EFFECTS OF TURMERIC PASTE ON GROWTH PERFORMANCE, IMMUNE RESPONSE AND BLOOD CHARACTERISTICS IN JAPANESE QUAIL

A THESIS

BY

MD. SADDAM HOSSEN

Registration No.: 1605507

Session: 2016-2017

Semester: January-June, 2018

MASTER OF SCIENCE (MS)
IN
PHYSIOLOGY

DEPARTMENT OF PHYSIOLOGY AND PHARMACOLOGY
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200, BANGLADESH.

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DEDICATED
TO MY
BELOVED PARENTS

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The Author

ABSTRACT

The experiment was conducted from February to March 2018 at the poultry research shed under the Department of Physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The present study was investigated to know the effects of turmeric paste on growth performance, immune response and Blood characteristics in quail. In this study, forty 14-days old quails were assigned to four dietary treatments named T_0, T_1, T_2 & T_3 with Ten (10) birds in each groups in completely randomized design. Turmeric paste was supplemented to T_0, T_1, T_2 & T_3 through feed at the rates of 0%, 0.5%, 1.5% and 2.5% respectively throughout the rearing period from 14-day old to 49-day old. Body weight gain, feed consumption and feed conversion ratio were measured on a weekly basis. Blood samples were collected at the 35^{th} and 49^{th} day of age for determination of Blood characteristics (PCV, Hb and ESR) and antibody titers against infectious coryza. At the end of the experiment, 3 birds per group were slaughtered to obtain carcass characteristics data. The results of this study was indicated that final live weight gain and feed conversion ratio of birds was significantly ($p<0.05$) higher that received 2.5% turmeric paste compared to control T_0. This result also indicated that body weight gain, feed consumption and feed conversion ratio was increased along with increasing dose of Turmeric paste. Carcass characteristics were no significant difference among the treatment group except breast meat weight. Blood parameters (PCV and Hb) there were significant ($p<0.05$) difference among the treatment groups. Turmeric supplementation improved antibody titers against infectious coryza. It can be concluded that turmeric has the potential to improve growth performance, immune response and blood characteristics and its use at 2.5% through feed is recommended for better results.

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ABBREVIATIONS AND SYMBOLS

Abbreviations	Full meanings
%	Percentage
° C	Degree celcius
/	Per
:	Ratio
@	At the rate of
<	Less than
>	Greater than
±	Plus minus
AIDS	Acquired immuno deficiency syndrome
AGP	Antibiotic Growth Promoter
Agri	Agriculture
ANOVA	Analysis of variance
App	Applied
ATCC	American type culture collection
Av.	Average
BW	Body weight
Cm	Centimeter
Cm^2	Square centimeter
Contd.	Continued
CRD	Completely randomized design
CP	Crude protein
DD	Data deficient
DM	Dry matter
e.g.	For example
et al.	And others
ESR	Erythrocyte sedimentation rate
FCR	Feed conversion ratio
Fig.	Figure
GDP	Gross domestic product
G	Gram

Hb	Hemoglobin
HSTU	Hajee Mohammad Danesh Science And Technology university
HIV	Human immuno deficiency virus
i.e.	That is
IBD	Infectious bursal disease
IC	Infectious coryza
Int	International
Ital	Italian
J	Journal
K	Potassium
Kcal	Kilo-calorie
ME	Metabolizable energy
mg	Milligram
Mg	Magnesium
MJ	Mega joule
mm	Millimeter
Med	Medicine
MBC	Minimum bactericidal concentration
MCH	Mean cell hemoglobin
MCHC	Mean cell hemoglobin concentration
MIC	Minimum inhibitory concentration
MMP	Matrix metalloproteinase
MRSA	Methicillin resistant staphylococcus aureus
ND	Newcastle disease
NF	Neurofibromatosis
No.	Number
NRC	National research institute
P	Page
PCV	Packed cell volume
PHA	Passive hemagglutination assay
Poult	Poultry
Res	Research
SAEDF	Southern asia enterprise development fund

SED	Standard error difference
Sci	Science
SGOT	Serum glutamic oxaloacetic transaminase
Sq.	Square
SRBC	Sensitized red blood cell
TP	Turmeric paste
TLC	Total leucocyte count
TEC	Total erythrocyte count
USDA	United state department of agriculture
Univ	University
Vet	Veterinary
WFP	World food programme
WBC	White blood cell

CHAPTER I

INTRODUCTION

Poultry is one of the best growing segments of the agricultural sector in Bangladesh. It plays a vital role in the subsistence economy and contributes 1.6% in GDP (SAEDF 2008) in Bangladesh. Bangladesh Government initiated activities with the aim of improving the livelihoods of the poor sections by involving them in livestock and poultry rearing. The smallholder livestock development programme involving this group of people began in Bangladesh in 1984-85. To this end, the World Food Programme (WFP) played a vital role by providing assistance in the form of food aid, training and other logistical support. Still the Government is trying to protect the poultry sector from any hazards and is also promoting this sector through the motivation of village people and youth, training of rural women and landless farmers, small credit and input supply etc with the aim of poverty reduction. Bangladesh is a highly populated country and growth of population is increasing very fast in comparison to its land size, as a result huge pressure is created on people's basic needs. Demand of protein of this booming population is a great threat for us. There are so many sources of protein but it is impossible to fulfill the demand without poultry meat and egg. Different types of poultry are present. Quail is one of them. Quail meat is popular to all of us and there is no religious restriction to consume. According to our socio-economic situation, the knowledge of our farmer is very little because most of them are not properly trained for quail production.

The Japanese quail, *Coturnix japonica*, is a species of Old World quail found in East Asia. First considered a subspecies of the common quail, it was distinguished as its own species in 1983 (Hubrecht and Kirkwood, 2010). The Japanese quail has played an active role in the lives of humanity since the 12th century, and continues to play major roles in industry and scientific research. In our country, commercial farming of these birds is increasing day by day as the investment and maintenance is very low when compared to other birds.

Quails are very small sized bird. An adult quail weights between 150 to 200 grams and an egg weights around 7 to 15 grams. Female quails start laying eggs within their 6 to 7 weeks of age and continuously lay one egg daily. They lay about 300 eggs in their first year of life. After that they produce about 150 to 175 eggs in second year. Eggs production gradually decrease after their first year of laying period. Quail egg is very suitable for human health. It

contains 2.47 % less fat than chicken egg. Many people believe that quail eggs help to prevent blood pressure, diabetic and pant etc (Nouzarian *et al.*, 2011).

Quail meat is very tasty and nutritious. Fat is very low in their meat. So quail meat is very suitable for blood pressure patients. Eggs are very beautiful with multiple color. Quails do not incubate their eggs. So an incubator or brooder chickens have to use for hatching their eggs. Quail farming is very profitable like other farming ventures, such as chicken, turkey or duck farming business. Quail eggs are very nutritious than other poultry eggs. Because quail eggs contain comparatively more protein, phosphorus, iron, vitamin A, B_1 and B_2. Quail eggs have significantly higher concentration of cholesterol per gram of yolk than chicken and duck egg.

Jalaludeen et al. (2012) also reported that the eggs of chicken, duck and quail contain 423, 884 and 844 mg of cholesterol per 100g respectively. The egg has more beneficial effect. It cures cancer, high blood pressure, HIV AIDS, Ageing, allergy, bronchitis, diabetes, digestive disorder, gallstone etc. The removal of antibiotic growth promoters (AGPs) was problematic for growth performance and led to an increase in the incidence of disease outbreaks, especially sub-clinical necrotic enteritis. This has led to discovery of alternatives to AGPs. The modern trend is to replace AGPs with natural growth promoters. For this purpose, different natural growth promoters are 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. Phytogenic growth promoters mainly improved the gut health for optimum functioning.

Phytogenic growth promoters are ideal for poultry because they are natural, residue free, eco-friendly and having no side effects. The phytogenic growth promoters showed antimicrobial, antiparasitic, insecticidal, antifungal, antiviral and antitoxic effects. They enhanced feed consumption, improved digestion and growth performance, minimized the incidence of disease and increased profitability.

Due to its medicinal properties, the use of turmeric in poultry feed became extensive during the last decade. It is widely cultivated herbaceous plant of tropical region. Curcumin is the active ingredient that is present at 1.5-2% of weight of turmeric root. Turmeric contains 3 different analogues of curcumin, which contains 5% bisdemethoxy curcumin, 18% demethoxy curcumin, and 77% diferuloylmethane. Rhizomes of this plant are dried to obtain turmeric powder, a yellow or gold-colored spice, which is also used for health care, food preservation and as a dye in textile industry. Its color is due to a pigment, which is diferuloylmethane in structure. Curcumin is insoluble in water and soluble in ethyl sulfoxide,

ethanol, oils, and acetone are a useful natural growth promoter and safe alternative to antibiotics. It is also strongly alleged that turmeric can improve digestion and nutrient metabolism. The main yellow bioactive substances isolated from the rhizomes of Curcuma are curcumin, demethoxy curcumin and bisdemethoxy curcumin which is present to the extent of 2-5 % of the total spice in turmeric powder.

Nouzarian et al. (2011) stated that Curcumin is the main important bioactive ingredient responsible for the biological activity of curcuma. Curcumin has been shown to have several biological effects, exhibiting anti-inflammatory (Holt.2005), antioxidant (Iqbal.2003; Pal.2001) and hypolipidaemic (Ramirez Tortosa *et al.,* 1999) activities. The anti-inflammatory activity of curcumin was associated with its ability to inhibit the production of pro-inflammatory cytokines such as TNF-α, IL-1, IL-8, and inducible nitric oxide synthase (Chandramohan and John, 2002). Curcumin has also been studied extensively as a chemo preventive 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). The significant biological properties of turmeric powder make it a potential substitute for in-feed antibiotics in livestock diets. A number of studies have been conducted to evaluate its effects on the performance of quail, broiler chickens, laying hens and rabbits, however, the results have not been consistent (Nouzarian *et al.,* 2011).

