Effect of dietary ginger on the performance of broiler chicken

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By

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Date: 20.10.20

CERTIFICATE-I

This is to certify that the thesis entitled **"Effect of dietary ginger on the performance of broiler chicken"** submitted in partial fulfilment of the requirements for the award of the degree of **Master of Veterinary Science (Livestock Production and Management)** to the Odisha University of Agriculture and Technology is a faithful record of bonafide and original research work carried out by **Pravanjan Kumar Pradhan** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

Sudesh Kanungo

CHAIRMAN

ADVISORY COMMITTEE

CERTIFICATE-II

This is to certify that the thesis entitled **"Effect of dietary ginger on the performance of broiler chicken"** submitted by **Pravanjan Kumar Pradhan** to the Odisha University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **Master of Veterinary Science (Livestock Production and Management)** has been approved/disapproved by the student's advisory committee and the external examiner.

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Place: Bhubaneswar

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LIST OF ABBREVIATIONS

AIA	:	Acid insoluble ash
ALP	:	Alkaline phosphatase
ALT	:	Alanine aminotransferase
ANOVA	:	Analysis of variance
AST	:	Aspartate aminotransferase
Avg.	:	Average
BW	:	Body weight
Ca	:	Calcium
CBH	:	Cutaneous basophilic hypersensitivity
CF	:	Crude fibre
CP	:	Crude protein
Dl	:	Decilitre
DM	:	Dry matter
EE	:	Ether extract
ESR	:	Erythrocyte Sedimentation Rate
FAO	:	Food and Agriculture Organisation
FCR	:	Feed conversion ratio
Fig.	:	Figure
Fl	:	Femtoliter
G	:	Gram
Hb	:	Haemoglobin
HCl	:	Hydrochloric acid
$HClO_4$	:	Perchloric acid
HDL	:	High Density Lipoprotein
HNO_3	:	Nitric acid
H_2SO_4	:	Sulphuric acid
i.e.	:	That is
kcal	:	Kilocalorie
kg	:	Kilogram
KH_2PO_4	:	Potassium dihydrogen phosphate
$KMnO_4$	:	Potassium permanganate

K_2SO_4	:	Potassium sulphate
L	:	Litre
LDL	:	Low Density Lipoprotein
MCH	:	Mean Corpuscular haemoglobin
MCHC	:	Mean Corpuscular haemoglobin concentration
MCV	:	Mean Cell Volume
ME	:	Metabolizable energy
Mg	:	Milligram
N	:	Normality
NAD	:	Nicotinamide adenine dinucleotide
NADH	:	Nicotinamide adenine dinucleotide (reduced form)
$NADPH_2$	:	Nicotinamide adenine dinucleotide hydrogen phosphate
$Na_2S_2O_3$	:	Sodium thiosulphate
NaOH	:	Sodium hydroxide
NS	:	Normal saline
NFE	:	Nitrogen free extract
P	:	Phosphorus
PBS	:	Phosphate buffer saline
PCV	:	Pack cell volume
PHA-P	:	Phytohaemaglutinin-phosphate
Pg	:	Picogram
ppm	:	Parts per million
Se	:	Selenium
SGOT	:	Serum glutamate oxalate transaminase
SGPT	:	Serum glutamate pyruvate transaminase
SRBC	:	Sheep red blood corpuscles
TA	:	Total ash
TEC	:	Total Erythrocyte Count
TLC	:	Total leucocyte count
U	:	Unit
U/L	:	Units per liter

ABSTRACT

The current experiment has been designed to study the effect of dietary ginger on the performance of broiler chicken. One hundred twenty colour synthetic broiler (Black rock) chick of one day age were allotted to 4 groups with three replicates having 10 chicks per replicate, viz. T_1 (control), T_2 (0.5% ginger powder supplementation), T_3 (1% ginger powder supplementation) and T_4 (1.5% ginger powder supplementation). Body weights and feed consumption of the birds were taken in every week. At the end of the experiment on 42nd day, the birds from T_3 had the highest body weight (1478.20±27.27 g) which was significantly ($P<0.05$) higher than those of others. The cumulative body weight gain was significantly ($P<0.05$) higher in treatment groups than control. Numerically higher cumulative body weight gain was observed in T_3 group. The feed intake remain unaffected in ginger supplement group. At the end of the experiment, the cumulative FCR of T_3 birds was found to be significantly ($P<0.05$) superior than control (2.58.±0.03 vs. 2.81± 0.02). The Hb %, PCV %, TEC, TLC, MCV, MCH remained unaffected by ($P>0.05$) ginger supplementation. The supplemented groups had significantly lower cholesterol level in comparison with the control birds, and the lowest value was recorded in group T_4 (129.43 ± 2.87 mg/dl). Serum Cholesterol level was significantly ($P<0.05$) higher in T_1 birds (163.83 ± 3.43 mg/dl) as compared to T_3 (137.26 ± 4.27 g/dl) or T_2 birds (144.18 ± 5.05 mg/dl). Serum triglyceride was the lowest in T_4 (35.18±1.18) followed by T_3 (41.34±1.04), T_2 (46.99±2.61) and T_1 (54.73±2.85), the values differing significantly ($P <0.05$) between the groups. Each of the supplemented groups showed higher ($P<0.05$) HDL than the control, the T_3 and T_4 groups having the highest values. While the LDL didn't differ significantly ($P>0.05$) between groups T_2, T_3 and T_4, each of these groups had significantly ($P<0.05$) lower value than the control. Each of the supplemented groups showed higher ($P<0.05$) SRBC and CBH response, the T_3 and T_4 groups showing the highest values. The carcass characteristics and organ weight remained unaffected between treatment groups. It was concluded that dietary supplementation of ginger at 1% level improved body weight, FCR, lipid profile and immune response in broiler birds.

