DIETARY EFFECT OF TURMERIC (*Curcuma longa*) POWDER ON THE PERFORMANCE OF BROILER

A Thesis

By

MUHAMMAD AL-HELAL MONDOL

Registration No. 1205106

Session: 2012-2013

Semester: January-June, 2014

MASTER OF SCIENCE (M.S.)

IN

POULTRY SCIENCE

DEPARTMENT OF DAIRY AND POULTRY SCIENCE
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ABSTRACT

This study was aimed at investigating the dietary effect of different levels of Turmeric (*Curcuma longa)* powder on the performance of broiler during summer (June-July), 2013. Four experimental rations designated as T_0, T_1, T_2 and T_3 having 0%, 0.5%, 1.0% and 1.5% Turmeric (*Curcuma longa)* powder was fed to 120 broiler chicks (Ross 308), randomly distributed into 12 replicates, so as to have 3 replicates per treatment and 10 chicks per replicate. The experiment carried out for 28 days. Average weight gain, feed consumption, feed efficiency, dressing yield and survivability were used as criteria of response to feeding turmeric powder. Organs weight including heart, liver and gizzard was also recorded. The mean body weight gain per broiler was 1079, 1279, 1137 and 1151g in 28 days for groups T_0, T_1, T_2, and T_3, respectively ($P<0.01$). The average feed consumption per broiler was 1999, 1796, 1890 and 1854 g ($P>0.05$) in 28 days for groups T_0, T_1, T_2, and T_3, respectively. The average feed efficiency (feed/gain) was 1.86, 1.41, 1.66 and 1.61 ($P<0.01$) in 28 days for group T_0, T_1, T_2, and T_3, respectively. The mean dressing yield was 57%, 61%, 58% and 59% ($P<0.05$) for groups T_0, T_1, T_2, and T_3, respectively. The average weight of liver was 43, 42, 43 and 43 g ($P>0.05$) and the average weight of heart was 8.6, 8.01, 8.3 and 8.15 g ($P>0.05$) for groups T_0, T_1, T_2, and T_3, respectively. The mean gizzard weight was 37, 38, 37 and 37 g ($P>0.05$) for groups T_0, T_1, T_2, and T_3, respectively. Survivability was 96%, 93%, 96% and 93% ($P>0.05$) for groups T_0, T_1, T_2, and T_3, respectively. It was concluded that the use of Turmeric (*Curcuma longa)* as feed additive at a level of 0.5% enhances the overall performance of broiler chicks. Research to investigate the effect of different levels of Turmeric (*Curcuma longa*) in layers and breeders is recommended.

Key words: Turmeric**,** Dressing yield, Survivability

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ABBREVIATIONS	ELABORATIONS
FCR	Feed conversion ratio
MS	Master of Science
mg	Miligram
g	Gram
kg	Killogram
lit	Liter
ME	Metabolizable energy
CP	Crude protein
CF	Crude fiber
NS	Not significant
ml	Mililiter
µg	Microgram
IU	International unit
USA	United States of America
K	Potassium
Mg	Magnesium
Mn	Manganese
Na	Sodium
Kcal	Kilocalorie
P	Phosphorus
S	Sulphur
Ca	Calcium

CHAPTER I

INTRODUCTION

Poultry plays an important role in the economic development of the country. Bangladesh provides a very fertile and virgin field for the development of broiler industries. Broiler production has become a profitable and most popular income generating activity at present time for the people of the country. The broiler industry in Bangladesh is developing rapidly and its success depends on how rapidly a bird attains maximum marketable weight. The principle of poultry production is to achieve high level of performance through efficient utilization of feed keeping survivability as maximum as possible. The ultimate consumers of the end products of poultry are human beings and the major concern of all industries is the well being of the mankind. People of modern times are very much conscious about their health and quality of food items that they will consume. The term feed additive is applied in a broad sense, to all products other than those commonly called feedstuffs, which could be added to the ration with the purpose of obtaining some special effects (Feltwell and Fox, 1979).

The main objective of adding feed additives is to boost animal performance by increasing their growth rate, better-feed conversion efficiency, greater livability and lowered mortality in poultry birds. These feed additives are termed as "growth promoters" and often called as non-nutritive feed additives (Singh and Panda, 1992). Many synthetic drugs and growth promoters are supplemented to the broilers to have rapid growth, but their use have shown many disadvantages like high cost, adverse side effect on health of birds and long residual properties etc. Growth promoters are chemical and biological substances, which are added to livestock feed with the aim to improve the growth of chickens in fattening, improve the utilization of feed and in this way realize better production and financial results. Their mechanism of action varies. Positive effect can be expressed through better appetite, improved feed conversion, stimulation of the immune system and increased vitality, regulation of the intestinal micro-flora, etc. A variety of feed additives are being included in poultry diet to derive maximum growth of broiler chickens. 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 (Raghdad *et al.,* 2012).

Beneficial effects of bioactive plant substances in animal nutrition may include the stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, activation of immune responses and antibacterial, antiviral and antioxidant actions (Toghyani *et al.,* 2010, 2011).

The active ingredients found in Turmeric (*Curcuma longa)* are curcumin, demethoxy-curcumin, bisdemethoxycurcumin, (Wuthi-Udomler *et al.,* 2000) and tetrahydrocur-cuminoids (Osawa *et al.,* 1995). Plant extracts were found to have antifungal, (Wuthi-udomler *et al*., 2000) and anti- oxidative value (Osawa *et al*., 1995; Iqbal *et al.,* 2003). Some pharmacological activities of Turmeric (*Curcuma longa)* as nematocidal (Kiuchi *et al.,* 1993), hypolipidaemic (Ramirez-Tortosa *et al.,* 1999) and anti-inflammatory (Ammon *et al.,* 1993; Holt *et al.,* 2005) were demonstrated. Curcumin has also been studied exten-sively as a chemopreventive agent in several cancers (Duvoix *et al.,* 2005). Additionally, it has been suggested that curcumin possess hepatoprotective, antitumor, antiviral and anticancer activity (Polasa *et al.,* 1991). It is used in gastrointestinal and respiratory disorders (Anwarul *et al.,* 2006). Moreover Soni *et al*. (1997) proved the protective effects of Turmeric (*Curcuma longa)* as feed additives on aflatoxin-induced mutage-nicity and hepatocarcinogenicity. So, scientists are again concentrating on the use of our ancient medicinal system to find beneficial herbs and plants, which can be safely used to increase poultry production.