By realizing all sorts of fact we are planning to rear quail by using herbal medication like turmeric instead of any synthetic agent, to avoid human health hazards as well as economic quail production in Bangladesh.

The general objective of this study is to observe the effects of turmeric paste on growth performance, immune response and blood characteristics in Japanese quail with the following specific objectives:

- To know the effect of turmeric supplementation on feed consumption, feed conversion ratio, live body weight, body weight gain and carcass characteristics in quail.
- To determine the effect of turmeric supplementation on antibody production against infectious coryza and blood characteristics in quail.

CHAPTER II

REVIEW OF LITERATURE

Quail is a small, stocky bird with short legs and varied plumage. Quail breeding is also known as coturniculture. The quail is farmed for its eggs (intended for consumption, decoration and remedies) and for its meat

The Japanese quail is similar in appearance to the European Common Quail, *Coturnix coturnix*. Overall, they are dark brown with buff mottling above and lighter brown underneath. They have a whitish stripe above the eye on the side of the head. Legs are orangish-gray to pinkish-gray as is the beak (Hoffmann 1988). In contrast to the males, females usually (but not always) lack the rufous coloring on the breast and black flecking or markings on the throat (Johnsgard 1988). There are variations in plumage color. Some birds are whitish to buff with rufous to chestnut mottling above. Others have a very dark brown appearance with little to no mottling. In addition, there have been golden-brown varieties bred in captivity (Hoffmann 1988). Wing sizes in males and females is similar ranging from 92 to 101 mm. Both male and female have similar sized tails ranging from 35-49 mm in length (Johnsgard 1988).

2.1 Housing of quail

The Japanese quail is primarily a ground-living species that tends to stay within areas of dense vegetation in order to take cover and evade predation (Buchwalder and Wechsler, 1997). Quail are robust birds that do not mind low temperatures, but prefer a dry climate. Cohabitation with other poultry species is difficult and there is a significant risk of the quail being killed by chickens. Wild quail run, jump up to 20-30 cm and scratch the earth to find insects, but they only fly during migration periods or to escape predators.

Thus, its natural habitats include grassy fields, bushes along the banks of rivers, and agricultural fields that have been planted with crops such as oats, rice, and barley (Pappas, 2013, Buchwalder and Wechsler, 1997). It has also been reported to prefer open habitats such as steppes, meadows, and mountain slopes near a water source.

2.2 Reproduction of quail

Like hens reared for laying, modern laying quail that are the result of along selection process lay all year round. However, the number of eggs laid is higher between February and September. The male and the female begin to reproduce around 6 weeks old. However, it is better to wait until the male and female are 8 weeks old to ensure the production of fertile eggs .As with other quail, eggs were laid at a rate of one per day (Lambert, 1970), with 7-14 eggs per clutch (Hoffmann, 1988). An egg averages 29.8 by 21.5 mm is size and weighs 7.6 g (Johnsgard, 1988). Incubation time is 19-20 days (Lambert, 1970), although clutch sizes have been associated with latitude and length of photoperiod. In Japan, clutch size is 5-8 eggs, while in Russia, clutch size is 5-9 eggs (Johnsgard, 1988). The chicks are considered to be mature and able to mate after four weeks old (Hoffmann 1988). As soon as the first eggs are discovered in the bird houses, the birds must be divided into breeding groups (one male and four to five females).

In nature, the female builds her nest on the ground, well hidden in the tall grass. The breeding season varies with location. In Russia, the season starts in late April and continues to early August. In Japan, nesting occurs from late in May and usually ends in August. On the rare occasion, eggs may be found in nests in September (Johnsgard, 1988). When raised in a quail house or a cage, she will rarely sit on her eggs if she cannot find a discreet spot. That is why the Japanese quail has, in many cases, lost the brooding instinct

2.3 Production performance of Japanese quail

The production of eggs with eggshell quality is an important concern of the egg industry. According to Roland (1989) losses due to low eggshell quality or other reasons may reach 20% before the eggs arrive at retail. Hurwitz (1989) asserted that the nutritional factors that affect eggshell quality depend on the metabolic exchanges, which occur during egg formation. In the uterus, the organic fraction of the eggshell is synthesized by the glands, and calcium – its largest component – is mobilized from the blood. Eggshell is sensitive to calcium availability and carbonate is influenced by dietary factors that affect acid-base balance. This author also observes that eggshell mineral content is 90%, out of which 98% consist of calcium carbonate. It is well known that, during eggshell formation, the transference of calcium from the plasma to the uterus in layers in very fast of an average of one minute.

According to Etches (1996) eggshell is formed mostly during the night, when birds do not eat and this may increase calcium deficiency for egg formation. Therefore, calcium is mobilized from the bones. Leeson *et al.* (1991) verified that calcium requirements are generally very low, except at the time eggshell is deposited. Faria *et al.* (2011) observed that commercial layers lay more frequently during the morning, after a period of fasting during the night, when eggshell is formed.

Aiming at improving eggshell quality in commercial layers, Joly *et al.* (2015) mentions some techniques, such as feeding calcium-rich feeds in the afternoon, high particle size calcium dietary addition, short lighting period during the night, etc. However, in order to successfully apply these techniques in quails, feed intake behavior and lay times must be similar between these two bird species.

2.4 Present status of Japanese quail

In 1998 the Japanese quail was listed as DD (Data Deficient) on the Japanese Red List, and its designation as a game species should therefore be reconsidered as soon as possible. An examination of the annual numbers of quails hunted, based on Wildlife Statistics data and other literature sources, indicates that the population level of Japanese quail started to decline in the 1930s, and has subsequently shown a dramatic decrease. Japanese quail is thought to have no harmful effects on agriculture and has retained its status as a game species solely owing to its value as a hunting target. Within Japan, the Japanese quail *Coturnix japanica*is bird species familiar to many people. It was first designated as a game species in 1918 and has been captive-bred and released into the wild since the early 1970s. For the Japanese quail population to recover from its from endangered status a combination of stricter hunting regulations and the active restoration of suitable habitat is urgently required quail.

2.5 Effects of turmeric paste on body growth, feed intake, and feed efficiency

Greater body weight gain and better feed efficiency are among important economic goals in poultry farming. The bans on application of different growth promoter have affected this goal, resulting in poor growth performance and resistance of drug in poultry. Many studies have examined potential effects of feed additives, like antibiotic growth promoter, prebiotics, probiotics, organic acids, and herbs on growth performance of poultry compared to those of antibiotics.

Muhammad et al (2014) reported turmeric paste supplementation at the rates of 1.0 and 1.5% significantly improved body weight gain, but 0.5% supplementation had no effect. Turmeric paste supplementation significantly decreased feed consumption at the rates of 0.5 and 1.5%. All levels of turmeric paste improved FCR, but supplementation at the rate of 1.5 % proved to be the most efficient. Turmeric supplementation at higher dose (1.0 and 1.5%) improved body weight gains and showed best FCR results. The supplementation at the rate of 0.5% showed better FCR and decreased feed consumption, but did not affect body weight gain.

Al-Jaleel (2012) reported improved body weight gain and FCR at 1.0 and 1.5% turmeric supplementation without the effect on feed intake. Effects of turmeric paste on growth performance are inconsistent and these discrepancies can be attributed to the form of supplement (powder, paste, or fresh turmeric), dosage, or whether turmeric paste is added to feed or drinking water.

Al-Sultan (2003) reported a reduced feed consumption at 0.5% l showed normal organ architecture for breast muscle, spleen and ileum but not for the liver. Similarly, birds raised on commercial antibiotics showed normal organ morphology compared to the positive control.

Qasem et al. (2015) found less feed intake at 1.0,1.2, 1.4, 1.6, 1.8 and 2.0% of turmeric paste supplementation. In line with the present findings. It is concluded that the bioactives of turmeric paste could be used as feed supplement to improve feed efficiency in broilers with no deleterious effect on weight gain, carcass yield, abdominal fat levels and internal organs

Mondal et al. (2015) described an improvement in FCR through TP supplementation at rates of 0.5, 1.0 and 1.5%. Present findings are also in agreement with the results of Al-Sultan and Durrani et al., showing that TP supplementation at the rate of 0.5% improved FCR.

Nouzarian et al. (2011) also found better FCR at 1.0% supplementation evaluated that the effects of dietary inclusion of turmeric paste to substitute antibiotic growth promoter (Enramycin) on performance, carcass characteristics and intestinal micro flora of broiler chicks. The results obtained found that turmeric powder groups and antibiotic group brought

about higher body weight gain and feed intake compared to the control group. However, significant differences ($P<0.05$) were observed in feed conversion ratio between the groups treated by turmeric powder, antibiotic Enramycin and the control group.

Tayyem et al. (2006) found that curcumin contents for specific brands of turmeric vary from 0.58 to 3.14% of dry root weight in different countries and regions. Moreover, the studies have shown that soil factors, genus diversity, level of acidity and available nutrients can affect the curcumin content in turmeric plants.

This is an agreement with the finding of (Al-Sultan, 2003; Durrani et al. 2006; Suvanated et al. 2003; Zeinali et al. 2009 ; Wuthi-Udomler et al. 2000; Samarasinghe et al. 2003). In spite of the low consumption compared with other groups, the fact that this herb plant may provide some compounds that enhance digestion and absorption of some nutrients in the diet Also that may be due to the active materials (curcuminoids and Curcumin) found in turmeric, causing greater efficiency in the utilization of feed, resulting in enhanced growth. Turmeric has been reported to exhibit antimicrobial properties and ethanol turmeric extract demonstrated high potential to inhibit some pathogenic bacteria of chickens (Miquel et al. 2002; Ong-ard et al. 2010).

Salih et al (2013) reported chicks fed diet supplemented with 7 g TP/ kg diet had significantly ($p<0.05$) higher weight and body weight gains compared to other treatment groups, followed by group 2 that received a diet with 5 g TP/ kg diet.