CHAPTER-I

INTRODUCTION

Poultry industry in India has always been an integral component of livestock production system which represent the major success story. This industry has become the means of livelihood of almost major workforce in the country. This industry has grown from grass root level backyard to higher level commercial industry within a short span of time period. This transformation occurred due to scientific breeding, hatching, rearing and processing activities in poultry industry. In our country this industry is now full grown up because of higher returns, short time interval and small scale land. Changing lifestyle in human race and fooding plan has increased the level of acceptance of poultry products. In recent livestock census the total poultry population increased by 16.8% over previous census. Now India is the 3rd largest producer of egg and 4th largest producer of chicken in the world (FAO, 2016).

Poultry products are not only a good source of protein in the diet of human being but also have a good income augmenting power because of lower expenses in rearing (Demeke, 2003). In coming days there is undoubtedly a sharp increase in this sector because of expansion of consumer based marketing and various economic reform. Nutrition plays an important role in enabling improvement and consolidation of industry. The feed cost accounts an expensive input of 70-80 per cent of broiler production cost (Akdeniz *et al.,* 2006). For smooth feeding management poultry nutritionist formulating a high standard feed ration along with some changes which will improve the feed efficiency of bird.

The aim of use of various feed additives are to advance the growth cycle, improve production capacity, resistant to fatal disease and economical feed utilization. Better metabolism of nutrient, streamlined feed utilization and advanced growth is the characteristics of good feed additive (Church and Pond, 1988). Along with growth augmenting activity, feed additives have very beneficial effect on the health of broiler bird like prevention to certain disease.

In today's world among the entire growth promoter, antibiotics are commonly used in poultry industry, although now a day's their use is decreasing towards

extinction. Rampant use of antibiotic as growth promoter has raised serious concern because of some detrimental effect like microbial resistance in birds and residues in carcass, which ultimately disturb the food chain (Rahmatnejad *et al.*, 2009). For this reason, poultry scientists are now striving for new alternatives to antibiotics which have growth promoting activity without side effects on broiler bird and ultimately to the human being. Proper physiological function and appropriate microbial environment in animal are done by the pro nutrient activity of growth promoters. It has been revealed that some plant extracts have pro nutrient activity with very less side effect for which these are used in poultry feed sector.

Ecofriendly and natural products have better beneficial effect on poultry as compared to synthetic substances which is scientifically proven. Herbal products are taken for best alternative to acquire a good response. Everyone is looking for this phytogenic products because of eye catching results revealed by the substance. From the ancient days plant medicines in its crude form have been used to cure various diseases. Herbal products are manifesting better oxidation activity (Hui, 1996), antimicrobial activity (Dorman and Weis, 2000), better digestion activity (Brugalli, 2003) in broiler.

Ginger (*Zingiber officinale*) is famous as folk medicine and the properties present in ginger have antimicrobial, antioxidative and pharmacological effects (Ali *et al.*, 2008). Ginger can be anticipated as the best potential alternate to synthetic antibiotic growth promoter (Karangiya *et al.*, 2016). Glucosinolate, sterols and triterpenes found in ginger have carminative and diuretic properties (Al-Yahya, 1986). It has been revealed that nine compounds found in ginger have influential effect on gastrointestinal function by forming bond with serotonin receptor. Ginger have the quality to control the free radical with lipid peroxidation activity (Al-Amin *et al.*, 2006) and have anti-diabetic properties (Morakinyo *et al.*, 2011). Magnification of palatability of feed and its utilization, balanced secretion of digestive enzyme, improved production frequency and adding taste to flavourless feed are the important activity of ginger for which it is considered as the best possible alternative to synthetic antibiotic growth promoter (Owen and Amakiri, 2012).

