turmeric powder in the diet of broiler birds and their effects on different productive parameters, biochemical constituents and economics of production. Data collected on the chemical constituent found in turmeric powder, the adequate levels of turmeric powder to be added in the diet of broiler birds, the different methods of turmeric addition, like inclusion in the diet or mixing in water or any other method was considered. Results on body weight gain, feed intake, feed conversion efficiency, some blood constituents as haemoglobin, packed cell volume, high density lipoprotein (HDL), low density lipoprotein (LDL), cholesterol and triglycerides were incorporated. Supplementation of turmeric powder on dressing percentage and carcass yield along with organ weigh were also considered. Finally, the economics of production for every unit of production was also considered. From the reviews, it may be concluded that dietary supplementation of turmeric powder was found to be beneficial in terms of performance as body weight gain, feed intake, feed conversion efficiency, live ability, performance index, carcass characteristics and organ weight, blood constituents like haemoglobin, packed cell volume, high density lipoprotein (HDL), low density lipoprotein (LDL), cholesterol and triglycerides and overall net profit of rearing broiler birds as compared to the non-turmeric added birds.

Keywords: Bio-chemical parameters, broiler birds, carcass characteristics, growth performance, turmeric powder.

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Introduction

Poultry sector has developed an unprecedented growth during the last three decades. It now plays as a very important role in the economic development of the country. It has transited from home consumption to commercial production. The poultry farming occupies an important position due to its enormous potential to bring about rapid economic growth, particularly benefiting the weaker sections due to its low investment requirement (Park *et al.*, 2012).

This sector provides a great employment opportunity even to unskilled labourers and women thereby providing income to the vulnerable group.

Today, poultry is one of the fastest growing segments of the agricultural sector rising at a rate of 8-10 percent per annum as compared to agricultural crops (1.5-2 percent per annum) and ranks 3rd in egg production (Chatterjee and Rajkumar, 2015). About 3million farmers and 15 million agrarian farmers are employed in the poultry industry that grows poultry products (Karthikeyan and Nedunchezhian, 2013).

The major factors for successful poultry production are high genetic potential, balanced nutrition and health maintenance. On the other hand, there is a major demand to produce high quality poultry meat and egg at low price without relying on antibiotics and other medicines in poultry feed and water (Shivappa-Nayaka *et al.*, 2012). The principle of poultry production is to achieve high level of performance through efficient utilization of feed keeping survivability as maximum as possible. The optimum performance of birds is mainly dependent on the genetic potential of bird, quality of feed, environmental conditions and disease outbreaks (Sugiharto, 2016).

In broiler production, the feed cost alone contributes to about 70-75 percent of the total cost of production; economically poultry production is possible only when the feed cost is reduced and efficiency of feed utilization is increased (Qureshi, 1991). Uses of food additives are an ideal tool to boost the profits of poultry farmers. Moreover, microbial resistance against antibiotics is becoming increasingly evident. Therefore, the use of antibiotics as growth promoters in poultry and animal feed has been banned. Many have described or revealed in their studies where bioactive plant have been used as additives in poultry feed to stimulate the appetite and feed intake with increased secretion of digestive enzymes.

Additionally, as anti-microbial drugs, the additives may also activate the immune system (Jayaprakasha *et al*., 2005). As use of in-feed antibiotics and hormones not only increases the cost of production but also leads to residues in meat and develops antibiotic resistance in microbes (Al-Jaleel, 2012). For one of this purpose, different natural growth promoters are being used worldwide. Prebiotics, probiotics, organic acids, enzymes, antioxidants and herbs are good antibiotic alternatives.

Herbs and their extracts are excellent alternatives due to the variety of beneficial activities (Durrani *et al*., 2006).Beneficial effects of bioactive plant substances in animal nutrition may include the stimulation of appetite and feed intake, the improvement in endogenous digestive enzyme secretion, activation of immune response and antibacterial, antiviral and antioxidant actions (Toghyani *et al*., 2010). Thus, feed additives are an ideal tool to boost the profits of poultry farmers. Spices and herbs such as oregano, garlic, thyme, rosemary, black pepper, hot red pepper and sage are listed among the most commonly researched photobiotic in broiler ration (Jamir *et al*., 2019;Munglang and Vidyarthi, 2019; Rio *et al*., 2019; Shohe *et al*., 2019).