Keeping this view in mind, the research was conducted with the following objectives:

1. To investigate the effect of feeding Turmeric *(Curcuma longa)* powder on the performance of commercial broiler.
2. To investigate the effect of Turmeric (*Curcuma longa)* powder on the meat yield of commercial broiler.

CHAPTER II

REVIEW OF LITERATURE

Turmeric (*haldi*), a rhizome of *Curcuma longa*, is a flavourful yellow-orange spice. Its plant is 3 feet in height and has lance-shaped leaves and spikes of yellow flowers that grow in a fleshy rhizome or in underground stem. An orange pulp contained inside the rhizome constitutes the source of turmeric medicinal powder (Chainani *et al.,* 2003). Components of tumeric are named curcuminoids, which include mainly curcumin (diferuloyl methane), demethoxycurcumin, and bisdemethoxycurcumin. Curcumin (diferuloylmethane) is a polyphenol derived from *Curcuma longa* plant, commonly known as turmeric. The active constituents of turmeric are the flavonoid curcumin (diferuloylmethane) and various volatile oils including tumerone, atlantone, and zingiberone. Other constituents include sugars, proteins, and resins. The best-researched active constituent is curcumin, which comprises 0.3-5.4% of raw turmeric. Curcumin has been used extensively in ayurvedic medicine for centuries, as it is nontoxic and has a variety of therapeutic properties including antioxidant, analgesic, anti-inflammatory, antiseptic activity, and anticarcinogenic activity (Çıkrıkçı *et al.,* 2008). The chemical composition, medicinal properties, beneficial effect of turmeric on birds and animals are reviewed in this chapter.

2.1 Composition of turmeric

More than 100 components have been isolated from turmeric. The main component of the root is a volatile oil, containing turmerone, and there are other coloring agents called curcuminoids in turmeric. Curcuminoids consist of curcumin demethoxycurcumin, 5'-methoxycurcumin, and dihydrocurcumin, which are found to be natural antioxidants (Ruby *et al.,* 1995; Selvam *et al.,* 1995). In a standard form, turmeric contains moisture (>9%), curcumin (5–6.6%), extraneous matter (<0.5% by weight), mould (<3%), and volatile oils (<3.5%). Volatile oils include d-α-phellandrene, d-sabinene, cinol, borneol, zingiberene and sesquiterpenes (Ohshiro *et al.,* 1990).

There are a variety of sesquiterpenes, like germacrone; termerone; ar-(+)-, α- and β-termerones; β-bisabolene; α-curcumene; zingiberene; β-sesquiphellanderene; bisacurone; curcumenone; dehydrocurdione; procurcumadiol; bis-acumol; curcumenol; isoprocur-

cumenol; epiprocurcumenol; procurcumenol; zedoaronediol; and curlone, many of which are species specific. The components responsible for the aroma of turmeric are turmerone, arturmerone and zingiberene.

The rhizomes are also reported to contain four new polysaccharides-ukonans along with stigmasterole, β-sitosterole, cholesterol and 2-hydroxymethyl anthraquinone (Kapoor 1990; Kirtikar *et al.*, 1993). Nutritional analysis showed that 100 g of turmeric contains 390 kcal, 10 g total fat, 3 g saturated fat, 0 mg cholesterol, 0.2 g calcium, 0.26 g phosphorous, 10 mg sodium, 2500 mg potassium, 47.5 mg iron, 0.9 mg thiamine, 0.19 mg riboflavin, 4.8 mg niacin, 50 mg ascorbic acid, 69.9 g total carbohydrates, 21 g dietary fiber, 3 g sugars, and 8 g protein (Balakrishnan, 2007). Turmeric is also a good source of the ω-3 fatty acid and α-linolenic acid 2.5% (Goud *et al.*, 1993).

Raina *et al.* (2002) found that the rhizome oil contained 84 constituents, comprising 100% of the oil, of which the major ones were 1,8-cineole (11.2%), α-turmerone (11.1%), β-caryophyllene (9.8%), *ar*-turmerone (7.3%) and β-sesquiphellandrene (7.1%). The leaf oil contained 83 components, comprising 97.4% of the total oil, of which the main constituents were terpipolene (26.4%), 1,8-cineole (9.5%), α-phellandrene (8%) and terpinen-4-ol (7.4%).

2.2 Antioxidant properties of turmeric

Turmeric possesses excellent antioxidant properties. It is reported to be more potent in preventing lipid peroxidation than alpha-tocopherol, pine bark extract, grape seed extract or the commonly used synthetic BHT (Sreejayan and Rao, 1993, 1994).

Ramaswamy and Banerjee, (1994) found that turmeric dye exhibited excellent antioxidant properties on coconut oil, groundnut oil, cottonseed oil, and sesame oil.

Ramirez *et al.* (1995) observed that curcumin protects against free radical damage because it is a strong antioxidant. Toda *et al.* (1985) reported that water- and fat-soluble extracts of turmeric and its curcumin component exhibit strong antioxidant activity, comparable to that of vitamins C and E. An *in vitro* study measuring the effect of curcumin on endothelial heme oxygenase-1, an inducible stress protein, was conducted utilizing bovine aortic endothelial cells. Incubation (for 18 hours) with curcumin resulted in enhanced cellular resistance to oxidative damage (Mortellini *et al.*, 2000).