Yim and Tana (2016) examined potential effects of turmeric paste on improving growth performance in broilers with coccidiosis and found that turmeric powder at 0.1%, 0.3%, and 0.5% added to the feed of these broilers does not lead to significant difference in terms of body weight gain.

The positive influence may be due to the fact that TP supplementation increased the villi length and decreased the pH of intestine. Turmeric decreased the intestinal microbes, selectively increased Lactobacillus count and enhanced the secretion of digestive enzymes thus improving nutrient absorption ultimately resulting in improved growth performance. Turmeric also enhanced the production of the bile, which improves the digestion of fats. The results of the present study did not agree with.

2.6 Effects of turmeric paste on carcass characteristics of quail

Muhammad et al (2014) reported Supplementation of turmeric paste at the rates of 0.5 and 1.5% significantly improved dressing percentage, while the breast weight was improved when turmeric paste was supplemented at the rate of 1.5%. The supplementation did not significantly affect the organs weight.

Durrani et al. (2006) showing that TP supplementation at the rate of 0.5% significantly improved dressing percentage, but did not have any significant effect on the liver, heart and gizzard weight. The results are also in agreement with Al-Jaleel who showed that TP supplementation had a positive effect on dressing percentage when supplemented at the rates of 0.25, 0.5, 1.0 and 1.5%, without effect on gizzard and the heart weight. Al-Sultan (2003) found that TP did not have any significant effect on the liver weight, while Nouzarian et al., (2011) reported that TP supplementation at the rates of 0.33, 0.66 and 1.0 % significantly influenced the liver weight and abdominal fat weight. Higher values of liver and gizzard and Proventriculus (% BW) were obtained from birds on 7 g TP/ kg diet. However, birds on 5gTP/ kg diet and 9 g TP/ kg diet not different significantly. These results were in disagreement with (Ashayerizadeh et al. 2009). The heart, Small intestine and pancreas relative weight (%BW) of birds in different treatments and control group found really the same. Whereas the abdominal fat relative weight (%BW) was reduced significantly ($p<0.05$) in broilers supplemented with 5 gTP/ kg diet , 7 g TP/ kg diet , 9 g TP/ kg diet than those of non-supplemented group. These results was in agreement with other study performance (Al-Sultan, 2003; Zeinali et al. 2009; Emadi and Kermanshahi, 2007; Emadi and Kermanshahi, 2006). Application of different levels of (TP) significantly affected the carcass traits ($P<0.05$). The highest percent of breast and thigh was observed in 7 g TP/ kg diet. This is agreement with findings of (Osawa et al. 1995). The increasing of breast and thighs weight may be due to optimum antioxidant activity of Turmeric (Curcuma longa) that stimulate protein synthesis by bird enzymatic system. The back, Drum-stksics, neck and wings relative weight (%BW) of birds in different treatments and control group found really the same. In the present study, the dietary treatments did not affect dry matte, or crude ash, of breast and thigh meats of broiler. Significantly increased of crude protein % ($P<0.05$) in breast meat and significantly decreased of Ether extract (%) ($P<0.05$) in thigh meat in broilers supplemented with turmeric powder 7 g TP/ kg diet than (5, 9 g TP/ kg diet) and non-supplemented group.

The cause of decreased of Ether extract (%) in thigh meat may due to Curcumin that enhance bile production and hence fat digestion (Al- Sultan and Gameel, 2004), and the cause of increasing of crude protein % in breast meat and increasing of breast and thigh weight because the (Curcumin) stimulated the digestion system in poultry.

2.7 Effects of turmeric paste on blood characteristics of quail

Valle paraso et al. (2010) concluded that oral supplementation of turmeric paste on broiler, result showed that 2% solution was a significant ($P<0.05$) increase in total WBC count along with absolute differential count of monocytes, lymphocytes and heterophils.

Altug et al. (2010) supplementation of turmeric paste and β-glucan on dogs, Result of this study observed that there was increase in platelet count, WBC's, peripheral blood mononuclear lymphocyte counts, peripheral blood polymorph nuclear lymphocyte counts, neutrophils, monocytes, PCV, haemoglobin concentration. The CD3, CD4 and CD8 T-lymphocyte and B-lymphocyte ratio as well as serum IgG and IgM concentration were also increased.

Ajabnoor (1990) investigated the effect of turmeric on blood glucose levels in normal and alloxan diabetic mice. There was a highly significant ($P<0.05$) decrease in serum glucose level after intra-peritoneal administration of bitter principle of turmeric

Rajasekaran et al. (2001) investigated that oral administration of turmeric paste in alloxan induced diabetes mellitus in rabbits. Result showed that turmeric paste at a concentration of 500 mg/Kg body weight significantly ($P<0.05$) decrease in blood glucose level and serum lipid profile confirming the hypoglycemic and hypolipaemic effects of turmeric.

Akinmoladun and Akinloye (2004) observed that effect of turmeric paste on lipid profile and fasting blood sugar concentration of rabbits fed with high cholesterol diet. They showed that total plasma cholesterol and fasting blood glucose levels were decreased as compared to control group and indicating hypoglycemic and hypolipaemic effects of turmeric paste.

Zhang et al. (2007) indicated that Supplementation turmeric paste and propolis preparation result showed that there were significantly ($P<0.05$) higher contents of serum globulins, dextrose, urea nitrogen and calcium as well as activity of SGOT in broilers that receive turmeric paste

Madan et al. (2008) evaluated that oral administration of turmeric paste extract to Swiss albino mice (300 mg/kg i.p.) daily for five days, significantly ($P<0.01$) increases the total white blood cells count. Further, it increases humoral immune response, as demonstrated from the increase in plaque-forming cells in the spleen and circulating antibody titer

Eevuri and Putturu (2013) observed that oral supplementation of turmeric paste in broilers significantly reduced the serum cholesterol, serum triglycerides and increased the humoral response against NCD vaccine.

Darabighane et al. (2011a) observed that different form of turmeric paste (paste and powder) are fed in broiler reported that an increase in total white blood cell count result of adding turmeric paste to broiler feeds. In another study that used turmeric paste powder in broiler feeds, a significant increase was observed in total white blood cell count, red blood cell count, and haemoglobin in groups treated with turmeric paste powder compared to the control group with the 1% turmeric paste powder group showing the highest haemoglobin, red blood cell, and white blood cell count.

Bolu et al. (2013) showed that there were no adverse effects of turmeric paste on turkey poults health, as determined from the analysis of various hematological parameters and serum metabolites. The results indicated that turmeric paste inclusion at 20 ml/liter in drinking water could successfully replace antibiotics in turkey poults rearing.

Mmereole (2011) reported that increase TEC, PCV, TLC, MCH, MCV, MCHC values in turmeric treated group that receive) as compared to antibiotic supplemented group that receive in broiler.

Singh et al. (2013) reported that higher Hb, PCV, TLC, total plasma glucose and serum calcium values in turmeric treated group that receive 2% turmeric paste in feed compared to control group in broiler.

2.8 Effects of turmeric paste on immune response of quail

An important property of turmeric paste that has been the subject of many in vivo and in vitro experiments is improvement in immune response, probably due to the curcumin contained in turmeric (Harlev et al. 2012, Djeraba and Quere, 2000). Improved or reinforced immune response in poultry creates resistance against diseases, and health of a flock, which can be the result of preparedness of immune system against pathogenic agents, is an important factor in

improving long life, homogeneity and growth performance of birds. Therefore, greater emphasis has been placed by researchers on improving immune response.

Turmeric supplementation showed positive influence on antibody titers against Infectious coryza. All levels of TP supplementation improved antibody titers as compared to control, while adding TP at the rate of 1.5% showed the highest antibody titers against both disease The results of the present study regarding the immune response coincide with the findings of Qasem et al.,(2015) confirming that TP supplementation at the rates from 1.0 up to 2.0% significantly improved antibody titer against ND, while the titer against IBD was significantly higher TP was added in the feed at the rates of 1.4 and 1.6%.,

Nouzarian et al., (2011) observed no significant effect of turmeric on the titer against ND when it was supplemented at the rates of 0.33, 0.66 and 1.0%. Qasem et al., (20) also did not find positive results of turmeric on IBD titer when it was supplemented at the rates of 1.0, 1.2, 1.8 and 2.0%.

Besharatian et al. (2012) investigated an increase in total immunoglobulin of 35-day-old broilers that received turmeric powder (0.5% and 1% mixed with feed) and aqueous extract of turmeric paste (15 and 30 ml/l, added to drinking water).

Waihenya et al. (2002) reported that loss and clinical symptoms, in infections by NDV, as a result of using turmeric paste in broilers. In addition to turmeric effects on antibody titer against NDV, researchers have investigated antibody titer against sheep red blood cells (SRBC).

Akhtar et al. (2012) observed that ethanol and aqueous extracts of turmeric orally administered at 300 mg per kg body weight per day for three consecutive days to broilers increased antibody titer against SRBC compared to the control group.

Darabighane et al. (2012) reported an increase in antibody titer against SRBC in broilers treated with turmeric paste, compared to the control group. The findings of Besharatian et al. (2012), Akhtar et al. (2012), and Darabighane et al. (2012) in connection to effects of turmeric paste on cellular immunity after PHA-P injection indicate improved cellular immune response in broilers that received turmeric powder (0.5% and 1%) and aqueous extract of turmeric. Therefore, turmeric can affect humoral and cellular immunity as evidenced by those studies that examined turmeric paste effects on immune response of broilers

In examining the effects of turmeric on lymphoid organs, researchers reported relative weight gain in these organs of broilers (Darabighane et al. 2012 Akhtar et al. 2012; Feng et al. 2011; Jiang et al. 2005). Besharatian et al. (2012) did not observe a significant difference in weight of lymphoid organs, but reported a weight gain in spleen and bursa. Such relative increase in the weight of lymphoid organs as a result of adding turmeric to feed or drinking water suggests immune (humoral and cellular) system readiness against antigens. In addition, the polysaccharides contained in turmeric paste can improve immune system response in chickens that received B. Avium inactivated vaccine (Sun et al. 2011).