Turmeric (*Curcuma longa* L.) is arhizomatous herbaceous perennial plant of the ginger family, *Zingiberaceae*. It is native to tropical South Asia but is now widely cultivated in the tropical and subtropical regions of the world (Shrishail *et al*., 2013).

In Ayurveda medicine, turmeric is primarily used as a treatment for inflammatory conditions and intraditional Chinese medicine, it is used as stimulant, aspirant, carminative, emenagogue, astringent, detergent and diuretic (Remadevi *et al*., 2007).

Table 1: Composition of Turmeric

S/No	Composition	Percentage
1.	Proteins	6.3
2.	Fats	5.1
3.	Minerals	3.5
4.	Carbohydrates	69.4
5.	Moisture	13.1

(Chattopadhyay*et al*., 2004)

Table 2: Mineral composition of *Curcuma longa*

Mineral	element (%) *C. longa*
Sodium	0.01±0.00
Potassium	0.42±0.00
Magnesium	0.05±0.00
Calcium	0.02±0.00
Phosphorus	0.03±0.00
Iron	0.57±0.01

Values are mean ± SEM; n = 3

Table 3: Proximate analysis of Turmeric (*Curcumalonga*) Rhizome and Leaves

Parameter	Turmeric Rhizome	Turmeric Leaves
Moisture content	10.54±0.08	10.27±0.03
Dry Matter	89.46±0.08	89.72±0.03
Ash	7.87±0.04	11.37±0.04
Crude Protein	6.54±0.07	17.87±0.10
Fat	6.29±0.01	2.41±0.01
Crude Fibre	4.14±0.02	15.29±0.01
Carbohydrate	64.58±0.04	42.74±0.05

Means of three determinations on a dry weight basis ± standard deviation

Due to its medicinal properties, the use of turmeric in poultry feed became extensive during the last decade (Khan *et al*., 2012). It has both oil part as well as coloring pigment part. The coloring material is a rich source of the phenolic compounds, *Curcumin* (Roughley and Whiting, 1973), Bis demethoxy *curcumin* (BDMC) and demethoxy curcumin (DMC), collectively referred to as *Curcuminoids* which act as powerful antioxidants and a colorless metabolite namely Tetra hydro curcumin (THC) (Huang *et al*., 1995). The active substances in

Turmeric oil are *Curcuminoids* (Toennesen, 1992), Aromatic turmerones and alpha and beta turmerones (Ferreira *et al*., 1992) and curlone (Kiso *et al*., 1983).

Curcuminoids (3 to 5 percent as found in Turmeric powder) have a wide spectrum of biological activities including antioxidant, antibacterial, antifungal, antiprotozoal, antiviral,

anti-coccidial and anti-inflammatory property (Masuda *et al*., 2001). The oil part also exhibits antibacterial, antifungal and anti-inflammatory properties (Chandra and Gupta, 1972).

Turmeric has good pharmacological properties and can be a useful natural growth promoter and safe alternative to antibiotics. Dietary supplementation of curcumin is limited because of its low solubility in alkaline pH and being subject to hydrolysis when exposed to light, which result in poor absorption in animals (Kochhar,2008). Studies on broiler birds have shown increased weight gain (Samarasinghe *et al*., 2003) and improved FCR (Samarasinghe *et al*., 2003;Wuthiudomler*et al*., 2000) with dietary supplementation of turmeric. In contrary, Gowda *et al*. (2008); Kumari *et al*. (2007); Mehala and Moorthy (2008) found no effect of turmeric on FCR.