Cohly *et al.* (1998) reported that turmeric and curcumin provide protection against oxidative stress in a renal cell line.

Figure 1. Turmeric rhizome (Dried)

Figure 2. Turmeric powder

Table 2.1 Nutritive value of turmeric (*Curcuma longa*) per 100 g

Nutrient profile	Nutritive Value
Energy	354 Kcal
Carbohydrates	64.9 g
Protein	7.83 g
Total Fat	9.88 g
Cholesterol	0 mg
Dietary Fiber	21 g
Vitamins	
Folates	39 µg
Niacin	5.140 mg
Pyridoxine	1.80 mg
Riboflavin	0.233 mg
Vitamin A	0 IU
Vitamin C	25.9 mg
Vitamin E	3.10 mg
Vitamin K	13.4 µg
Electrolytes	
Sodium	38 mg
Potassium	2525 mg
Minerals	
Calcium	183 mg
Copper	603 µg
Iron	41.42 mg
Magnesium	193 mg
Manganese	7.83 mg
Phosphorus	268 mg
Zinc	4.35 mg

(Source: USDA National Nutrient data base)

2.3 Anti-inflammatory properties of turmeric

Ammon *et al.* (1993) reported that curcumin reduces inflammation by lowering histamine levels and possibly by increasing the production of natural cortisone by the adrenal glands, whereas Mukhopadhyay *et al.* (1982) observed that oral administration of curcumin in instances of acute inflammation was found as effective as cortisone or phenylbutazone and half as effective in cases of chronic inflammation and its anti-inflammatory properties may be attributed to its ability to inhibit both biosynthesis of inflammatory prostaglandins from arachidonic acid and neutrophil function during inflammatory states. The antiarthritic effects of turmeric include inhibition of joint inflammation and periarticular joint destruction. It also inhibited inflammatory cell influx, joint levels of PGE2 and periarticular osteoclast formation in rats (Funk *et al.*, 2006).

2.3.1 Effect of turmeric on liver and colon

Curcumin possesses hepatoprotective and choleretic properties. It protects the liver from a number of toxic compounds such as carbon tetrachloride (CCl4) (Deshpande *et al.*, 1998; Park *et al.*, 2000), galactosamine (Kiso *et al.*, 1983), acetaminophen (paracetamol), (Donatus *et al.*, 1990) and *Aspergillus* aflatoxin (Soni *et al.*, 1992).

Miyakoshi *et al.* (2004) observed that diets containing turmeric extract suppressed increases in lactate dehydrogenase (LDH), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels caused by D-galactosamine-induced liver injury in rats. Turmeric's hepatoprotective effect is mainly a result of its antioxidant properties as well as its ability to decrease the formation of proinflammatory cytokines. Sodium curcuminate, a salt of curcumin, also exerts choleretic effects by increasing biliary excretion of bile salts, cholesterol, and bilirubin as well as by increasing bile solubility, thereby, possibly preventing and treating cholelithiasis. Curcumin has choleretic activity that increases bile output and solubility, which may be helpful in treating gallstones (Ramprasad *et al.*, 1957).

Deshpande *et al.* (1998) indicated that 5% turmeric extract decreased carbon tetrachloride–induced increases in serum levels of bilirubin, cholesterol, AST, ALT, and alkaline phosphatase (ALP) in mice.

2.4 Effect of turmeric on heart

The protective effects of turmeric on the cardiovascular system include lowering cholesterol and triglyceride levels, decreasing susceptibility of low density lipoprotein (LDL) to lipid peroxidation (Ramirez *et al.*, 1995). Ramprasad *et al.* (1957) reported that turmeric extract's effect on cholesterol levels may be due to decreased cholesterol uptake in the intestines and increase conversion of cholesterol to bile acids in the liver. Srivastava *et al.* (1986) found that curcumin prevent platelets from clumping together, which in turn improves circulation and inhibition of platelet aggregation by curcumin constituents thought to be via potentiation of prostacyclin synthesis and inhibition of thromboxane synthesis.

2.5 Anticancer properties

Curcumin is antimutagenic as it potentially helps to prevent new cancers that are caused by chemotherapy or radiation therapy used to treat existing cancers. It effectively inhibits metastasis (uncontrolled spread) of melanoma (skin cancer) cells and may be especially useful in deactivating the carcinogens in cigarette smoke and chewing tobacco (Mehta *et al.*, 1997; Menon *et al.*, 1991). The anticarcinogenic effects of turmeric and curcumin are due to direct antioxidant and free-radical scavenging effects and their ability to indirectly increase glutathione levels, thereby aiding in hepatic detoxification of mutagens and carcinogens and in inhibiting nitrosamine formation (Hanif *et al.*, 1997, Dorai *et al.*, 2001).

2.6 Antimicrobial properties of turmeric

Turmeric has strong antimicrobial properties Turmeric extract and the essential oil of Curcuma longa inhibit the growth of a variety of bacteria, parasites, and pathogenic fungi. Improvements in lesions were observed in the dermatophyte and fungi-infected guinea pigs, as at 7 days post-turmeric application, the lesions disappeared (Apisariyakul *et al.*, 1995). Curcumin has also been found to have moderate activity against *Plasmodium falciparum* and *Leishmania majo* (Rasmussen *et al.*, 2000)

Belle (1980) reported that turmeric extract as antibacterial and anti-inflamatory natural dye for cosmetics like shampoos, lotions, and sprays.

Curcumin and turmeric extract tested on different strains of bacteria showed they possess strong antibacterial activity (Basu, 1971; Wuthi-Udomlert *et al.*, 2000; Chauhan *et al.*, 2003).