Ginger helps in smooth functioning of digestive system by maintaining the digestive p^H and enzyme and ultimately maintaining the desired microbial load in

digestive system (Herawati, 2010). More body weight and low FCR is manifested in ginger supplemented broiler birds (Oleforuh-Okoleh *et al*., 2014). Ginger supplementation in poultry feed @ 2% produced higher body weight, less feed consumption and lowest changeover on organ system (Herawati, 2010). It has been revealed that ginger has the capacity to decrease serum cholesterol level and bacterial growth along with reduced oxidative stress (Stanacev *et al.,* 2011). Ademola *et al*. (2009) detected higher body weight of bird fed diet with 2% ginger supplementation. Ginger exhibit important properties like pain relieving, antiemetic, cardiac relaxation (Utpalendu *et al.,* 1999). Dietary supplementation of ginger @ 0.25% in the diet improved immune response, antioxidant activity in broiler Chickens (Qorbanpour *et al.,* 2018). Higher dressed weight and body weight was seen in ginger added diet (Al Mahdy *et al.,* 2017). Ginger addition @ 0.1 and 0.2% in birds diet showed lower serum cholesterol, triglyceride and glucose than control (Mohamed *et al.,* 2012)

Improved histological gut health and antilipidemic properties was shown in the bird with ginger inclusion @ 6 g/kg diet (Shewita and Taha, 2018). Powdered form of ginger inclusion in diet @ 0.5% showed reduced cholesterol in broiler (Zhang et al., 2009).

By analyzing the above combined couple of information, the present study was suggested in broiler chicken with the under mentioned objectives:

1. To evaluate the consequence of ginger powder inclusion on the production parameters of broiler chicken
2. To assess the role of ginger powder on hematological attributes of chicken
3. To evaluate the effect of feeding ginger powder on serum biochemicals and lipid profiles of broiler chicken
4. To assess the effect of ginger powder on immunity parameters
5. To study the carcass traits of broilers in ginger supplemented diet

CHAPTER-II

REVIEW OF LITERATURE

The literatures about the effect of feeding ginger powder on performance, haematological, biochemical, immunity parameters and carcass traits of broiler birds are presented here. The experiment is reviewed on:

1. Production performance of broiler
2. Haematological parameter
3. Blood biochemical parameter
4. Immunity parameter
5. Carcass trait of broiler

In recent days various types of feed additives are used to enhance the bird's production performance, disease prevention and efficient feed utilization.

Ginger (*Zingiber officinale*) is famous as folk medicine and the properties present in ginger have antimicrobial, antioxidative and Pharmacological effects (Ali *et al*., 2008). Ginger can be anticipated as the best potential alternate to synthetic antibiotic growth promoter (Karangiya *et al*., 2016). Glucosinolate, sterols and triterpenes found in ginger have carminative and diuretic properties (Al-Yahya, 1986). It has been revealed that nine compounds found in ginger have influential effect on gastrointestinal function by forming bond with serotonin receptor. Ginger have the quality to control the free radical with lipid peroxidation activity (Al-Amin *et al*., 2006) and have anti-diabetic properties (Morakinyo *et al*., 2011). Magnification of palatability of feed and its utilization, balanced secretion of digestive enzyme, improved production frequency and adding taste to flavourless feed are the important activity of ginger for which it is considered as the best possible alternative to synthetic antibiotic growth promoter (Owen and Amakiri, 2012).

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2.1 Effect of ginger on growth and FCR in birds

Arshad *et al.* (2012) found the performances of 160 day old broiler chicks with 4 experimental group as A,B,C and D with four replicate and they were provided with ginger extract in water at the rate of 30, 40, 50ml/liter of water respectively and no ginger extract was provided to D group being control. The experiment revealed that higher body weight in treatment than control. It was concluded that use of ginger extract had significantly improved the overall performance of commercial broiler chicks.

Mohamed *et al.* (2012) done trail on three weeks old Ross broiler chicks with three treatment including three replicate and they were supplemented with 0, 0.1 and 0.2 percent ginger powder in the ration in T_1,T_2 and T_3 groups respectively. The outcome of the trail revealed significantly higher gain in body weight, feed intake and FCR both in T_2 & T_3 than T_1 group.

Barazesh *et al.* (2013) conducted trail on 192 Ross broiler chicks with addition of ginger powder at different level @ 0, 0.5%, 1% and 1.5% respectively in four treatment groups. The trail revealed that providing 1% level of ginger powder in the ration has best feed conversation ratio and higher level of inclusion of ginger in the ration showed lower feed intake and gain in body weight.

Elmakki *et al*. (2013) experimented on 160 Cobb day old broiler chicks with 0, 0.25, 0.5 and0.75% of ginger powder were added in the ration to know the outcome on the performance and the result showed lowest feed consumption in 0.5% ginger supplemented group. In the second week and 6^{th} week the FCR was significantly higher ($P<0.05$) with supplementation of ginger powder at 0.25, 0.50 and 0.75 percent in the ration.

Fakhim *et al*. (2013) determined the outcome of adding ginger extract to the drinking water with wheat soya meal basal diet at 0.25%, 0.5%, 0.75% and 1% respectively on 192 chicks. Feed intake, body weight gain and FCR were remain unaffected ($P>0.05$) among the treatments. However, during day one to 10^{th} day of the trail showed higher ($P<0.05$) feed conversation ratio.