Body Weight and Growth Rate

Feed intake in the birds fed diets containing 0.50 or 1.0% turmeric powder did not differ significantly, but the feed intake in the birds increased numerically as compared to the basal diet (Radwan *et al*., 2008). Feed intake was not changed by the dietary treatments, suggesting that addition of turmeric powder did not affect palatability (Park *et al*., 2012 and Rahardja *et al*., 2015) reported that turmeric powder supplementation up to 2% did not affect feed intake, but increasing supplementation to 4% resulted in a significant lower feed intake. AL-Kassie *et al*., 2011furtherreported that the inclusion of turmeric mixture at levels of 0.75% and 1% in the diets improved feed intake (Gowda *et al*., 2019). Found that feeding turmeric (444 ppm) in the basal diet significantly decreased feed intake in birds (Durrani *et al*., 2006).

Al-Sultan (2003) observed that the use of turmeric powder at 0.50 percent level resulted in higher average body weight (1344.5 g) followed by birds which received 0.25 percent (1329.8 g), 1 percent(1306 g) and control (1268.2 g). It also improved the overall performance of broiler birds. Durrani *et al*. (2006) revealed that average body weight gain (734 g) was highest in birds fed diet containing turmeric at the level of 5 g/kg of feed as compared to the control group (646 g) and inclusion of turmeric powder enhanced the overall performance of broiler birds. Al-Kassie *et al*. (2011) reported that the body weight gain of broilers fed with turmeric and cumin mixture at the level of0.75 percent and 1.00 percent was improved (2608 ±35.40 and 2568 ± 42.1 g, respectively) significantly($P<0.05$) in comparison to control (2290 ± 41.30 g).

Al-Jaleel (2012) revealed that inclusion of turmeric at 0.50 per cent in the diet improved body weight significantly ($P<0.05$) as compared to control group. Suriya *et al.* (2012) assigned treatment diets of three levels of each garlic, turmeric and cinnamon at 0.25, 0.50 and1.00 percent into basal diet. The overall body weight gain of broiler birds fed with 0.25 percent turmeric (2434.64 ± 31.96 g), 0.50 percent garlic (2388.86 ±47.77 g) and 0.50 percent cinnamon (2467.05 ± 36.12g) found to be significantly ($P<0.05$) higher when compared with control group (2207.71 ± 45.75 g). Rajput *et al*. (2013) postulated that the dietary supplementation of curcumin at 200 mg/kg significantly ($P<0.05$) improved live body weight (2.563 kg) in comparison to control (2.489 kg). Hussein (2013) reported that supplementation of turmeric powder at 7.0 g/kg of diet significantly ($P < 0.05$)improved body weight and body weight gain (2.364 kg)as compared to control (2174.8). Abou-Elkhair *et al.*(2014) studied the effect of supplementation of diet with black pepper (*Piper nigrum*) (T1), turmeric powder (*Curcuma longa*) (T2), coriander seeds(*Coriandrum sativum*) (T3) and their combinations in broilers on the body weight gain of broilers and observed significantly ($P < 0.05$) higher body weight during the entire period of 5 weeks i.e. T1 (1839 g), T3(1810 g), T5 (1869 g) and T6 (1860 g) diets as compared to control (1698 g).

Dingfawang *et al*. (2015) revealed that a turmeric rhizome extract supplemented diet had no significant effect ($P>0.05$) on the body weight) as compared to control group. Mondal *et al.* (2015) observed that dietary addition of turmeric (*Curcuma longa*) powder as feed additive at a level of0.5 percent enhanced the growth performances as compared to control group. Tripathi (2015) reported that the Supplementation of 0.50 percent turmeric powder in feed significantly ($P < 0.01$) improved the body weight and body weight gain over broilers of control group. Kafi *et al.* (2017) reported that diet supplemented with turmeric powder 7.5g/kg feed showed highest body weight followed by 5g/kg in broiler birds. Kumar and Shukla (2017) conducted an experiment where broiler chicks were divided into five groups T0, T1, T2, T3 and T4 which were supplemented with Turmeric powder at 1.0g, 2.0g, 3.0g and 4.0g/kg of

broiler ration, respectively. All the treatment groups recorded significantly higher means for body weight than of control.