However, one should also take into account indirect immune -modulatory effect resulting from intestinal microflora since turmeric can reduce the number of pathogens in intestines, thereby improving immune response and body resistance. Darabighane et al. (2012) reported an increase in antibody titer against Newcastle disease virus NDV) on days 24 and 38 by adding turmeric paste to broiler feeds (at 1.5%, 2%, and 2.5%).

Valle- Paraso et al. (2010) reported that broilers treated with 2% turmeric paste (mixed with the water) showed significant increase in antibody titer against infectious coryza on days 37 and 52, compared to the control group.

Alemi et al. (2012) added turmeric powder (at 0.5%, 0.75%, and 1%) to broiler feeds and reported an increase in antibody titer against IC. Jiang et al. (2005) reported that an improvement in antibody titer in broilers against coryza as a result of adding acemannan (0.1% and 0.05%), polysaccharide (0.1%), and turmeric paste (0.1%) to broiler feed.

Qasem et al., (2015) confirming that TP supplementation at the rates from 1.0 up to 3.0% significantly improved antibody titer against Infectious Coryza, while the titer against Infectious Coryza was significantly higher when TP was added in the feed at the rates of 1.4 and 1.6%.

2.9 Effects of turmeric paste on antibacterial activity of quail

Bacterial infections are among the important infectious diseases. Hence, over 50 years of extensive researches have been launched for achieving new antimicrobial medicines isolated from different sources. Despite progress in development of antibacterial agents, there are still special needs to find new antibacterial agents due to development of multidrug resistant bacteria. The antibacterial study on aqueous extract of *C. longa* rhizome demonstrated the MIC (minimum inhibitory concentration) value of 4 to 16 g/L and MBC (minimum

bactericidal concentration) value of 16 to 32 g/L against *S. epidermis* ATCC 12228, *Staph. Aureus* ATCC 25923, Klebsiell apneumoniae ATCC 10031, and *E. coli* ATCC 25922. The methanol extract of turmeric revealed MIC values of 16 g/mL and 128 g/mL against *Bacillus subtilis* and *Staph aureus*, respectively. Moreover, it has decreased the *Staph. aureus, B. cereus* and *Listeria monocytogenes* contamination after 14 days of cold storage period . Turmeric oil as a byproduct from curcumin manufacture also was found effective against *B. subtilis, B. coagulans, B. cereus, Staph. aureus, E. coli,* and *P. aeruginosa*. Curcumin also exhibited inhibitory activity on methicillin-resistant *Staph. aureus* strains (MRSA) with MIC value of 125–250 g/mL(Soheil Z. M.et al 2014) . The in vitro investigation of 3 new compounds of curcumin, namely, indium curcumin, indium diacetyl curcumin, and diacetyl curcumin, against *Staph. aureus, S. epidermis, E. coli, and P. aeruginosa* revealed that indium curcumin had a better antibacterial effect compared to curcumin itself and it may be a good compound for further in vivo studies. However, diacetylcurcumin did not exhibit any antibacterial effect against tested bacteria. These results demonstrated promising antibacterial activity for different curcumin derivatives as well. The stability and assembly of protoflaments as a crucial factor for bacterial cytokinesis are introduced as a possible drug target for antibacterial agents. Curcumin suppressed the *B. subtilis* cytokinesis through induction of flamentation. It also without signifcantly affecting the segregation and organization of the nucleoids markedly suppressed the cytokinetic Z-ring formation in B. subtilis. It was demonstrated that curcumin reduces the bundling of protoflaments associated with the binding ability to Fits with a dissociation constant of 7.3 M. It showed that curcumin via inhibition of assembly dynamics of Fits in the ring can possibly suppress the bacterial cell proliferation as one of the probable antibacterial mechanisms of action. The study on *E. coli* and *B. subtilis* demonstrated that curcumin by the inhibitory effect against polymerization could suppress the assembly leading to disruption of prokaryotic cell division. Also, curcumin showed significant antibacterial activity with MIC values between 5 and 50 g/mL against 65 clinical isolates of Helicobacter pylori. Curcumin also has an inhibitory effect on NF-B activation and as a result on the release of IL-8 and cell scattering which led to a reduction in inflammation of gastric tissue as the main consequence for H. pylori in stomach. It inhibits the IB degradation, the activity of NF-B DNA-binding and IB kinase. Indeed, curcumin inhibited the matrix metalloproteinase-3 and metalloproteinase-9 activity (MMP- 3 and MMP-9) as inflammatory molecules involved in H. pylori infection in mice and in cell culture with a dose dependent manner. Curcumin showed more efficient (Soheil Z. M.et al 2014).

CHAPTER III

MATERIALS AND METHODS

3.1 Experimental site & duration

The experiment was conducted for a period of 5 weeks from 4st February to 10th March, 2018 at experimental poultry shed under the Department of Physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University (HSTU) to investigate the dietary effect of Turmeric paste on growth performance, immune response and blood characteristics of quail. To complete this research work following steps were followed-

3.2 Management of experimental shed

At first the shed for rearing quail (experimental shed at HSTU campus governed by Department of Physiology and Pharmacology) was properly prepared. The experimental pens were thoroughly cleaned with bleeching powder, white washed and disinfected with water before putting the experimental chick into these. All the birds were provided same management conditions like floor space, temperature, relative humidity, ventilation and light.

Figure1: Management of Experimental Shed

3.3 Collection and management of quails

At 14 days of age, Japanese layer quails were collected from H. R. Enterprise (live bird and feed seller), Dinajpur. Immediately after unloading from the chick boxes the chicks were given vitamin-C and glucose to prevent the stress occurring during transport. Optimum light was provided daily throughout the experimental period. All the groups were reared under the similar conditions of temperature, humidity, light, ventilation and floor space. The litter management was also done very carefully. A weighed amount (60gm) of the ration was

offered to the birds twice a day and the left over feed was collected to calculate feed consumption of the birds.

The body weights of assigned quails were taken with digital weight balance and the data were recorded. The finally selected 40 quails were housed under normal husbandry condition and reared in quail cage. All of them were fed with commercial crumbled plus mesh feed at the rate of 30 g per bird per day and fresh water *ad-libitum.*

During the whole experimental period, all quail were exposed to a 16 hours continuous photoperiod (natural light+artificial light) in an open sided house. Electrical bulbs were used for additional light at night. Hens were provided to similar care and management in all replications throughout the study period. Adequate hygiene and sanitation were maintained properly.

Figure 2: Management of experimental quail

3.4 Experimental layout

The total number of 40 quails were randomly selected and divided into 4 groups (T_0, T_1, T_2, T_3) at completely randomized design for assessing the effect of turmeric supplementation.Each group consists of 10 quails Quails of group T_0, are considered as control, fed only with commercial quail ration. Quails of group T_1, were supplemented with formulation of .5g turmeric paste per kg feed. Quails of group T_2, were supplemented with formulation1.5g turmeric paste per kg feed. Quails of group T_3, were supplemented with formulation of 2.5g turmeric paste per kg feed. All the quail of control and treated groups wear closely observed for 5 week and following parameter were studied.