The growth of histamine-producing bacteria *(Vibrio parahaemolyticus, Bacillus cereus, Pseudomonas aeruginosa*, and *Proteus mirabilis)* was inhibited by garlic and turmeric extracts at a 5% concentration (Paramasivam *et al.*, 2007). Turmeric was also found to inhibit histamine production in *Morganella morganii* (potent histamine-producing bacteria). However, inhibition of histamine production and histidine decarboxylase activity of turmeric is less than that of clove and cinnamon (Shakila *et al.*, 1996). Turmeric extract was found to inhibit growth of the foodborne pathogen *V. parahaemolyticus* with good sensitivity (Yano *et al.*, 2006). A methanolic extract of turmeric inhibited the growth of different strains of *Helicobacter pylori* with a minimum inhibitory concentration range of 6.25–50.0 μg/ml (Mahady *et al.*, 2002). Among the various plant extracts that killed *H. pylori*, such as cumin, ginger, chili, borage, black caraway, oregano, and licorice, turmeric was found to be the most efficient (O'Mahony *et al.*, 2005).

2.7 Local effects

Snow (1995) observed that fresh juice from the rhizome or a paste prepared from turmeric or decoction is often used as a local application as well as internally in the treatment of leprosy, snake bites, and vomiting associated with pregnancy.

2.8 Gastric effects

Turmeric and curcumin has been historically used as a carminative and digestive. Prucksunand *et al*. (2001) conducted an experiment and found that curcumin has a significant role in cases of gastric ulcers. Platel *et al.* (1996) reported that curcumin stimulates digestion of fats and carbohydrates in animal models.

2.9 Turmeric as poultry feed

Raghdad *et al*. (2012) conducted an experiment and found that the inclusion of turmeric at the levels of 0.50% in the diets improved body weight, feed conversion ratio and feed consumption. At the same time there was no difference for edible parts, dressing percent,

PCV, RBC, Hb, and WBC while there was improved Albumin and globulin. Al-Sultan *et al.* (2003) concluded that the use of tumeric as feed additive at level of 0.5% enhance overall performance of broiler chickens and cost effective. Durrani *et al.* (2006) concluded that the use of Turmeric (*Curcuma longa)* as feed additive at level of 0.5% enhances the overall performance of broiler chicks.

Yaghobfar *et al.* (2011) reported that supplementation of turmeric powder to diets based soybean oil could improve production index in broiler fed diets contained 8 g/kg without affect immune system.

Galib *et al*. (2011) concluded that the use of mixture containingcumin (*Cuminum cyminum*) and turmeric (*Curcuma longa*) as feed additive at levels 0.75% and 1% enhanced the overall performance of broiler chicks and depressed the cholesterol, Hb, RBC, WBC, and H/L ratio concentration.

Nouzarian *et al.* (2011) dietary inclusion of turmeric powder failed to induce any significant improvement on performance indexes except feed efficiency of broiler chickens. Nevertheless, the application of turmeric powder in the diet proved to have positive influence on carcass abdominal fat and serum triglyceride concentration at slaughter age.

CHAPTER III

MATERIALS AND METHODS

3.1 Statement of the research work

The experiment was conducted at the poultry shed under the Department of Dairy and Poultry Science, in Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, to investigate the dietary effect of turmeric (*Curcuma longa*) powder on the performance of broiler (Ross 308) during the period from 20 June to 11 July, 2013. To complete the research work following steps were followed:

3.2 Preparation of the experimental house and equipment

An open sided house with two rooms were used for rearing the experimental birds. The experimental house was properly washed and cleaned by forced water using a hosepipe. After washing with clean water, the rooms were disinfected by quick lime and the rooms were left vacant for 15 days. At the same time all feeders, plastic buckets, waterers and other necessary equipments were also properly cleaned, washed and disinfected with Virocid®, subsequently dried and left them empty for at least one week before the arrival of chicks. Ceiling, walls, and wire nets were also thoroughly disinfected by spraying Virocid® (4ml/lit). After 7 days, the house was divided into 12 pens of equal size using wood ship and wire net.

3.3 Collection of the experimental birds

A total 120 day-old broiler chicks (Ross 308) were purchased from CP Bangladesh Limited, Birampur, Dinajpur, Bangladesh.

3.4 Layout of the experiment

The day-old chicks were reared at brooder house to adjust with the environmental condition up to 7 days. After 7 days, chicks were randomly allocated four dietary treatment groups of 30 chicks each; each treatment was composed of three replications with 10 birds. The layout of the experiment is shown in Table 3.1.

Table 3.1 Layout showing the distribution of experimental broilers

Dietary treatments	Number of broilers in each replication			Total
	R_1	R_2	R_3	
Control (without turmeric powder)	10	10	10	30
Control+0.5% turmeric powder	10	10	10	30
Control+1% turmeric powder	10	10	10	30
Control+1.5% turmeric powder	10	10	10	30
Total No. of broilers	40	40	40	120

3.5 Procurement of feed ingredients

Required amounts of feed ingredients for making the experimental diets were procured from the local market of Dinajpur town. During procurement, ingredients were evaluated carefully for their freshness by observing its color with naked eye and smell with nose.

3.6 Collection, processing and storage of turmeric powder

Dried *Curcuma longa* rhizomes purchased from local spices market of Dinajpur (Bangladesh). The samples were further ground into powder by machine at Bahadurbazar (Dinajpur). The obtained powder was packed in a polythelene bag and preserved in the feed storage room until used for feed formulation. Proper care was taken in the feed storage room to avoid spoilage.

3.7 Preparation of the experimental diet

Loose feed was used throughout the experimental study. The experimental period were divided into two phases (broiler-starter and broiler-finisher). Broiler starter diet was provided between 0 and 14 days, and broiler finisher was fed from 15 to 28 days. Turmeric powder was incorporated into the experimental diets manually in appropriate doses.