Arslan *et al.* (2017) reported that turmeric supplementation at 1 and 1.5 percent improved growth performance as compared to control group. Ahlawat *et al*. (2018) reported that supplementation of turmeric powder at 0.50 percent in the diet of broilers resulted in increased average body weight gain than that of control. Shohe *et al.* (2019) observed that average gain in body weight was significantly (P<0.05) the highest in T4 group (7.5 g turmeric powder/kg feed) followed by T3 (5 g turmeric powder/kg feed), T2 (2.5 g turmeric powder/kg feed) and the least in T1 group; however, there was no significant difference in body weight gain between T2 and T3 group.

Feed Intake

Al-Sultan (2003) observed that incorporation of turmeric powder had non-significant effect on feedintake of broiler birds. Durrani *et al*. (2006) showed that the feed intake reduced significantly in broilers when supplied with diet containing 0.50 percent turmeric powder in comparison to control. Mehala and Moorthy (2008) conducted an experiment on 280 commercial day-old broiler chicks and reported that T1,T2, T3, T4, T5, T6 and T7 were 3490.14 ± 38.49 g,3427.34 ± 81.94 g, 3548.91 ± 32.82 g, 3537.22 ±110.70 g, 3480.16 ± 54.19 g, 3494.57 ± 114.55 g and3403.61 ± 50.23 g, respectively and that there was no significant effect of treatments on feed consumption. Doley *et al*. (2009) performed an experiment to find out the effect of supplementing broiler feeds with garlic, ginger, and turmeric powder on feed intake.

The experimental findings suggested that feed intake did not differ significantly for the diets supplemented with ginger (74.21 ± 0.70 g), garlic (73.20 ± 1.02 g) and turmeric powder (73.01 ± 0.57 g) as compared with the basal diet (72.25 ± 0.47 g). Al-Kassie *et al*. (2011) studied the performance of 300 day old broiler chicks. Diets were supplemented with combination of turmeric (*Curcuma longa*) and cumin (*Cuminum cyminum*) at the rate of 0, 0.25, 0.50, 0.75 and 1.00 percent in the basal diets for 6 weeks. The results revealed that feed consumption by broilers at the age of sixth week was4496 ± 61.20, 4543 ± 64.30, 4538 ± 58.40 and 4525±62.30 g in the diets containing combination of turmeric and cumin at 0.25, 0.50, 0.75 and 1.00 percent level.

However, the treated groups differed significantly (P <0.05) lower than control (4603 ± 58.4g) group. Nouzarian *et al.* (2011) revealed that feed intake didnot differ significantly for the broilers fed on diet added with turmeric powder. Akbarian *et al*. (2012) evaluated the effects of inclusion of turmeric rhizome powder (TRP) and black pepper (BP) on performance of male broiler birds and found that the feed intake (FI) of broilers was not influenced when supplemented with TRP and BP in the diet of broiler birds. Al-Jaleel (2012) revealed that inclusion of turmeric at the level of0.50 percent resulted in significantly higher feed consumption (2135.9 ± 51.9 g) as compared to control (1555.7 ± 43.6 g) at the end of third week; however at the end of sixth week there was no significant difference in the feed consumption among the treatments as compared to control. Rajput *et al*. (2013) revealed that dietary supplementation of curcumin at 200 mg/kg had no significant difference on feed intake as compared to control. Hussein (2013) concluded that supplementation of turmeric powder at 7 g/kg of diet significantly (P < 0.05) effect lower feed intake when compared with the control.