Lay out of the experiment

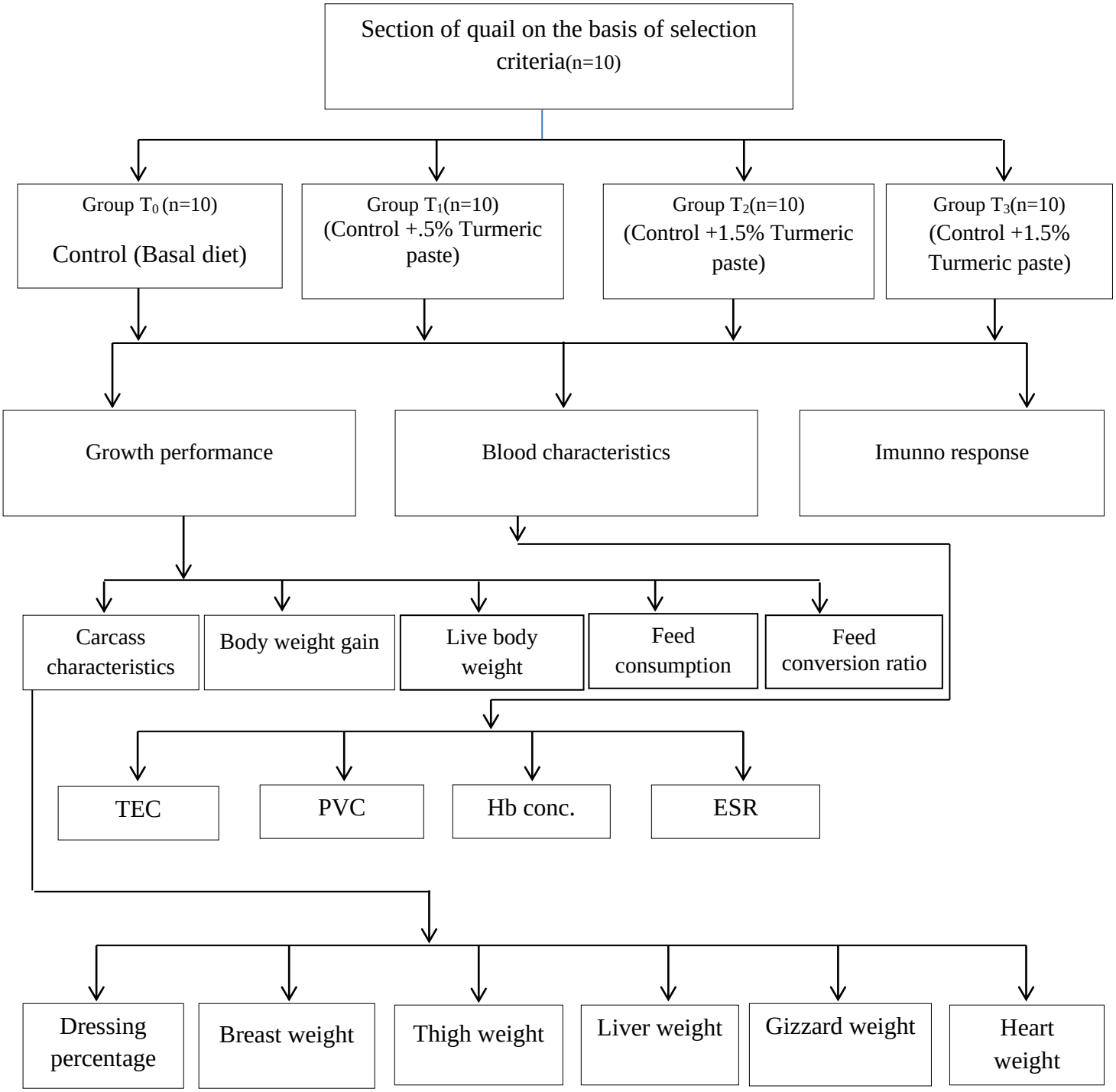

Figure 3: Layout of the experiment

3.5 Collection of experimental materials and feed

Fresh turmeric was collected from local market in Dinajpur. Loose feed purchased from the local market of dinajpur were used for ration formulation for feeding experimental quail. The ration was formulated to meet all nutrient requirements as specified by the 9th revised edition of National Research Council (NRC, 1994) for layer and was designated as the control diet. Diets were supplied with 0 (control), 0.5, 1.5 and 2.5% turmeric paste. Feed and water were provided adlibitum.

Table 1: Turmeric (*Curcuma longa*), Nutritive Value per 100 g.

Principle	Nutrient Value
Energy	354 Kcal
Carbohydrates	59.4g
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	25.25 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, 2003)

Figure 4: Experimental feed for quail

3.6 Observation of growth performance

3.6.1 Feed consumption

Feed consumption is the amount of feed consumed every week; it was calculated for each treatment at weekly basis. At the end of the week, the residual amount of feed was weight and subtracted from the known weight of feed at the beginning of week. The product was divided by the total number of birds.

3.6.2 Live body weight gain

The quails were weighed at start (initial body weight) and then at the end of the experiment (final body weight). Body weight gain was calculated by the difference of initial body weight and final body weight.

Body weight gain = Final body weight - initial body weight

The body weight of each quail measured with the help of digital balance

3.6.3 Feed conversion ratio

During the 35 days experimental period, body weight gain and feed consumption were recorded weekly and feed conversion ratio was then calculated.

Figure 5: Measurement of Body weight of experimental quail

3.6.4 Carcass characteristics

At the end of the experiment 3 birds from each group were randomly selected and slaughtered to obtain data on carcass characteristics

3.7 Vaccination of quail

Experimental birds were vaccinated against infectious coryza by NOBILIS CORVAC vaccine (Trivalent inactivated vaccine for the immunization of quail against Infectious Coryza, serotype A, B and C in a water-in-oil emulsion). Vaccination was done by eye-drop method at Day 22 and quail were re-vaccinated through drinking water at Day 35.

3.8 Measurement of antibody titer against infectious coryza

Blood samples (3 birds/group) were collected at Day 28 and 49 for determination of antibody titers against infectious coryza. These samples were collected from the brachial vein in 5 ml sterilized syringes and pooled from each group and 12 blood samples were analyzed. After collecting blood the syringes were kept in slanted position to obtain serum. The serum was transferred into sterilized 0.5 ml serum cups.

The titer is the amount, or the concentration, of a substance in a solution. The term is often used to describe concentrations of biological molecules (i.e., bioproducts), such as antibodies and other proteins. The titer is an indication of the number of times a solution can be diluted and still contain detectable amounts of the molecule of interest. In fact, when calculating titer, the numerical value assigned to a titer is a direct indication of the dilution factor.

To calculate antibody titer, a blood serum sample containing antibody is diluted in serial ratios (1:2, 1:4, 1:8, 1:16... *and so on*). Using an appropriate detection method (e.g., colorimetric, chromatographic, etc.), each dilution is tested for the presence of detectable *levels* of antibody. The assigned titer value is indicative of the last dilution in which the antibody was detected. Thermo Scientific™, Easy-Titer™ Mouse IgG Assay Kit, Catalog number: 23300 by Thermo Fisher Scientific.

Description

The Thermo Scientific Easy-Titer Mouse IgG Assay Kit includes antibody-sensitized microspheres to measure the specific concentration of antibodies by an easy and rapid microagglutination technique using standard microplates and UV-Vis plate reader (spectrophotometer). This kit is specific for mouse IgG and, unlike total protein assays, can specifically measure the concentration of target antibody in samples (e.g., serum, plasma, culture supernatant) that contain other proteins. It is sensitive, requiring very small sample volumes. Antibody concentration is determined from the assay response (absorbance) by comparison to a standard curve prepared using dilutions of a known antibody sample (sold separately).

Specifications

Assay Type:	Immunoassay, Isotyping Assay, Protein Quantitation Assay
Detection Method:	Colorimetric
For Use With (Equipment):	Microplate Reader, Spectrophotometer
Product Line:	Easy-Titer™
Product Size:	96 tests
Technique:	Absorbance, Solution-based Detection

3.9 Blood characteristics

Blood samples were collected from wing vein of quail of both control and treated groups at 35th and 49th day to observe the following characteristics:

(a) Total Erythrocyte Count (TEC)

(b) Hemoglobin estimation (Hb)

(c) Erythrocyte Sedimentation Rate (ESR)

3.9.1 Determination of total erythrocyte count (TEC)

Total erythrocyte count was done following the method described by Lamberg and Rothstein (1977). Well-mixed blood sample was drawn with red blood cell diluting pipette exactly up to 0.5 marks of the pipette. Outside of the tip of the pipette was wiped with cotton. Then the pipette was immediately filled with the red cell diluting fluid (Hayem's solution) up to 101 marks. The free end of the pipette was wrapped around with the rubber tube stretching to both the ends and held with thumb and middle finger. The content of the pipette was mixed thoroughly by shaking with 8-knot motion for 3-5 minutes. Then the counting chamber was placed with special cover glass under microscope using low power (10X) objectives. After discarding 2 or 3 drops of fluid from the pipette, a small drop was placed to the edge of the cover glass on the counting chamber as the entire area under the cover glass was filled by the fluid. One-minute time was spared to allow the cells to settle on the chamber under the cover glass. Taking 5 larger squares (4 in the 4 corners and the central one) of the central large square, the cells were counted from all the 80 small squares (16 × 5) under high power objectives (45X). After completion of counting, 21 the total number of RBC was calculated as number of cells counted × 10,000 and the result was expressed in million/µl of blood.

3.9.2 Determination of hemoglobin concentrations (Hb)

The N/10 hydrochloric acid (HCL) was taken in a graduated tube up to 2 marks with the help of a dropper. Well-homogenized blood sample was then drawn into the Sahli pipette up to 20 cm. mark. The tip of the pipette was wiped with sterile cotton and the blood of the pipette was immediately transferred into the graduated tube containing hydrochloric acid. This blood and acid were thoroughly mixed by stirring with a glass timer. There was a formation of acid hematin mixture in the tube by hemolysing red blood cells by the action of HCL. The tube containing acid hematin mixture was kept standing in the comparator for 5 minutes. After that distilled water was added drop by drop. The solution was mixed well with a glass stirrer until the color of the mixture resembled to the standard color of the comparator. The result was read in daylight by observing the height of the liquid in the tube considering the lower meniscus of the liquid column. The result was then expressed in g%. The above procedure was matched by the Helligehemometer method as described by Lamberg and Rothstein (1977).

3.9.3 Determination of erythrocyte sedimentation rate (ESR)

The fresh anticoagulant blood was taken into the Wintrobe haematocrit tube by using special loading pipette exactly up to 0 marks. Excess blood above the mark was wiped away by sterile cotton. The filled tube was placed vertically undisturbed on the wooden rack for one hour. After one 22 hour the ESR was recorded from the top of the pipette. The result was expressed in mm/in 1st hour.

3.10 Statistical analyses

Data were analyzed by analysis of variance using Completely Randomized Design with factorial arrangement of time and treatments (Steel and Torrie, 1986). The obtained data were subjected to one-way ANOVA. Differences between means were tested at the 5% probability level using Duncan's LSD test. All the statistical analyses were done using SPSS program version 16 (SPSS, Richmond, VA, USA) as described by Dytham (2011).

CHAPTER IV

RESULTS AND DISCUSSION

In this experiment, all the treatments supplied with various levels of turmeric paste in growth performance, immune response and blood characteristics which are discussed below-

4.1 Effect of turmeric paste supplementation on feed consumption of quail

Feed intake of quail in different dietary treatments during experimental periods was almost statistically similar and the differences were non-significant (P>0.05). So, the result clearly showed that the dietary turmeric paste up to 2.5 percent in the diet decreased feed intake in the last month of the quail due to odour of turmeric paste. The results closely related with the report of Chowdhury *et al.* (2002) and Reddy *et al.* (2012), showed feed consumption, feed efficiency and egg production were not affected by supplements of 2.5 4, 6, 8 or 10% turmeric paste. Lim *et al.* (2006) and Yalcin *et al.* (2007), who found no significant changes in layer performance and feed intake when layer diets were supplemented with GP. Similarly, Ologhobo *et al.* (2008) reported no significant effect of dietary sun-dried GP on feed intake, weight gain, and feed conversion ratio of broilers wheres Samanta and Dey (1991), who reported that Japanese quails gained more weight (p<0.05) without affect on feed consumption and feed efficiency with turmeric paste.

Table 2: Feed consumption of quail from 14 to 49 days of age.