At first required amount of feed ingredients were weighed by digital weighing balance. Then micronutrients (vitamin-mineral-aminoacid premix, lysine and methionine) and common salt were mixed thoroughly with small amount of weighing rice polish in a

separate place. After that the remaining rice polish were mixed with the previously mixed ingredients. After proper mixing, it was then thoroughly mixed with maize and soyabean meal properly. Required amount of soyabean oil was sprayed on the mixed feed ingredients and finally, different level of turmeric powder was mixed like rice polish with different treatment. During the time of mixing cross mixing was applied. Mixing was done manually and no coccidiostat or any other feed additives were added to the formulated diets in order to obtain clear-cut effect of the test-diet. The experimental diets were designed as-

T_0: control

T_1: control+ 0.5% turmeric powder

T_2: control+ 1% turmeric powder

T_3: control+ 1.5% turmeric powder

Table 3.2 Composition of the experimental starter and finisher diets fed to broilers

Feed ingredients	Amount (kg/100kg feed)	
	Starter (1-14 days)	Finisher (15-28days)
Maize	53.5	57.00
Rice polish (Auto)	10.0	10.0
Soybean meal (44)	23.0	18.0
Protein Concentrate (Jasoport)	10.0	10.0
Oyester shell	1.0	0.75
DCP(Di-calcium phosphate)	0.5	0.75
Soybean oil	1.5	3.0
Common salt	0.25	0.25
Vitamin- mineral- aminoacid Premix	0.25	0.25

Turmeric powder was added to the experimental diets (except control diet) at required amount according to each treatment.

Vitamin-mineral-aminoacid premix was added @ 250 g per 100 kg which contained: vitamin A: 4800 IU; vitamin D: 960 IU; vitamin E: 9.2 mg; vitamin k_3: 800 mg; vitamin B_1: 600 mg; vitamin B_2: 2 mg; vitamin B_3: 12 mg; vitamin B_5: 3.2 mg; vitamin B_6: 1.8 mg; vitamin B_9: 2 mg; vitamin B_{12}: 0.004 mg; Co: 0.3 mg; Cu: 2.6 mg; Fe: 9.6 mg; I: 0.6 mg; Mn: 19.2 mg; Zn: 16 mg; Se: 0.48 mg; DL – Methionine: 20 mg; L- lysine: 12 mg.

Table 3.3 Chemical Composition of experimental ration

Nutrients	Starter diet	Finisher diet
ME (kCal/kg)	2977	3074
CP (%)	21.21	19.40
CF (%)	5	5
Ca (%)	1.00	0.95
Available P (%)	0.74	0.75
Ash (%)	6	6
Lysine (%)	1.02	0.89
Methionine (%)	0.35	0.35

3.8 Routine management

The experiment birds were exposed to similar care and management in all treatment groups throughout the experimental period. The following management practices were followed during the whole experimental period and these management practices were identical for all dietary groups.

3.8.1 Litter management

Fresh, clean and dried rice husk was used as litter materials at a depth of about 3 cm. The litter was well covered by clean newspaper up to the first 7 days. Before use of litter calcium carbonate was spread on the floor. After first week, upper part of the litter with droppings were removed regularly and stirred three times a week up to the end of the experiment. The litter was disinfected with Virocid® solution in every other day. Litter materials, when found damp for any reason, were removed to prevent accumulation of ammonia and other harmful gases. At the end of each week, litter was stirred to break its

compactness and maintain proper moisture. At the end of 2nd and 3rd weeks of age, dropping were cleaned from the surface of litter.

3.8.2 Floor space

All the broilers were given a floor space of 1 sq. feet. Fresh dried rice husk were used as litter materials on the floor at a depth of 4 inch.

3.8.3 Brooding of broiler

The experiment was conducted in summer (June to July/2013). During the experimental period, the experimental temperature was higher than that requirement. The broilers were housed on floor and routinely managed as any other commercial broiler flock. Heating was provided by a single electric brooder, where the initial temperature was set at 37^{o} C and decreased gradually at the rate of 3^{o}C in each week until they were adjusted to normal environmental temperature of the house and final temperature was 28^{o} C at the end of experiment. Additional heat was provided by fitting 100-walt electric bulb at the center of the pen about 6 inches above the floor from the 7-day old. The height of the bulbs was increased by raising the bulb gradually as per need of temperature. Polyethene sheets were used on two sides of the house and in ventilators to protect cold and stormy wind. These sheets were removed partly or completely particularly at the later stage of finishing period when room temperature was found favorable. Daily room temperature (^{o} C) was recorded every six hours with a thermometer.

3.8.4 Lighting

All birds were exposed to continuous lighting of 23 hours and one hour dark period per day throughout the experimental period. The dark period was practiced to make the broilers familiar with the possible darkness due to electricity failure. Supplementary light at night was provided by electric bulb by hanging at a height of 2.8 miters to provide necessary lighting.

3.8.5 Feeding and drinking

Feeds were supplied to the chicks on clean newspapers at three hours interval for the first 3 days. Linear feeder and round plastic drinker were used during brooding period. After that linear feeder was replaced by round plastic drinker. After 2 weeks, feeds were

supplied twice daily (once in the morning and again in the afternoon) and water was supplied thrice daily (once in the morning, in afternoon and again at night). Feed and fresh water were offered to the bird manually according to experimental schedule. One round plastic feeder and drinker were provided for ten birds**.** Feeders were cleaned at the end of each week and drinkers were washed daily. All broilers in different treatments had fresh feed and drinking water *ad libitum* throughout the experimental period.

Figure 3. Feeding and drinking of broiler

3.8.6 Immunization

All broilers were vaccinated against Baby Chick Ranikhet Disease and Infectious Bronchitis at day one. The birds were vaccinated against Gumboro disease firstly at 14th day and boostering at 21st day. Vaccine was administered through drinking water at the cooler part of the day (evening).