Abou-Elkhair *et al*. (2014) researched on the effect of feed supplemented with black pepper (*Piper nigrum*), turmeric powder (*Curcuma longa*), coriander seeds (*Coriandrum sativum*) and their combinations on feed consumption of broilers and reported that there was no significanteffect on feed intake between control (2,595 g) and T1(2,589 g), T2 (2,572 g), T3 (2,565 g), T4 (2,611 g), T5(2,577 g) and T6 (2,588 g). Fallah and Mirzaei (2016) observed that broilers receiving different levels of turmeric plus thyme powders had highest feed intake than that of control group. Kafi *et al.* (2017) conducted an experiment where birds were fed in 5 groups viz. T1 (0.5 percent turmeric), T2 (0.75 percent turmeric), T3 (0.5 percent ginger), T4 (0.75 percent ginger), T5 (combination of 0.5 percent turmeric and ginger) and reported that feed intake was significantly lower in birds supplemented with turmeric then ginger as compared to control group.

Arslan *et al.* (2017) reported that turmeric supplementation either at 0.5 or1.5 percent level reduced feed intake in broilers as compared to control. Shohe *et al.* (2019) observed that average feed intake was significantly (P<0.05) the lowest in T4 group (7.5 g turmeric powder /kg feed) followed by T3 (5 g turmeric powder/kg feed) T2 (2.5 g turmeric powder/kg feed) and the highest in

T1 group; however, there was no significant difference in the values between T1 and T2 group and between T2 and T3groups.

Feed Conversion Efficiency

Al-Sultan (2003) studied the effect of turmeric powder at different levels (0.25, 0.50 and 1.0 percent) in diet as feed additive on FCR of broiler birds in comparison to control birds. The data revealed that the use of turmeric powder as feed additive at level of 0.50 percent was the best (2.08) as compared to control (2.47). Durrani *et al.* (2006) observed significant improvement ($P < 0.01$) in feed conversion ratio (feed/gain) of broilers fed diet containing 0.50 percent turmeric powder as compared to control group. Rahmatnejad *et al*. (2009) carried out an experiment on 240 day old Ross 308 broilers to evaluate the effects of prebiotic (T2), garlic powder (T3) and turmeric powder (T4) inclusion on FCR of broiler chicks with control (T1). Significant effect on feed conversion ratio ($P < 0.05$) was observed for T2 (1.72) in comparison to control (1.99) and two other treatmentT3 (1.96) and T4 (2.07). Al-Kassie *et al*. (2011) led to a conclusion that the inclusion of cumin and turmeric mixture at levels of 0.75 and 1.00 percent in the diets improved feed conversion ratio significantly and the respective values were 1.74 and 1.76 as compared to control (2.01). Nouzarian *et al*. (2011) reported that birds exhibited better feed conversion ratio ($P < 0.05$)at 0.5 percent during entire experimental periods than control group. Sugiharto *et al*. (2011) reported that broilers supplemented with turmeric extract at 800mg/kg diet resulted in better FCR in broilers.

Akbarian *et al*. (2012) evaluated the effects of inclusion of turmeric rhizome powder (TRP) on FCR of broiler birds. Two levels of TRP (0.00 and 0.50 g/kg) were used and the results revealed that FCR was not influenced significantly by TRP supplementation in the diet (1.45) as compared to control (1.38). Al-Jaleel(2012) also reported that inclusion of turmeric powder at 0.5 percent improved feed conversion efficiency. Hussein (2013) reported that turmeric powder supplementation at 7 g/kg of diet significantly ($p <0.05$) improved feed conversion ratio when compared with the control. Rajput *et al*. (2013) revealed that dietary supplementation of curcumin at 200 mg/kg of feed significantly improved feed conversion efficiency at marketing age (42nd day).

Naderi *et al*. (2014) recorded significantly better feed conversion ratio in birds fed diet containing turmeric at 2.5 g/kg (1.85) as compared to the control group (1.93). Dingfawang *et al*. (2015) conducted a study where birds were fed acorn-soybean basal diet supplemented with turmeric rhizome extract (TRE) at 0, 100, 200 and 300 mg/kg diet for 12 weeks. The results revealed that a TRE supplemented diet at 100 to 300 mg/kg had better ($P<0.05$) feed conversion ratio compared to controls from week 9 to 12. Fallah and Mirzaei (2016) observed that broilers receiving different levels of turmeric plus thyme powders had lowest FCR as compared to control group. Kafi *et al*. (2017) reported that feed conversion ratio was significantly higher in T1 and T2 (0.5 and 0.75percent turmeric) as compared to control groups.