Age of birds	Control	Treatment Groups			P Value	Level of significance
	T_0	T_1	T_2	T_3		
Day 7	85.0 ±0.56	86.0± 0.76	92.01± 0.32	98.50± 0.12	0.992	NS
Day 14	90.05 ± 1.53	91.02 ± 1.22	98.02± 1.9	100.03 ± 1.12	0.629	NS
Day 21	92.01 ± 1.45	93.05 ±1.38	99.00 ±1.64	108.0± 1.71	0.538	NS
Day 28	95.5± 1.35	98.20 ±1.15	109.01±1.54	110.0± 1.51	0.739	NS
Day 35	99.00± 0.2	105.110 ± 0.07	111.00 ± 0.04	117.40 ± 0.09	0.548	NS
Total	461.56	473.37	509.04	533.93	0.579	NS

* means significant at 5% level of significance (P<0.05)
NS = Not significance (P>0.05)

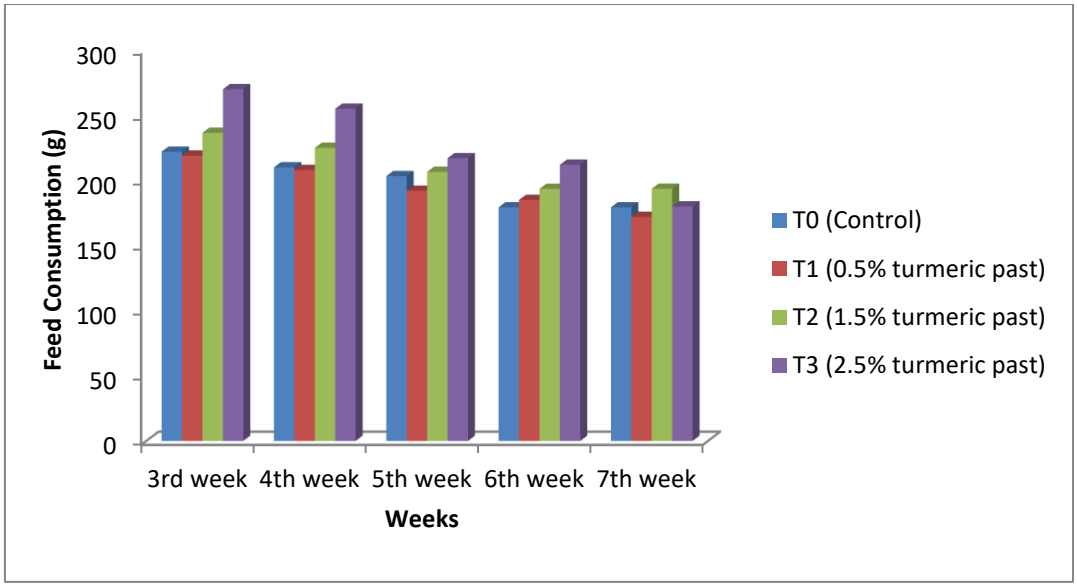

Figure 6: Feed consumption (g) of experimental quail

4.2 Effect of turmeric paste supplementation on body weight gain of quail

The efficacy of supplementation of turmeric paste @ 0.5%, 1.5% and 2.5% upto 7 weeks increase live weight weekly basis compared to the control T_0 group. In 7^{th} weeks the highest values was found (138.6±11.8g) T_3 group that was received 2.5% paste in feed and the lowest values was found (125.7±18g) that receive plain feed T_0. Within the turmeric group respective treatment .5%, 1.5% & 2.5 in feed live weight was found (127.7±16g), (132.5±16 g) and (138.6±11.8 g). The result of this study clearly showed that increase inclusion level of turmeric increase live weight upto 7 weeks of age. Live weight of 6^{th} and 7^{th} weeks there were a significant ($p<0.05$) differences among the treatment group. Supplementation of turmeric paste 2.5% was showed the maximum live weight gain and statistically significant ($p<0.05$) compare to plain feed group and turmeric group T_2, but similar result was found with T_1 treatment group. However the highest inclusion level of turmeric paste 2.5% was showed maximum live weight (138.6±11.8 g) and minimum live weight was showed (125.7±18g) in T_0 treatment group at the terminal stage of experiment. Within turmeric treatment group 0.5% group was represented lowest live weight gain whereas 2.5% treatment group represent highest live weight gain. It is clearly stated that increase inclusion level of turmeric increase live weight. The significant effect of turmeric on body weight gain was in agreement with the findings of some previous studies Singh *et al.* (2017) who reported that supplementation of turmeric at different inclusion level (0.6%, 0.9% and 1.2%) result of this

study (up to 6 weeks) indicated that growth performance increase significantly that receive (0.6%, 0.9% and 1.2%) turmeric compared to the control group in broiler. Islam *et al.* (2017) who showed that the live weight gain and feed efficiency were significantly (P<0.05) better in the broilers provided 1.5% turmeric compare to control.

Table no.3: Live body weight gain of experimental quails at 7 days interval

Age of birds	T_0	T_1	T_2	T_3	P-value	Level of significance
Day 14 Mean ± SD (gm)	23.81 ±0.68	25.24± 0.68	26.67± 0.24	25.48± 0.87	0.992	NS
Day 21 Mean ± SD (gm)	42.1 ± 1.03	43.5± 0.58	45.5 ± 0.75	48.6 ± 0.49	0.536	NS
Day 28 Mean ± SD (gm)	65.3 ± 1.44	67.9± 1.21	72.80 ± 1.46	75.7 ± 1.28	0.521	NS
Day 35 Mean ± SD (gm)	87.3 ± 1.39	90.5 ± 0.86	92.13 ± 1.28	98.54± 1.14	0.738	NS
Day 42 mean ± SD (gm)	114.32^{a} ±1.43	119.57^{b} ± 1.16	118.05^{ab}± 1.46	121.82^{c} ± 1.00	0.000	**
Day 49 mean ± SD (gm)	125.7^{a} ± 1.43	127.7^{b} ± 1.16	132.5^{c}± 1.46	138.6^{c} ± 1.00	0.001	**
Weight gain (g)	101.89^{a} ± 1.45	102.46^{a} ±1.38	105.83^{b} ±1.64	113.12^{c}± 1.71	.001	**

The mean values with different superscript (a to c) within the same row differs significantly, at least (p<0.05). All values indicate mean ± Standard error of mean

**** =** Significant at 1% level of significance (P<0.01)

NS = Not significance (P>0.05)

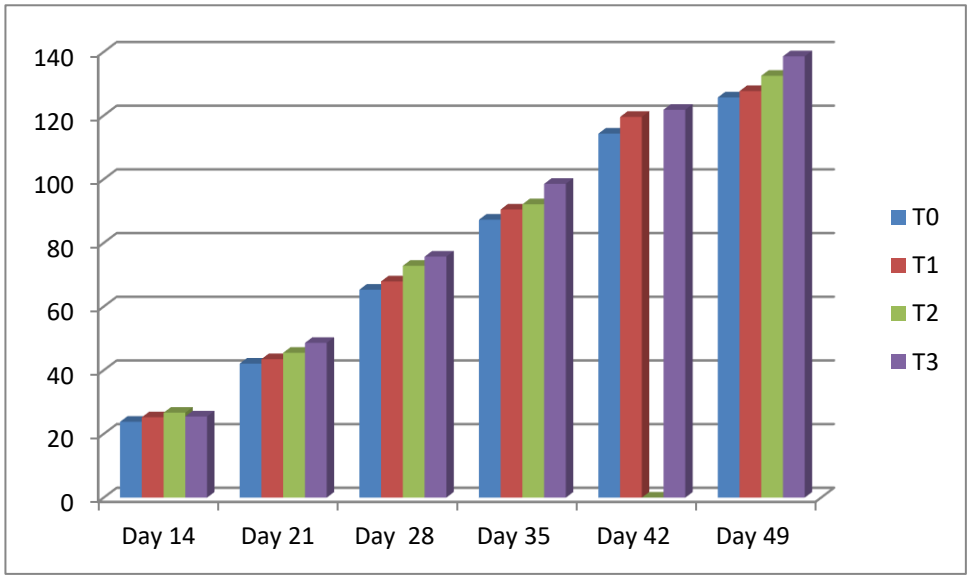

Figure 7: Body weight gain of experimental quail

4.3 Effect of turmeric paste supplementation on feed conversion ratio of quail

Feed conversion ratio in different dietary treatment at .5, 1.5 and 2.5 percent level had no significant effect (P>0.05) on feed efficiency(Table-4). The results indicate that there was no effect on feed efficiency after feeding up to 2.5 percent level of turmeric paste. This is in agreement with the result of Chowdhury *et al.* (2002) and Reddy *et al.* (2012) who reported that feed efficiency was not affected by supplements of 0, 2, 4, 6, 8 or 10% turmeric paste (P > 0.05) as averaged over the 6-week period or by supplements of 0.02% turmeric paste over eight weeks. In contrast, Canogullari *et al.* (2010) reported that supplementation of diets with turmeric paste had significant (P < 0.05) effects on feed consumption, feed efficiency.

Table 4: Average feed conversion ratio of quail from 14 to 49 days of age.