3.8.7 Medication

Immediately after unloading from the chick boxes the chicks were given Vitamin-C and glucose to prevent the stress occurring during transport. Water soluble vitamin and normal saline were also provided for the first 3 days of brooding. During the course of experimental period, electrolytes and vitamin-C were added with the drinking water to combat stress due to high environmental temperature (33 to 37^{o} C).

3.8.8 Sanitation

Proper hygienic measures and strict sanitation programs were followed during the experimental period. The entrance point and veranda were kept clean and disinfectant (Virocid®) was sprayed regularly. In addition, the service area of the experimental rooms, outside wall and feed storage room were kept clean.

3.8.9 Bio-security

To prevent the outbreak of diseases, the following measures were taken to maintain bio-security.

i. Entrance of visitors were not allowed except worker, researcher, supervisor and co-supervisor who visited farm by following special care. At the entrance gate of the experimental shed there was a signboard sited "RESTRICTED AREA –NO ENTRANCE WITHOUT PERMISSION".
ii. Before entrance, hands were washed with soap and shoes were changed, feet were dipped in a footbath containing disinfectant solution (potassium permanganate) and the footbath was at the entrance point.
iii. All equipment of the experimental house was kept clean.
iv. Sick broilers were promptly isolated to a separate place from the experimental pens.
v. Dead broilers were removed promptly and buried far away the experimental house.
vi. A special dress was used inside the house during working with broilers.
vii. The experimental areas were kept free of rats, cats, dogs, and wild flying birds.

3.8.10 Postmortem examinations of broilers

Dead birds (if any) were sent to the Upazila Veterinary Hospital, Sadar Dinajpur to carry out post-mortem exanimation. After postmortem examination, the results were collected and necessary measures were taken to remove the problem without applying medicines.

3.9 Processing of broilers

At 28 days of age, one bird from each treatment was selected randomly. Before slaughtering the birds were kept in fasting condition for 24 hours. Just before slaughtering the birds were weighed. Birds were slaughtered according to halal method. Following slaughter, broilers were allowed to bleed for about 2 minutes. Then the birds were scaled in hot water (60-65^{o} C) for about 120 seconds in order to loosen the feather of the carcasses and weighed again. Breast meat, thigh meat, drumstic meat were separated from the carcass. Finally, processing was performed by removing head, shank, viscera, oil gland, kidney and giblets. As soon as these were removed the gall bladder was removed from the liver and pericardial sac and arteries were cut from the heart. Cutting it loose in front of the proventriculus and then cutting with both incoming and outgoing tracts removed the gizzard. Then, it was split open with knife, emptied and washed and the lining removed by hand.

3.10 Data collection and record keeping

The following records were kept during four weeks of rearing period:

i. Live weight: Initial and the end of each week
ii. Feed consumption: At the end of each week
iii. Survivability: Recorded from mortality
iv. Temperature: Six times daily during the experimental period.
v. Dressing yield: At the end of the experiment one broiler was slaughtered from each replication to estimate dressing yield.

3.10.1 Live weight gain

The average body weight gain of each replication was calculated by deducting initial body weight from the final body weight of the birds.

Final weight – Initial weight

3.10.2 Feed intake

Feed intake was calculated as the total feed consumption in a replication divided by number of birds in each replication.

$$\text{Feed Intake (g/bird)} = \frac{\text{Feed intake in a replicatio n}}{\text{No. of birds in a replicatio n}}$$

3.10.3 Feed conversion ratio

Feed conversion ratio (FCR) was calculated as the total feed consumption divided by weight gain in each replication.

$$\text{FCR} = \frac{\text{Feed intake (kg)}}{\text{Weight gain (kg)}}$$

3.10.4 Survivability

Survivability percentage was calculated as the total broilers survived divided by the number of starting birds multiplied by 100.

3.10.5 Dressing yield

Dressing yield is based on the relationship between the dressed carcass weight and live bird weight after things like the skin and internal organs have been removed. Dressing yield can be calculated by taking weight of the carcass divided by weight of live bird.

$$\text{Dressing yield} = \frac{\text{Weight of the carcass}}{\text{Weight of live bird}} \times 100$$

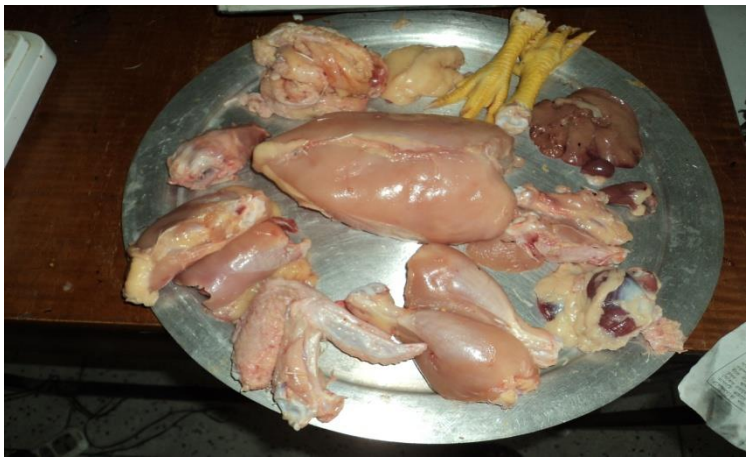

Figure. 4. Different cut-up parts of broiler

3.11 Statistical analysis

Data on different variables were subjected to analysis of variance (ANOVA) in a Completely Randomized Design (CRD), (Steel and Torrie, 1980). The significant differences between the treatment means were calculated by the Duncan's Multiple Range Test (DMRT). All analyses were performed by using MSTATC Program.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Performance of broiler

The results of productive performance in terms of live weight gain, feed consumption, feed conversion ratio, dressing yield, organ growth traits, survivability were used as criteria of response of broiler to different dietary levels of turmeric powder are presented in the following sections.