Yesuf *et al*. (2017) reported that turmeric supplementation at1 g/kg feed significantly improved feed conversion ratio (FCR) as compared to control groups. Arslan *et al.* (2017) reported that turmeric supplementation at 0,0.5, 1.0 and 1.5 percent improved feed conversion efficiency but supplementation at the rate of 1.5 percent showed the best results in comparison to control group. Shohe *et al.* (2019) observed that average feed conversion efficiency was significantly ($P<0.05$) the lowest in T4 group (7.5 g turmeric powder /kg feed) followed by T3 (5 g turmeric powder / kg feed), T2 (2.5g turmeric powder / kg feed) and the highest in T1group. This might be better performance of in terms of body weight, body weight gain and feed intake in T4group as compared to other group.

Blood Parameters

Al-Sultan (2003) reported that turmeric supplementation at 0.5 and 1.0 percent increased both erythrocytic and total leukocytic count than control. Mehela and Moorthy (2008) reported that the serum glucose, total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides level did not differ significantly among treatment groups. Al-Noori *et al*. (2011) carried out a study to determine the effects of *Curcuma Longa* powder on some blood parameters of broiler chickens. Hundred and thirty five ROSS breed one day old broiler chicks were randomly divided into 3 groups (45 chicks per each) of mixed sex.

Curcuma longa powder was supplemented to the basal diet at T10.0 (Control), T2 0.5 and T3 1.0

percent respectively for6 weeks. Haemoglobin (Hb), Packed cell volume (P.C.V) exhibited a significant increase (P<0.05) as compared with control, treatment T2, T3 *Curcuma longa* recorded the highest values of Hb which were 10.3, 9.08gm/100ml then control (7.87 gm/100ml) and P.C.V were 30.3, 28.35 than that of control group(25.38 percent). Sugiharto *et al*. (2011) reported that broilers supplemented with turmeric extract at 800mg/kg diet enhanced production of hemoglobin in broilers. Al-Jaleel (2012) concluded that inclusion of turmeric at different level in feed viz. 0, 0.25, 0.50, 1.0and 1.5 percent showed was no significant difference in PCV (31.4, 32.2, 31.5, 31.7,32.1 percent) and Hb (8.94,9.05, 8.95, 8.94, 8.93 g/ml).

Hosseini-Vashan *et al*. (2012) reported that blood cholesterol and low density lipoprotein (LDL) decreased and blood high density lipoprotein (HDL) increased when TP supplemented to diet of heat stressed birds. Hussein (2013) revealed that supplementation of turmeric powder at 7g/kg feed of broiler diet reduced serum concentration of cholesterol and triglycerides when compared with the control. Fallah and Mirzaei (2016) observed that broilers receiving different levels of turmeric plus thyme powders had lower uric acid, total cholesterol, HDL, LDL and triglyceride concentrations as compared to the control group. Kafi *et al*. (2017) conducted an experiment where birds were fed in 5 groups as T1(0.5 percent turmeric), T2 (0.75 percent turmeric), T3(0.5 percent ginger), T4 (0.75 percent ginger), T5(combination of 0.5 percent turmeric and ginger) and reported that blood parameters such Hb (7.92, 7.38,7.65, 7.75, 7.24, 7.74 g/ml), PCV (31.5, 32, 32.5, 31.5,31.5 percent) were not statistically different among control and other treatment groups. Arslan *et al.* (2017) reported that turmeric supplementation improved antibody titers against ND and IBD, serum total cholesterol was reduced and HDL - cholesterol was increased, while LDL-cholesterol and triglycerides remained unaffected irrespective of different levels turmeric supplementation but the results at 1.5 percent level supplementation was found to be the best. Shohe *et al.* (2019) observed the average values of haemoglobin were 8.67, 8.85, 8.83, 8.88 g/ml in groupsT1, T2, T3 and T, respectively. The respective PCV values were 31.67, 31.93, 31.87 and 31.95 percent. The values for haemoglobin and PCV were not statistically different irrespective of different various treatment groups.