Zomrawi *et al.* (2013) conducted trail on 160 day old Hubbard broiler chicks with four treatment to reveal the outcome of adding feed additive as ginger powder at 0, 1, 1.5 and 2 percent level and studied the outcome on the performance of broilers. Result revealed significant decrease ($P<0.05$) in body weight gain and feed intake in case of feeding 1.5 and 2 percent level of inclusion of ginger powder in the ration of T_3 and T_4 groups respectively. But addition of 1% ginger powder in the ration showed better performance. However among the treatment group no significant differences were seen as regards to FCR.

Eltazi *et al.* (2014) found the outcome of adding mixture of garlic and ginger at different level in powdered form on productive performance. An experiment for 6 weeks period was conducted by taking 160 nos. of one day old, unsexed (Ross-308) broiler chicks which were assigned to 4 treatments and each group subdivided into 5 replicates @ 8 chicks per pen. The garlic and ginger mixture in powdered form were added to the ration of Group A, B, C and D as basal diet without addition of ginger and garlic, 1% (garlic0.75% and ginger 0.25%), 1.25% (garlic 1% and ginger 0.25%) and 1.75% (garlic1.5% and ginger 0.25%) respectively. The best FCR and highest body weight gain were found in case of adding 1.75% mixture of ginger and garlic powder.

Rafiee *et al.* (2014) conducted an experiment on 144 nos. of Ross 308 day old broilers with four groups. The control group (T_1) was fed with basal diet and T_2 and

T_3 groups were given with 0.2% of ginger and cumin powder respectively. The outcome of the trail depicted that the feed intake and body weight gain was significantly ($P<0.05$) higher in T_2 and T_3 and there has been better FCR in T_3. The result revealed significantly ($P<0.05$) higher body weight gain in T_2 & T_3. T_3 showed better FCR. Feeding of ginger and cumin at 0.2% level showed significantly better performance in broiler chicken.

George *et al.* (2015) carried out trail on outcome of growth rate on addition of ginger as feed additive in the ration and procured 96 day old Anak broilers with four treatment groups with replicate of eight birds in each group. T_1, T_2, T_3 and T_4 groups were provided with 0g, 2g, 4g and 6g of ginger/kg of ration and found that T_4 (6g/kg feed) had the best body wt gain, FCR than other birds.

Oleforuh-Okoleh *et al.* (2015) conducted trail on eighty day old broiler chicken with four treatment groups with each having four replicate and the T_1, T_2, T_3 and T_4 groups were provided with basal diet, 50ml of aqueous ginger extract, 50ml of aqueous garlic extract and mixture of ginger and garlic aqueous extract of 25 ml each respectively. The performance of T_2 group was better ($P<0.05$) in relation to feed conversation ratio, weekly body weight gain, and final weight.

Karangiya *et al.* (2016) found the outcome of adding no garlic and ginger in T_1, 1% garlic in T_2, 1% ginger in T_3 and combination of 1% ginger and 1% garlic in T_4 group respectively with four dietary treatments along with each were having three replicate. Result showed T_3 and T_4 have higher feed intake. Body weight gain was significantly ($P<0.05$) higher in T2 supplemented with garlic and in T_3 group supplemented with ginger respectively. However the birds in T_3 group supplemented with ginger showed lower FCR.

Al Mahdy *et al*. (2017) conducted the experiment with 40 broiler chicks with four treatment groups and found that 1% level of ginger extract has significantly ($P< 0.05$) better effect than 2% level on growth performance, feed intake, feed conversation ratio and dressed weight in treatment group.

Belal *et al*. (2018) observed the outcome of infusion of ginger and garlic in the diet as powdered and water based in case of two hundred Cobb-500 broiler chicks

with five experimental treatments along with four replicate each having ten 10 chicks and the control group $T_1$was provided normal feed. T_1 and T_2 birds were provided with 15 gram kg -1 combined form of ginger and garlic in feed with 50ml in 1 litre of water as water based infusion respectively. Better feed intake, body weight and FCR at the 14^{th}, 21^{st}, 28^{th} and 35^{th} day of the trial. There was better performance of the chicks when provided with powdered form rather than water based infusion.

Qorbanpour *et al.* (2018) found the outcome of adding multi strain probiotic and ginger on growth and FCR of bird in an experiment for 42 days by taking a 225 nos. of Ross 308 broiler chicks with five treatment groups including three replicate. The birds were supplemented with T_1- Control, T_2-multistrain probiotic and 0.15, 0.20, 0.25% ginger in T_3, T_4, and T_5 respectively. At the end the result showed there is no effect ($P>0.05$) on the feed intake on daily basis, FCR and weight gain with the experimental diet in birds.

Shewita *et al*. (2018) studied the inclusion of ginger on the growth rate of broiler chicken. In the 42 days of experiment period 180 nos. of unsexed (Avian 48) broiler chicks were offered with 4 treatment group and 45 birds in each group with having 3 replicates .The experimental birds were given with G1- basal diet and 2g/kg, 4g/kg, 6g/kg ginger powder supplementation with basal diet in G2, G3, G4 respectively. The outcome of the experiment showed that there has been significantly decrease in body weight in G4 in comparison with G2 and G3. The feed intake was improved than G4. As regard to the feed conversation ratio the lowest level was observed in G3. The outcome of supplementing ginger powder in feed at the rate up to 4g/kg of diet showed better growth performance.