4.2 Effect of turmeric powder on body weight gain

Initial body weight of day-old broiler chicks fed on different dietary treatment was similar (P>0.05) (Table 4.1). From 1 to 14 days of age, the highest (358.10g) body weight gain was attained by broilers received turmeric powder at 0.5 % (P<0.05) and also from 15 to 28 days of age, the body weight gain was significant (P<0.01) in treatment T_1 (920.70g). During 1 to 28 days of age, the body weight gain (1279.0gm) in birds fed diet containing turmeric powder at level of 0.5% was significantly higher (P<0.01) followed by birds received 1.5% (1151.0g), 1% (1137.0g) and 0% (1079.0g) turmeric powder. The significant increase in body weight in treatment T_1 (1279.0g) may be due to optimum antioxidant activity of turmeric (*Curcuma longa*) at the level of 0.5% that can stimulate protein synthesis by bird's enzymatic system. The significant effect of turmeric powder on body weight was in agreement with the findings of some previous reports (Durrani *et al.,* 2006; Raghdad *et al.,* 2012; Osawa *et al*., 1995; Samarasinghe *et al.,* 2003; Wuthi-Udomler *et al.,* 2000). They had found that inclusion of turmeric at the rate of 5g/kg significantly increase body weight of broiler. But these findings contradict with the observation of Namagirilakshmi (2005), who stated that broiler fed on turmeric either at 0.25, 0.50, 0.75 or 1%) level did not significantly affect body weight gain.

4.2.1 Effect of turmeric powder on feed intake

Feed intake of broilers in different dietary treatments from 1 to 14 days of age was statistically significant (P>0.05) but during 15 to 28 days of age and also 1 to 28 days of experimental periods was almost statistically similar and the differences were non-significant (P>0.05) (Table 4.1). The above results agreement with of some earlier

studies (Nouzarian *et al.*, 2001; Wuthi-Udomler *et al.*, 2000). In those studies, feed intake of different broiler treatment did not differ significantly ($P<0.05$). However, these results disagreed with Raghdad *et al.* (2012) who found that significant difference in feed consumption.

Table 4.1 Performance of the broiler chickens fed the experimental diets

Parameters	T_0	T_1	T_2	T_3	Level of significance
Initial body weight (g/bird)	39.67±0.333	39.67±0.333	39.00±0.577	39.00±0.577	NS
Feed consumption(g/bird)					
1-14 days	467.10±6.30^{a}	417.30±11.05^{b}	438.30±11.30^{ab}	440.40±9.39^{ab}	*
15-28 days	1532.59±30.26	1379.38±34.92	1452.09±43.31	1414.45±0.80	NS
1-28 days	1999.74±33.92	1796.68±41.97	1890.43±54.52	1854.89±40.55	NS
Weight gain (g/bird)					
1-14 days	302.50±7.04^{b}	358.10±10.64^{a}	325.40±11.96^{ab}	336.50±8.32^{a}	*
15-28 days	776.20±35.51^{b}	920.70±14.34^{a}	811.50±15.35^{b}	814.80±5.57^{b}	**
1-28 days	1079.00±41.70^{b}	1279.00±20.73^{a}	1137.00±27.19^{b}	1151.00±14.18^{b}	**
FCR					
1-14 days	1.55±0.049^{a}	1.17±0.035^{c}	1.35±0.053^{b}	1.31±0.038b^{c}	**
15-28 days	1.98±0.062^{a}	1.50±0.061^{c}	1.79±.053^{b}	1.73±0.050^{b}	**
1-28 days	1.86±0.055^{a}	1.41±0.055^{c}	1.66±0.052^{b}	1.61±0.047^{b}	**
Survivability (%)	96.67±3.33	93.33±3.33	96.67±3.33	93.33±3.33	NS

Where, T_0 =0%; T_1 =0.5; T_2 =1 %; T_3 =1.5 %

^{abc} Figures in the row with similar superscripts alphabet did not differ significantly.

**=(P<0.01), *=(P<0.05), NS=(Non-significant)

Table 4.2 Effect of turmeric powder supplementation in diet of broiler on meat yield at 28 days of age

Parameters(g)	T_0	T_1	T_2	T_3	Level of significance
Abdominal fat	2.50 ± 1.00^{a}	1.31 ± 0.090^{b}	1.35 ± 0.090^{b}	1.62 ± 0.115^{b}	**
Heart	8.60±2.30	8.01±0.690	8.30±0.150	8.15±0.360	NS
Liver	43.05±0.150	42.90±0.100	43.00±0.650	43.08±0.790	NS
Gizzard	37.60±1.40	38.05±0.950	37.50±0.695	37.42±.575	NS
Dressing yield (%)	57.00 ± 0.20^{b}	61.00 ± 0.500^{a}	58.00 ± 0.50^{b}	59.00 ± 1.00^{ab}	*

Where, T_0 =0%; T_1 =0.5; T_2 =1 %; T_3 =1.5 %

^{abc}, Means in the same row with uncommon superscript differ significantly.

**=(P<0.01), *=(P<0.05), NS=(Non-significant).

4.3 Effect of turmeric powder on feed conversion ratio

Feed conversion ratio in different dietary treatments during the whole experimental period was statistically significant ($P<0.01$). At the end of the trial (28 days of age), the FCR was lowest in treatment T_1 (1.41) followed by T_3 (1.61), T_2 (1.66) and T_0 (1.86), respectively (Table 4.1), indicating that the best feed efficiency was due to optimum antioxidant activity of turmeric powder at the level of 0.5%. Similar result was found by Durrani *et al.* (2006); Raghdad *et al.* (2012); Al-Sultan *et al.* (2003); and Wuthi-Udomler *et al.* (2000). They reported that broilers that received diet with 0.5% of turmeric powder utilized their diets more efficiently. However, Yaghobfar *et al.* (2011) stated that there was no significant effect of feeding turmeric powder on FCR at the level of 0.4 and 0.8%.