Dressing Percentage and Carcass Yield

Al-sultan (2003) observed that there was increased liver, bursa, and thymus weight as 33.55 g,2.66 and 2.79g when supplemented with diet containing 0.50 percent turmeric powder. While the higher spleen weight (1.76 g) index was observed higher in birds having 1.00 percent as compared to control (1.03g). Durrani *et al.* (2006) reported higher dressing percentage (55 percent) for broilers fed on diet supplemented with turmeric powder at 0.50 percent than control (51.00 percent). They also reported that the average weight of liver was 3.5, 3.1, 3.2 and 3.2 g and the average weight of heart was 8.2, 8.6, 9.0 and 8.0 g(P > 0.05) for the groups containing 0.00, 0.25, 0.50and 1.00 percent of turmeric powder, respectively.

Emadi and Kermanshahi (2006) studied the effect of turmeric rhizome powder (TRP) on carcass characteristics of Ross male broiler birds from 0-49days. A corn-soybean meal based diets containing varying levels of TRP (0.00, 0.25, 0.50 and 0.75 percent) was fed to broilers. The result of the relative weight of liver (0.182, 0.189, 0.186, 0.184), heart (0.499, 0.455, 0.430, 0.404), spleen (0.121, 0.109, 0.101, 0.126) were measured and observed that the addition of TRP into diets significantly (P < 0.05) decreased heart weight at 0.75 percent inclusion level but there was no significant increase or decrease in liver or spleen weight due to turmeric addition irrespective of their levels.

Mehala and Moorthy (2008) observed that the abdominal fat percentage, breast and thigh muscle showed no significant difference when fed with diet supplemented with turmeric, *aloe vera* and its combination as compared to control group. Al-Noori *et al*. (2011) carried out a study to determine the effects of turmeric powder on carcass traits of broiler birds. Hundred and thirty five one day old ROSS breed broiler chicks were randomly divided into 3 groups (45chicks per group) of mixed sex. *Curcuma longa* powder was supplemented to the basal diet at 0.0 (Control), 0.5and 1.0 percent (groups 2 and 3) respectively for 6weeks. The results indicated no significant effect in dressing percent and liver, spleen, heart and gizzard weight. Nouzarian *et al.* (2011) observed significant decrease in liver weight (2.43 percent of live bodyweight) when turmeric powder was supplemented at10.00 g/kg in broilers diet as compared to control (3.17per cent of live body

weight) and there was no significant difference in heart and spleen weight among the four treatments i.e., 0.0, 3.3, 6.6 and 10.0 g/kg turmeric powder added to the basal diet than control group. Daneshyar *et al.* (2011) reported that addition of turmeric rhizome powder at 0.00, 0.25, 0.50 and 0.75percent levels in the diet did not show any significant difference in the pH and the fat, protein, dry matter and ash concentrations of thigh meat as compared to control group. Al-Jaleel (2012) and Radwan *et al.,* (2008) also observed significantly (P <0.05) higher dressing percentage (77.8 ± 1.85) in broilers fed diet supplemented with turmeric at 0.50percent level as compared to control (73.6 ± 1.85).