Gaikwad *et al.* (2019) observed significantly higher body weight and feed conversation ratio than control birds by adding ginger at 2% and cinnamon at 1% in the diet of chicken.

2.2 Effect of ginger powder on haematological parameter in broiler birds

Ademola *et al.* (2009) observed the influence of garlic, ginger and their combination on blood cells of broiler. Garlic and ginger were supplemented @ 1, 1.5 and 2 per cent. Result showed RBC count and haemoglobin concentration remain unaffected in blood of broiler supplemented with dietary garlic, ginger and mixture.

Moramadhi *et al.* (2010) determined the influence of ginger roots supplementation on Haematological attributes of broilers. 40 nos. of bird of one day old age were allotted to two groups having 20 birds in each. Control group given only distilled water and 2nd group given with infusion of ginger roots orally @ 100 mg/kg body weight for 42 days respectively. At last higher in Hb, PCV value in treatment group observed than control.

Kehinde *et al*. (2011) did an experiment to assess the changes on haematological attributes of cockerel chicks supplemented with different concentration of ginger. The experiment was done by taking 264 nos. of two week old cockerel chicks which were randomly distributed equally to four treatments group with having 6 replication in each treatment. The treatment group T_1, T_2, T_3, T_4 were given ginger supplementation at 0, 1.5, 3.0 and 4.5 per cent respectively with T_1 kept as control. The result showed haemoglobin count, WBC and lymphocyte concentration were remain unaffected on ginger supplementation. Significant variation ($P<0.05$) was seen in PCV & RBC count. Blood constituents of cockerel chicks were not affected by 1.5 & 3.0% ginger supplementation.

Bamidele and Adejumo (2012) conducted an experiment by taking 225 birds which were randomly allocated into five treatments and each treatment further redivided to 3 replicates having 15 birds per replicate. The experimental group T_1, T_2, T_3, T_4 were offered garlic supplementation @ 0.5, 1, 1.5, 2% respectively but ginger offered @ 0.5% to T_1, T_2 & 0.75% to T_3, T_4 group. The result showed the white blood cell count remain unaffected ($P>0.05$) on ginger, garlic supplementation.

Zomrawi *et al*. (2012) examined the outcome of hematological picture of broiler bird supplemented with natural feed additive ginger root powder. The experiment was performed by taking 128 (Ross 308) chick which subjected to four experimental group. First group kept as control and other three group supplemented with ginger @ 0.5, 1, 1.5% in basal diet respectively. The result showed Hb, PCV, RBC, MCV, MCH and MCHC percentage remain unaffected in 0.5% & 1% ginger supplementation.

Zomrawi *et al.* (2013) examined the influence of natural feed additive powdery ginger supplementation on haematological parameter of broiler chicks. 160

nos. of chicks were allocated to 4 groups. Which were again redivided into 4 replicates. The experiment birds were offered powdery ginger @ 0, 1, 1.5 and 2 % respectively. Result revealed Hb, PCV, RBC percentage were remain unaffected on ginger supplementation.

Saleh *et al.* (2014) evaluate the result of giving thyme & ginger oil on blood cell of broilers. A trial conducted by taking 105 nos. of chicks (Ross 208) which were distributed to seven homogenous group. The first group kept as control. Other three were given thyme oil @ 100, 200, 300 mg/kg to T100, T200, T300 group respectively. Similarly in other three group ginger were offered @ 100,200,300mg/kg in G100, G200, G300 group with basal diet. Result revealed that T200 showed significant increase in PCV & Hb & TLC, heterophil count seen more in T200 & G100 group.

George *et al*. (2015) added ginger @ 0g, 2g, 4g and 6g per kg of basal diet & observed that haemoglobin and pack cell volume were not affected by ginger treatment.

Oleforuh-Okoleh *et al*. (2015) evaluate the outcome of ginger and garlic suplementation on hematological parameter of broiler**.** Conducted the experiment with randomly dividing the broiler into T_1 (control), T_2, T_3, and T_4 group, which were supplemented with 0, and 50 ml of ginger, 50 ml of garlic and garlic and ginger in 1:1 ratio in drinking water respectively. By analyzing the founding they observed significant ($P < 0.01$) increase in Hb, PCV, WBC, RBC in ginger and garlic supplemented group.

Isidahomen *et al.* (2016) evaluated the change in growth characteristics and haematology attributes of breeding cock in response to ginger and vitamin C supplementation. A total sixty nos of 15-18 months age of exotic adult breeding cocks (Harco black) were randomly subjected equally to 4 experimental group with 15 birds in each group which is again redivided to 3 replicate having 5 birds per replicate. The groups were designed as T_1 control with no supplementation in diet, T_2 offered with1% ginger supplementation, T_3 with mix of 0.5% ginger & 0.5% vitamin C and T4 with 1% vitamin C respectively. Blood samples collected from different treatment groups analyzed which revealed T_2 had significantly ($P<0.05$) higher Hb, PCV, RBC,

MCH and MCHC. MCV remain unaffected in the treatments. T_2 showed higher hematological attributes. Conclusion drawn from the experiment that breeder cock offered with 1% ginger supplementation presented improved body wt with having good influence on haematology and blood chemical components.