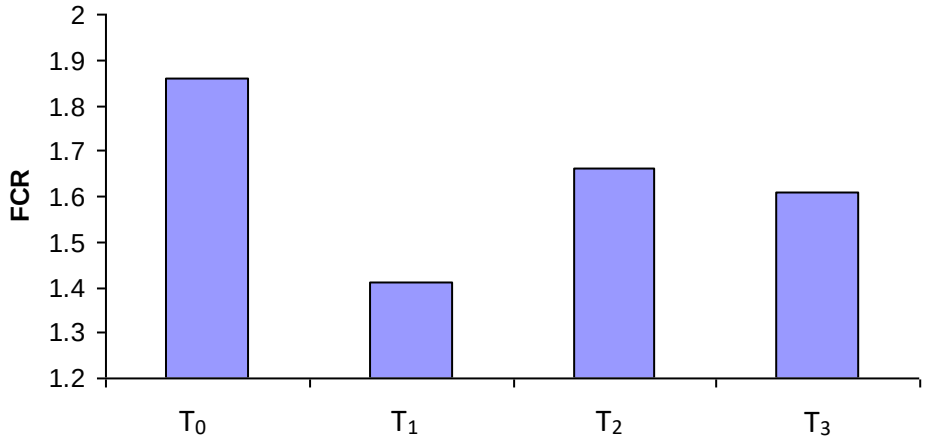

Figure. 5. Feed conversion ratio for different dietary treatments

4.4 Effect of turmeric powder on survivability

Survivability of broilers fed on different dietary treatments was very high during the study period. The survivability did not vary significantly ($P>0.05$) among different treatment groups during the whole experimental period.

4.5 Effect of turmeric powder on meat yield

Data on carcass characteristics and organ weights are presented in Table 4.2. This study showed that fat content of broiler was decreased significantly by supplementation of turmeric powder in broiler ration ($P<0.01$). Among different dietary treatments, amount of abdominal fat was lowest in T_1 (1.31g) followed by T_2 (1.35g), T_3 (1.62g) and T_0 (2.5g), respectively (Table 4.2). These results agreed with some other researchers (Nouzarian *et al.,* 2001; Al-Sultan *et al.,* 2003), who reported lower fat content in broilers that fed diet containing 0.5% turmeric powder.

The non significant ($P>0.05$) effect of turmeric powder on the weight of internal organs (heart, liver and gizzard) of broilers fed experimental rations was in close agreement with the observation (Lal *et al.,* 1999; Al-Sultan *et al.,* 2003), who reported that feeding of turmeric did not alter the size of liver, gizzard, heart.

This study demonstrated significant ($P < 0.05$) difference in dressing yield. The highest dressing yield (61%) was found in T_1 (0.5%) followed by T_3 (1.5%), T_2 (1.0%) and the lowest value (57%) found in T_0. Raghdad *et al.* (2012) used turmeric powder and found dressing percentage 73.6, 74.6, 77.8, 75.7 and 75.8 using 0%, 0.5%, 1.0% and 1.5%, and turmeric powder, respectively.

CHAPTER V

SUMMARY AND CONCLUSION

The objectives of this study were to evaluate the varying doses of turmeric powder supplemented diets on broiler chicks. The feeding value of turmeric powder on broiler (Ross 308) was evaluated in the poultry shed, Hajee Mohammad Danesh Science and Technology University, Dinajpur. In a feeding trial, four (4) diets were prepared including of turmeric powder at levels of 0% (control), 0.5%, 1.0% and 1.5%. Body weight and feed consumption were recorded on daily basis and weekly basis. At the last day of the experiment, a total of four broilers were sacrificed and meat yield, dressing percentage, internal organ weight and fat content were recorded. Survivability was also recorded throughout the study.

By using experimental diets feed intake of different dietary treatments were almost similar and the differences were statistically non-significant (showed in Table 4.1). Feed consumption by the broilers during the entire experiment period in different treatment groups was recorded and expressed as g/day. Although the rate of feed intake varied from day to day the highest feed intake (g/day) was recorded in control group (1919g) followed by in treatments containing 1% (1890g), 1.5% (1854g) and 0.5% (1796g) level of turmeric powder. In all test groups, feed consumption was almost similar to control group (1919g) ($p>0.05$). Data obtained on final average body weight indicated that there was no positive correlation between body weight and feed consumption. Feed conservation ratio (FCR) was the highest at 0.5% level of turmeric powder (1.41) compared with other groups. The FCR values were 1.86, 1.41, 1.66 and 1.61 at 0%, 0.5%, 1.0%, and 1.5% level of turmeric powder.

Survivability was almost similar in all dietary treatments ($p>0.01$). In this experiment, highest survivability (96%) was observed in control group and at 1.0% level of turmeric powder in comparison to others groups. Survivability was 93% at 0.5% and 1.5% level of turmeric powder. Fat content was reduced due to inclusion of turmeric powder. The highest fat content was observed in control group (2.5g) and the lowest (1.31g) at 0.5% level of turmeric powder.

The slaughter data of broiler chicks fed experimental diets were represented in % of live weight. No significant ($p>0.05$) effect was observed for internal organs (liver, heart and gizzard) weight of broilers fed experimental rations but there was significant ($P<0.05$) difference found on dressing yield. The highest dressing yield (61%) was found in T_1 (0.5%) and the lowest value (57%) found in control group.

Based on the results of the present study, it may be concluded that turmeric powder supplemented at a level of 0.5% has significant effect on body weight gain, FCR, abdominal fat content and dressing percentage of broiler, except feed intake and survivability. The results of the study also suggest that the supplementation of turmeric (*Curcuma longa)* powder at 0.5% level in diets has high potential as commercial applications for production performance of broiler. Therefore, turmeric powder can be used along with the other conventional feed ingredients. However, further research to investigate the effect of different levels of Turmeric (*Curcuma longa*) in layers and breeders is recommended.

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