Variables	Control	Treatment Groups			P Value	Level of significance
	T_0	T_1	T_2	T_3		
Feed conversion ratio (FCR)	4.53± 0.2	4.62 ± 0.07	4.81 ± 0.04	4.72 ± 0.09	.801	NS

NS = Not significance (P>0.05)

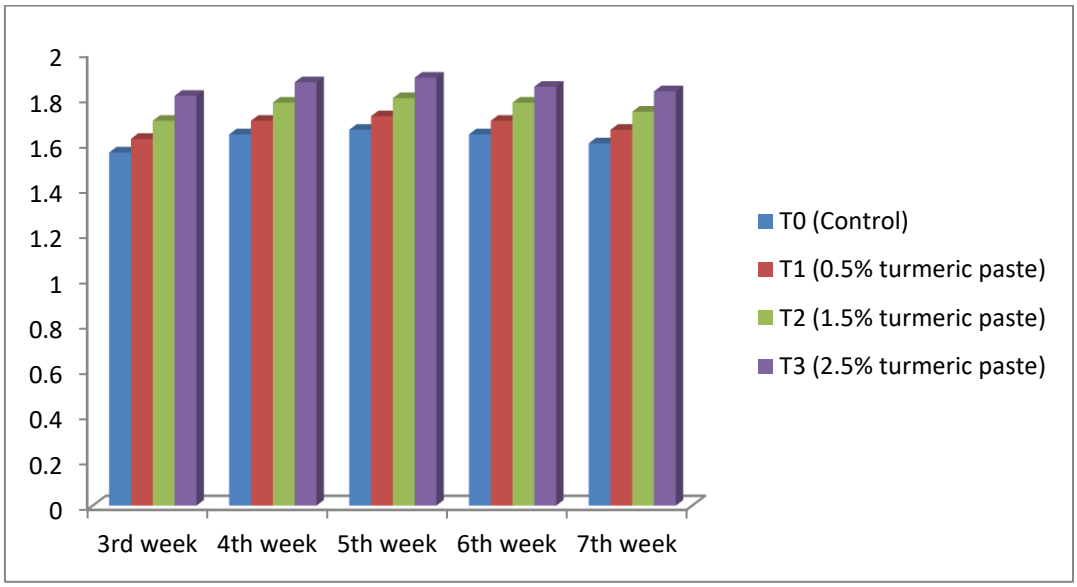

Figure 8: Feed conversion ratio of quails

4.4 Effect of turmeric paste supplementation on carcass characteristics of quail

After slaughtering and eviscerating, remove all edible and non edible by-product, dressing percentage of different treatment group showed in (Table 5). The Table indicated that, there were no significant differences among the treatment group. Relatively the heavier dressing percentage was observed in T_3 (63.19%) than other treatments T_0 (61.25%), T_1 (61.89%) and T_2 (62.55%) respectively. The highest dressing percentage was found (63.19%) in T_3 treatment group and lowest was found (61.25%) in T_0 treatment group. This finding favorably compared with earlier reports Darabighane *et al.* (2011) who found that the groups treated by turmeric paste has heavier dressing percentage compared to the control group. In same

viewed Singh *et al.* (2013) reported that turmeric paste the group that was given turmeric paste showed numerically higher dressing percentage as compared to control group and drug control group. Eevuri and Putturu (2013) who indicated that turmeric paste supplementation in broilers decreased the fat accumulation, increased dressing percentage, liver weight, spleen weight and whole giblet weights.

4.4.1 Effect on breast meat

Breast meat obtained (Table 5) was statistically significant ($P<0.05$) among the different treatment group. Supplementation of 2.5% turmeric paste was significant ($P<0.05$) compare to control group and T_2 treatment group. However, highest weight was found (29.7±3.8g) that receive 2.5% turmeric paste on feed and lowest was found (23.9±4.3g) in untreated group. In commercial growth promoter group T_0 similar to T_1 treatment and close to T_2 treatment group. This result near with Fallah (2015) who found that highest thighs, breast and total carcass weights were observed with supplementation 2.5% turmeric paste than other groups.

4.4.2 Effect on thigh meat

Data obtained from (Table 5) Thigh meat of quail was statistically non significant ($p>0.05$) among the different treatment group. Best result was observed in supplementation of turmeric paste treated group T_3 (9.5g) where as nutritional commercial group T_0 (8.0g) then T_1 (8.1g) and T_2 (9.0g) respectively.

4.4.3 Effect on heart, liver and gizzard weight

Heart, gizzard and liver weight of quail in different dietary treatment groups was statistically insignificant ($p>0.05$). From (Table 3) it was seen that head weight maximum in T_3 treatment group and minimum in T_0 treatment group. Heart and liver weight was almost similar while gizzard weight was maximum (2.0±1g) found in T_3 treatment group.

Table 5: Effects of turmeric paste on carcass characteristics of quail

Parameters	**T_0 control**	**T_1** (0.5% turmeric paste)	**T_2** (1.5% turmeric paste)	**T_3** (2.5% turmeric paste)	P Value	**Level of Sign.**
Final Live wt. (g)	$125.7^{a} \pm 1.53$	$127.7^{b} \pm 1.22$	$132.5^{b} \pm 1.9$	$138.6^{c} \pm 1.12$	0.001	**
Dressing (%)	61.25±0.35	61.89±0.24	62.55±0.2	63.19±0.31	0.992	NS
Breast meat wt. (g)	23.9^{a} ±4.3	26.5^{b} ±6	28.4^{c} ±5.5	29.7^{c} ±3.8	0.000	**
Thigh meat wt.(g)	8±2	8.19±2	9.0±2	9.5±1.5	0.653	NS
Heart (g)	1.01+05	1.1+.25	1.05+.3	1.2+.32	0.572	NS
Liver (gm)	2.77±1	2.52±1	2.37±2	3.15±1.5	0.531	NS
Gizzard (gm)	1.5±1	1.7±1	1.9±1	2.0±1	0.698	NS

The mean values with different superscript (a to c) within the same row differs significantly, at least ($p<0.05$). All values indicate mean ± Standard error of mean

**** = Significant at 1% level of significance ($P<0.01$)

NS = Not significance ($P>0.05$)

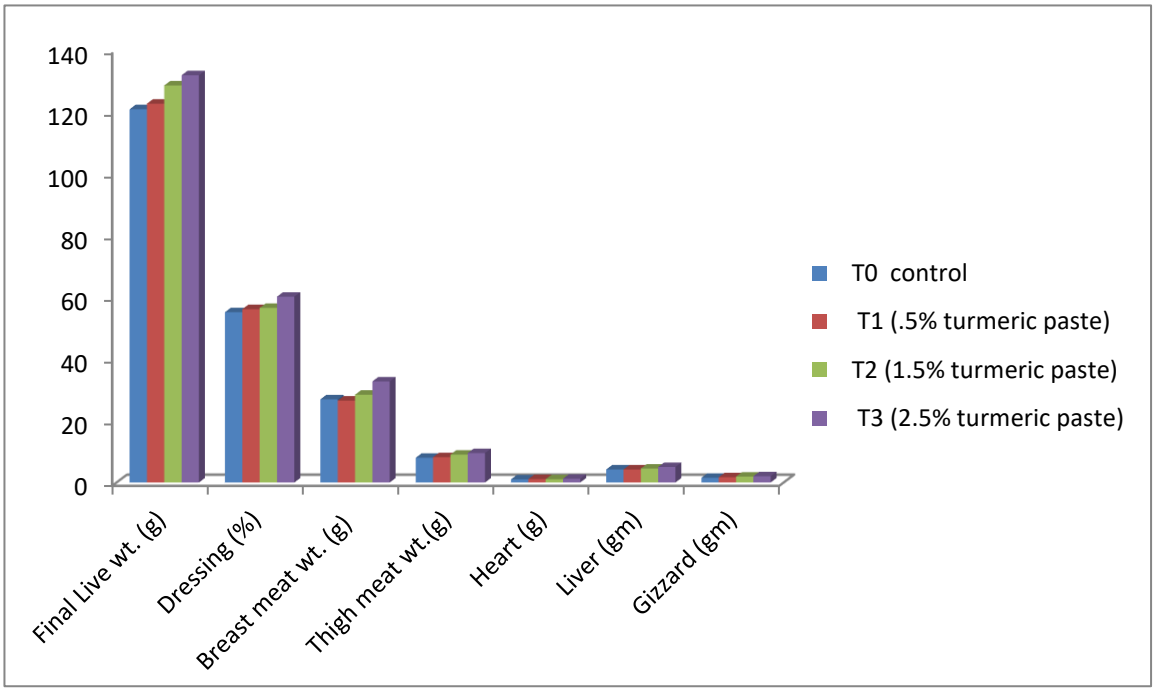

Figure 9: Carcass characteristics of experimental quail

4.5 Effect of turmeric paste supplementation on immune response (antibody titer against infectious coryza) of quail

Turmeric supplementation showed positive influence on antibody titers against Infectious coryza. All levels of Turmeric paste supplementation improved antibody titers as compared to control, while adding Turmeric paste at the rate of 2.5% showed the highest antibody titers Infectious coryza. The results of the present study regarding the immune response coincide with the findings of Qasem *et al(2015).* confirming that TP supplementation at the rates from 1.0 up to 3.0% significantly improved antibody titer against Infectious Coryza, while the titer against Infectious Coryza was significantly higher when TP was added in the feed at the rates of 1.4 and 1.6%. However, Nouzarian *et al.,(2011)* observed no significant effect of turmeric on the titer against Infectious Coryza when it was supplemented at the rates of 0.33, 0.66 and 1.0%. Qasem *et al(2015).* also did not find positive results of turmeric on Infectious Coryza titer when it was supplemented at the rates of 1.0, 1.2, 1.8 and 2.0%.