Al Mahdy *et al.* (2017) observed influence of ginger on the growth trends and haematological parameter of broiler. 40 no. of broiler chick were subjected to 35 days trial in which birds were randomly allocated equally to four treatment groups depicted as A offered with 1% ginger extract, B with 2% ginger extract, C and D as positive & negative control respectively. Aqueous ginger extract were given to the birds in clean drinking water. At the end the result showed significantly higher PCV value in bird supplemented with 2% ginger extract but other attributes remain unaffected.

Belal *et al.* (2018) examined the consequence of ginger and garlic supplementation on hematological attributes of broiler chicken. Both individual and combination of Ginger and garlic added in powder & infusion form were offered to the bird in diet and drinking water respectively. A 200 no. of unsexed chicks were distributed to 5 experimental group .The groups were T_0 (control), T_1 and T_2 groups were offered 15 g/ kg-1 of ginger and garlic powder in basal diet, T3 and T4 groups were offered 15 g/ kg-1 combined ginger & garlic in powdery form in diet and water based infusion at 50 ml L-1 of drinking water respectively. For analysis purpose 5 birds from each replication taken and blood was collected on 21^{st} and 35^{th} day of experiment. The result revealed significant difference ($P<0.05$) in hematological attributes like TEC, Hb, TLC, PCV, ESR, MCV, MCH & MCHC among the experimental group. However, the MCV remain unaffected by ginger and garlic on 21^{st} day which is also same for heterophil and basophil at 35^{th} day.

Shewita *et al.* (2018) observed the influence of ginger powder supplemented diet on the growth and haematological attributes of broiler chickens. A six week trial of 180 day old unsexed broiler chicks (Avian 48), which were randomly distributed equally to four treatment group (G1, G2, G3, G4) with three replicates in all experiment group having 15 birds in each replicate. The G1 group kept as control offered with basal diet and other three groups were given 2g/kg, 4g/kg and 6g/kg ginger powder inclusion in basal diet respectively. At the end the results revealed G4 (6g/kg ginger supplement) bird showed significant increase in leukocyte count than control.

2.3 Effect of ginger powder on blood biochemical parameter of broiler birds

Ademola *et al.* (2009) observed garlic, ginger and their combined influence on biochemical attributes of chicken. The experiment was conducted by taking 396 day old chick (Hubbard) which were distributed among eleven group. Garlic & ginger offered @ 1, 1.5 & 2% T0 group kept as control with no supplementation in diet. T_1-T_6 offered with garlic & ginger individually and T_7-T_{10} offered mixture of garlic & ginger. The outcome of experiment revealed combined ginger & garlic manifested better antilipidemic influence on cholesterol, triacyl glycerol than individually given. The combined garlic and ginger showed lower serum cholesterol, triacylglycerol value than individual.

Zhang *et al.* (2009) evaluated the influence of different processed particle of ginger on blood biochemical attributes of broiler. An experiment was conducted by taking 144 nos. of bird which were allocated to 24 wire cages in environmentally protected room. The control group with no supplementation & other groups were offered 5 different particle size of ginger @ 5g/kg of diet. Result revealed that reducing particle size of ginger reduced ($P<0.05$) cholesterol at 21 days and also showed increased ($P<0.05$) total protein at 21 & 42 days.

Mohamed *et al.* (2012) observed the impact of ginger infused diet on blood biochemical attributes of broiler chicken. 180 nos. of chick were taken for 3 week experimental trial. Birds allocated to three treatment class having 3 replication per class. Ginger offered @ 0, 0.1, 0.2% with basal diet in 3 class. It revealed that the total protein remain unaffected in ginger supplementation. However significantly lower ($P<0.05$) serum cholesterol, triglyceride and glucose level in 0.1 & 0.2% ginger supplement than control.

Barazesh *et al.* (2013) analyzed the impact of herbal ginger supplementation on lipid profiles of broiler. A 42 days experiment was performed by taking 192 nos. of chicks (Ross) which were allocated equally to 4 experiment groups with 4 replication. Ginger powder offered @ 0, 0.5, 1, 1.5% in basal diet to 4 group respectively. The outcome of experiment revealed no significant difference in HDL, LDL, glucose value in 1 & 1.5% ginger supplementation.

Saleh *et al.* (2014) evaluated the influence of thyme & ginger oil supplementation on blood biochemical attributes of chicken. The experiment was done by taking 105 nos. of chick (Ross 208) which were equally distributed to 7 group. The first group served as control with no supplementation in basal diet. Thyme oil supplemented in basal diet @ 100, 200, 300mg/kg in G100, G200, G300 group respectively. Similarly ginger oil supplemented @ 100, 200, 300 mg/kg in T100, T200, T300 group respectively. Outcome of the experiment revealed significant increase of total protein and globulin in T200 & reduced in G200 & G300. Overally group T100 &G100 exhibited best impact on biochemical attributes.