Hussein (2013) reported that turmeric powder supplementation at 7.00 g/ kg of diet significantly (P <0.05) increased liver (2.33 ± 0.15 g) and gizzard (2.44± 0.06 g) weight; however, abdominal fat (1.29 ± 0.12g) was decreased significantly (P < 0.05) in comparison to control (1.76 ± 0.13 g). Khwairakpam *et al*. (2016) and Durran *et al*., (2006) found no significant difference in dressing percentage, weight of cut up parts and giblet among the groups but there was significant (P<0.05) reduction in abdominal fat in broiler chicks due to garlic and turmeric powder. Arslan *et al*. (2017) and Gowda *et al.,* (2009) concluded that turmeric had the potential to improve dressing percentage and cholesterol profile in broilers and its use at 1.5 percent through feed is recommended for better results. Shohe *et al.* (2019) observed that the average dressing percentage of broiler birds at the end of sixth week in four groups, T1 (No turmeric powder), T2 (2.5 g turmeric powder / kg feed), T3 (5 g turmeric powder /kg feed) and T4 (7.5 g turmeric powder / kg feed) were73.94, 75.27, 76.57 and 78.06 percent, respectively.

Higher dressing percentage was recorded in T4 followed by T3, T2 and the least in T1 group. Further, the average carcass weight of broiler birds was 1.976, 2.007, 2.038 and 2.186 kg/bird for T1, T2, T3 and T4groups, respectively. The average gizzard weight was 43.00, 51.33, 44.60 and 49.67 g for T1, T2, T3 and T4groups, respectively. The average heart weight for T1, T2, T3 and T4 groups was 14.33, 15.00, 13.33 and 20.00g, respectively. Likewise, the average liver weight was 55.67, 51.00, 50.33 and 56.00 g for T1, T2, T3 and T4, respectively. From the results, it was observed that the values for dressing percentage and carcass yield were better in T4 group as compared to the other groups. Higher dressing percentage and carcass yield in T4might be due to the positive influence of turmeric powder that led to more gain in body weight of the broilers. However, the values for the organ weight didnot vary much from control and treatment groups similar findings had been reported by Al-Noori *et al*. (2011); Khwairakpam *et al*. (2016) who observed no significant effect of turmeric supplementation on liver, spleen, heart, gizzard weight.

Economics of Rearing

Al-Sultan (2003) observed that the use of turmeric powder as feed additive at 0.50 percent level in broiler birds was cost effective. Durrani *et al*. (2006) showed that inclusion of turmeric powder at0.50 percent level in ration of broilers has substantially decreased the cost of feed per kg gain as compared to control ration. Mondal *et al*. (2015) and Rahardja *et al.,* (2015) reported the supplementation of turmeric powder at 0.50 percent level in diet had high potential as commercial applications for production performance of broiler. Kafi*et al.* (2017) and Al-Kassie *et al.,* (2011) observed the cost of production and return of birds was being highly economical in treatment 0.75percent of turmeric in feed as compared to control groups. Shohe *et al.* (2019) observed that the values for cost of production per bird at the end of sixth week in four groupsT1 (No turmeric powder), T2 (2.5 g turmeric powder / kg feed), T3 (5 g turmeric powder/kg feed) and T4 (7.5 g turmeric powder/kg feed) were219.33, 220.24, 220.59 and 220.93 rupees per bird, respectively. The corresponding values for average cost of production per kg live weight of bird was 87.04, 85.36, 83.87 and 81.52 rupees. The profit per bird was71.77, 77.76, 83.36 and 92.02 rupees for T1, T2, T3 andT4 groups, respectively and the corresponding values for net profit per kg live weight of birds were 28.48, 30.13, 31.70 and 33.96 rupees.

From the results, it was found that the cost of production per kg live weight of broiler was lowest in T4 followed by T3, T2 and the highest in T1 group. The net profit per kg live weight of broiler was highest in T4 as compared to other groups. From the results obtained in the present study it may be concluded that dietary supplementation of turmeric powder at 7.5g / kg of feed gives higher economical return.

Conclusion

It was concluded that dietary supplementation of turmeric powder was found to be beneficial in terms of performance as body weight gain, feed intake, feed conversion efficiency, live ability, performance index, carcass characteristics and organ weight, blood constituents like haemoglobin, packed cell volume, high density lipoprotein (HDL), low density lipoprotein (LDL), cholesterol and triglycerides and overall net profit of rearing broiler chicken as compared to the non-turmeric added birds.

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