Table 6: Immune response (antibody titer) of experimental quail

Parameters	T_0 Control	T_1 (0.5% turmeric paste)	T_2 (1.5% turmeric paste)	T_3 (2.5% turmeric paste)	P Value	Level of sign.
Infectious coryza (antibody titer) 35 days	45	87	79	1.3	0.992	NS
Infectious coryza (antibody titer) 49 days	62.66^{a}	112.00^{ab}	108.33^{b}	117.33^{c}	0.001	**

The mean values with different superscript (a to c) within the same row differs significantly, at least ($p<0.05$). All values indicate mean ± Standard error of mean

****** = Significant at 1% level of significance ($P<0.01$)

NS = Not significance ($P>0.05$)

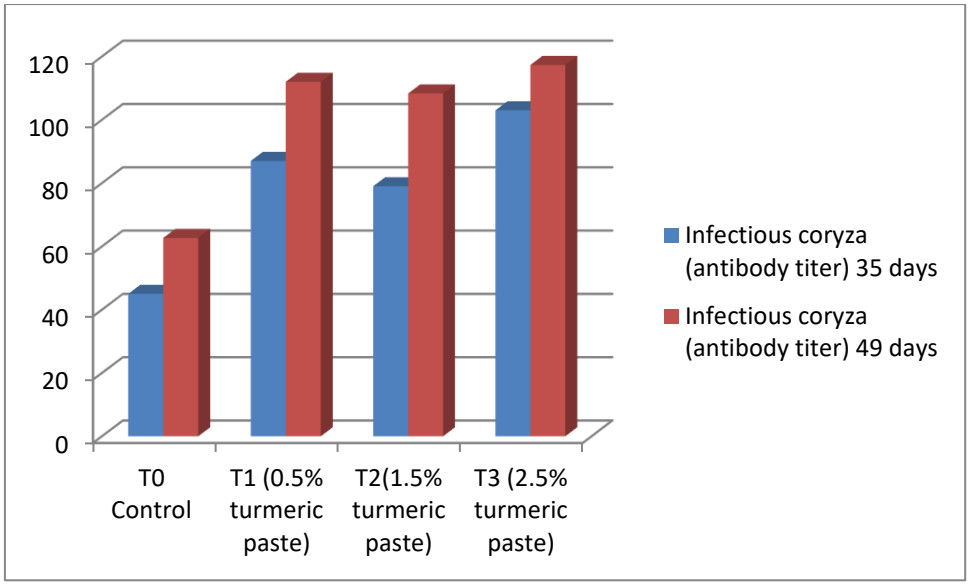

Figure 10: Immune response (antibody titer) of experimental quail

4.6 Effect of turmeric paste supplementation on blood characteristics of quail

Supplementation of turmeric paste, the results of the blood analysis of the experimental birds are present in (Table 7). It was observed that there were no significant ($p<0.05$) differences among the treatment groups in all the blood characteristics except the Hb and PCV. Hb value with birds on treatments T_2 and T_3 this was significantly ($p<0.05$) higher than the Hb value of birds on treatment T_0 and T_1 due to phytogenic effect of turmeric paste. Hb values of birds on treatments T_2 and T_3 were statistically similar ($p>0.05$). The Hb values of treatment T_0 and T_2 did not differ significantly ($p>0.05$). However, the highest values of Hb found in supplementation of 2.5 turmeric paste feed and lowest values were found in control group. Treatment T_2 and T_3 have significant ($p<0.05$) difference compared to control group T_0 while insignificant ($p>0.05$) to T_1 nutritional commercial group.

In case of PCV, the highest values of PCV found in supplementation of T_1 and T_3 turmeric paste feed and lowest values was found in T_2 group. Treatment T_2 and T_3 have significant ($p<0.05$) difference compared to control group T_0 while insignificant ($p>0.05$) to T_1 nutritional commercial group. In case of ESR, the highest values of ESR found in supplementation of 2.5% turmeric paste feed and lowest values was found in T_3 group. Treatment T_2 and T_3 have significant ($p<0.05$) difference compared to control group T_0 while insignificant ($p>0.05$) to T_1 nutritional commercial group.

In neutrophil percentage the highest value (57%) was found in turmeric paste group that receive 2.5 turmeric paste on feed and lowest value was found (54%) in T_0 control group. Lymphocyte percentage nutritional commercial group T_0 showed lowest result (39%) and highest result found (41%) in T_2 group. In monocyte, Eosinophil and basophil percentage the result in all treatment was statistically similar. Thus the current study clearly stated that supplementation of turmeric paste on feed @ (.5%,1.5% and 2.5%) increase haematological parameters. The similar result obtained from Singh *et al.* (2013) who was reported that Hb, PCV, TLC, total plasma, glucose and serum calcium values was higher in turmeric paste treated group that receive 2.0% turmeric paste compared to control group in broiler. Mmereole (2011) reported that increase TEC, PCV, TLC, MCH, MCV, MCHC values in turmeric paste treated group that receive (1% turmeric paste) as compared to antibiotic supplemented group in broiler. Turmeric paste on feed significantly increases blood parameters (RBC, WBC, PCV & ESR) in broiler Olupona *et al.* (2010). Blood analysis result of quail was near to normal blood reference values of *Gallus gallus* domesticus (Jain 1993). This results disagree with (Valle paraso *et al.* 2010) who was found that turmeric paste at 2% feed in broiler there was a significantly ($P<0.05$) increase in total WBC count along with absolute differential count of monocytes, lymphocytes and heterophils.

Table 7: Effect of turmeric paste on blood characteristics of quail

Parameters	T_0 Control		T_1 (0.5% turmeric paste)		T_2 (1.5% turmeric paste)		T_3 (2.5% turmeric paste)		P Value	Level of sign.
PCV %	27.01^{a}	32.03^{a}	26.20^{b}	35.32^{b}	28.52^{c}	30.41^{c}	27.5^{ab}	35.30^{ab}	0.001	*
TEC (Million/mm^3)	1.7	1.9	1.96	2.1	2.0	2.11	2.1	2.2	0.992	NS
Neutrophil %	49	54	51	55	52	56	52.9	57	0.628	NS
Lymphocyte %	33	41	37	39	38.12	39	39	40	0.653	NS
Eosinophil %	0.85	1	0.84	1	0.85	1	0.84	1	0.572	NS
Monocyte %	0.92	1	0.93	1	0.92	1	0.92	1	0.531	NS
Basophil %	0	0	0	0	0	0	0	0	0.698	NS
Hb (g/dl)	6.9	7.5	7.9	8.2	8.3	9	10.2	11	0.00	*
ESR(mm/hr)	22.30^{a}	28.11^{a}	26.72^{b}	30.34^{b}	23.07^{ab}	25.73^{ab}	17.61^{c}	21.09^{c}	0.679	NS

All values indicate mean ± Standard error of mean

** = Significant at 1% level of significance (P<0.01)

* means significant at 5% level of significance (P<0.05)

NS = Not significance (P>0.05)

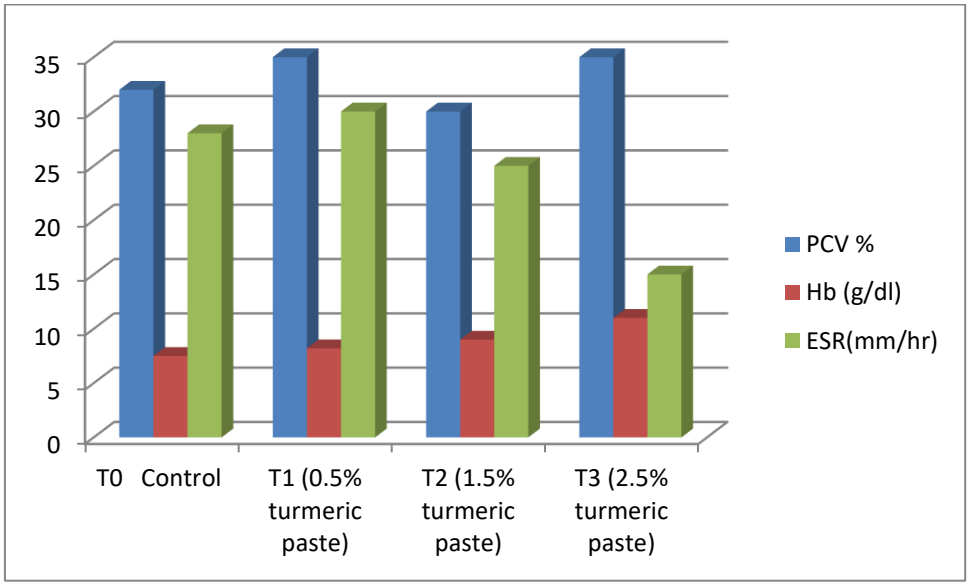

Figure 11: Blood characteristics of the control and treatment groups

CHAPTER V
CONCLUSIONS

The aim of this study to observe effect of turmeric paste on growth performance, immune response and Blood characteristics in quail. The study was conducted at the poultry research shed under the Department of Physiology and Pharmacology, Hajee Mohammad Danesh Science and Technology University, Dinajpur. Forty quail (*Coturnix japonica)* of 14 days old were allocated to 4 groups, each containing 10 quail. Quails were randomly allowed to 4 dietary treatments: $T_{0,}$ (control), T_1 (0.5% turmeric paste), T_2 (1.5% turmeric paste), T_3 (2.5% turmeric paste). The initial average live body weights at 14^{th} day were 23.81±0.68, 25.24±0.68, 26.67±0.24 and 25.48±0.87 respectively. The final live weight at 49^{th} day were 125.7±1.43, 127.7±1.16, 132.5±1.46 and 138.6±1.00 respectively. The highest body weight was obtained in T_3 followed by T_0 which differ significantly ($P<0.01$) from each other. Feed consumption of quail in different dietary treatments (461.56g, 473.37g, 509.04g and 533.09g respectively) was almost statistically similar and the differences were non-significant ($P>0.05$). Feed conservation ratio (FCR) was highest in T_2 (4.82) compared with other group.

Adding Turmeric paste at the rate of 2.5% showed the highest antibody titers (117.33) against Infectious coryza than other group (62.66, 112.00 and 108.33 respectively). Supplementation of turmeric paste at the rates of 1.5 and 2.5% significantly improved dressing percentage, while the breast weight was improved when turmeric paste was supplemented at the rate of 2.5%. The supplementation did not significantly affect the organs weight. Haematological characteristics of quail (PCV and Hb) there were significant ($p<0.05$) difference among the treatment groups. It can be concluded that supplementation with 2.5% of turmeric in diet in treatment group caused significant increase in weekly weight gain and immune response and improvement blood characteristics as compared to that of control group of quail. The positive influence may be due to the fact that turmeric paste supplementation increased the feed consumption and improvement blood characteristics of quail. Supplementation of turmeric with feed may be used for economical and efficient production of quail. This experiment was performed in small scale basis. To establish the Turmeric as a growth promoter, it is necessary to do more research on anti-fungal, bio-chemical and histopathological effect of turmeric should be performed.

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