Fallah *et al*. (2015) evaluated the impact of ginger and protoxin probiotic supplemented diet on blood biochemical attributes of chickens. The experiment was performed by taking 240 nos. of unsexed chick (Ross) which were allocated to 4 treatment group in which six replication assigned. The first group kept as control with no supplementation in basal diet &other treatment group offered with 1.5kg/ton ginger, 1.5 kg/ton protoxin, mix of 1kg/ton ginger with 1kg/ton protoxin in basal diet respectively. The results showed at 42 days that Supplementation with either ginger powder, protoxin or combination of both reduced ($P<0.05$) cholesterol, LDL, HDL and increased calcium & phosphor amount in supplemented bird than control.

Oleforuh-Okoleh *et al*. (2015**)** investigated the change in serum biochemical parameter of chicken in response to aqueous extract of ginger and garlic supplementation. A 56 days period of experiment was conducted by taking 80 day old broiler chick (Marshal strain) which were randomly distributed to 4 experimental group with 4 replicates having five birds in each replicate. T_1 kept as control with no supplementation & T_2, T_3, T_4 were offered 50 mls of ginger, garlic and a 1:1 ratio mixture of ginger and garlic in drinking water respectively. Result revealed that T_2 & T_3 showed a better response like decrease in serum cholesterol. Treated group showed higher ($P<0.01$) total protein, albumin, and globulin.

Isidahomen *et al.* (2016) studied the impact of diet with ginger and vitamin C addition on blood biochemical attributes of broiler. The experiment was conducted by taking 15-18 months aged of 60 nos. of breeding cock (Harco black) which were randomly allocated equally to four treatment group with 3 replicate having 5 birds in each. T_1 (control) with no supplementation given in basal diet. T_2, T_3, T_4 were offered

1% ginger, 0.5% ginger & vitamin C, 1% vitamin C supplementation respectively. On analysing serum biochemical attributes result revealed that total protein, Globulin and Uric acid showed significantly ($P<0.05$) higher value in cock given 1% ginger.

Tehseen *et al.* (2016) examined the impact of a mixture of two herbal plants Nigella and Ginger (NSG) on the lipid profile of broiler chickens. The experiment was conducted by taking 240 nos. of chicks which distributed to four experiment groups offered with four graded level of NSG @ 0, 1.5, 3.0, 5% respectively. Result revealed significantly ($P<0.05$) higher HDL in NSG-treated groups. Significantly ($P<0.05$) lower LDL in broilers given NSG at 5% level. The conclusion drawn that combined niger and ginger mix at 3% & 5% level have positive influential effect on blood cholesterol.

Qorbanpour *et al.* (2018) conducted an 42 days of experiment by taking 225 nos. of chicks (Ross-308) which were distributed to 5 experiment groups, with having 3 replicates in each group .The experiment chicks in control group were provided basal-diet with no additive supplementation, other groups with multi-strain probiotic and 0.15, 0.20 , 0.25% ginger powder respectively. The results showed blood biochemistry of birds remain unaffected in ginger supplementation.

Shewita *et al.* (2018) examined the influence of ginger powder on blood biochemical parameter of broiler. A six week trial was conducted by taking 180 nos. of unsexed broiler chicks (Avian 48) which were randomly distributed equally to four treatment group with each group having three replicates in which 15 birds per replicate. The group G1 offered with basal diet which kept as control, and other 3 groups were offered ginger @ 2g/kg, 4g/kg and 6g/kg in basal diet respectively. The results demonstrated higher serum total protein and decreased cholesterol level in 6g/kg supplemented group. The VLDL and triglyceride levels decreased significantly in the ginger supplemented groups than control.

Olagoke *et al.* (2019) evaluated the outcome of supplementation of garlic, ginger, roselle and their mix on the blood biochemical attributes of broiler chicken. The experiment was conducted by taking 210 nos. of chicks (Arbor Acre) which were distributed to seven groups with three replicate in each. The diet consist basal diet control (D1), control with 3% ginger (D2), 3% roselle (D3), 3% garlic (D4), 1.5%

each of ginger + garlic (D5), ginger + roselle (D6) and 500 IU vitamin E (D7). The result of the serum total protein indicated that values ranged from 2.67 to 4.17. High Density Lipoprotein value was highest ($P<0.05$) in D7 and closely followed by birds on D2, D4 and D6. The lowest blood cholesterol was recorded in D5 which was closely followed by D4 and D6. Ginger + garlic, garlic and ginger + roselle reduced blood cholesterol while roselle, ginger-garlic and ginger-roselle supplementation improved serum total proteins of broiler chickens.

2.4 Effect of ginger powders on immunity of broiler birds

Dieumou *et al.* (2009) observed better immune response in broilers offered ginger oil @ 10, 20, 40 mg/kg/day in diet. The reason behind this may be standard maintenance of intestinal microbial population.

Azhir et al. (2012) assessed effect of powdery form of ginger root on humoral immunity of broiler. Trial was performed by taking 96 one day old Ross broiler randomly allocated among 3 groups. Each group comprised 32 chickens with four replication for each (8 chickens in each replicate). Dietary treatments are control and ginger powder level @ 5g/kg and 10g/kg respectively. They observed bird supplemented with ginger @ 10g/kg manifested increased HI titre at 35 days.

Saleh *et al*. (2014) observed the impact of dietary addition of thyme & ginger oil on immunological factor of chicken. An experiment was performed by taking 105 nos. of Ross-208 broiler chick which were distributed equally to 7 groups. First group kept as control which were offered only basal diet with no supplementation. Thyme oil supplemented @ 100, 200, 300mg/kg to T100, T200, T300 group respectively. Similarly ginger added @ 100, 200, 300mg/kg to G100, G200, G300 group respectively. The control group fed with the basal diet. The outcome of experiment revealed that the heterophil of T200, G100 had higher phagocytic activity with higher antibody titer against New castle and infectious bursal disease which proved better immune response.

Al Shuwaili *et al*. (2015) suggested that inclusion of ginger & garlic in basal diet of chicken have better immune response.

Ghasemi and Taherpour (2015) in his experiment took 375 nos. of male broiler chicks which were randomly distributed to five groups. They observed increased antibody titres against IBD vaccine in the birds supplemented with ginger extract @ 200mg/kg.

Youssef *et al.* (2016) performed an experiment for investigate the impact of adding different form of ginger at desired levels upon immunological responses of broiler. 280 chicks were distributed among 7 group. Control group offered with corn soyabean based ration with no supplementation. Aqueous extract of ginger added @ 1, 1.25, 1.5% respectively. Similarly, ginger oil extract supplemented @ 100, 150, 200 mg/kg diet respectively. The results revealed that unaffected antibody titre with better level of immune response in ginger supplemented bird.

Qorbanpour *et al.* (2018) conducted 42 days experiment by keeping 225 nos. of Ross-308 broiler chick which equally distributed to 5 treatment group having 3 replication. Birds were offered no additive on control group .Similarly other group offered with Probiotic & ginger powder supplementation@ 0.15, 0.20, 0.25% respectively. The results showed higher antibody titer was witnessed in bird fed with 0.25% ginger than other which proved better immune response.

2.5 Effect of ginger powder supplementation on carcass traits in broiler birds

Ademola *et al.* (2009) determined the changes in carcass yield & organ weight of chicken offered with ginger, garlic &their combination. 396 chicks were randomly allocated to 11 treatment group having 3 replication. Garlic and ginger were added to broiler diets @ 1, 1.5 and 2%. Four mixtures of garlic and ginger were also formulated. Control group had no test ingredient. Garlic & ginger were offered @ 1, 1.5, 2% in diet respectively. Result revealed the carcass characteristics & organ development were significantly ($P<0.01$) affected in ginger treated group. The combined ginger & garlic had better influence than individual garlic & ginger.

Moorthy *et al.* (2009) evaluate the influence of ginger, curry leaves, pepper powder on the carcass traits of broiler. 210 nos. of commercial vencobb were taken for six weeks of experiment protocol. First group kept as control with no supplement in diet. Other 6 groups were offered 0.2% ginger, 0.2% pepper, 0.2% curryleaf

powder, 0.2% ginger with pepper, 0.2% ginger with curryleaf, 0.2% pepper with curryleaf respectively. The experiment revealed dressed, eviscerated, abdominal fat percentage were remain unaffected on ginger supplementation.

Zhang *et al.* (2009) did a trial to assess the impact of different particle size of ginger supplementation on carcass yield of broiler chicken. 144 nos. of birds were kept in 24 wire cages in an EC house. 5 different particle size of ginger were offered @ 5g/kg in basal diet. Birds were slaughtered and analyzed which revealed that bird supplemented with ginger powder had higher ($P=0.014$) carcass yield than control.

Shanoon *et al.* (2012) conducted an experiment to assess the influence of ginger oil on organ weight of broiler. 200 nos. of chicks were taken as experimental bird which were randomly allotted to four treatments groups. The outcome of trial revealed all organ weight & carcass characteristics were remain unaffected on ginger addition. However significantly decrease in head weight ($P<0.01$) & gizzard weight ($P<0.05$) than control.

Zomrawi *et al*. (2012) evaluate the influence of ginger on carcass traits of chicken.128 unsexed chicks were equally distributed to 4 treatment . Birds were fed ginger powder supplementation at level of 0, 0.5, 1, 1.5% respectively. Result showed dressing percentage remain unaffected in ginger added diet.

Barazesh *et al.* (2013) determined the impact of ginger powder on carcass traits of broilers. A 42 days period of experiment was conducted by taking 192 broiler chicks which were equally allocated to 4 treatment group with 4 replicates having 12 chicks in each. The experiment birds were supplied different level of ginger powder @ 0, 0.5, 1.0, 1.5% with basal diet in T_1, T_2, T_3, T_4 group respectively. The results showed carcass traits were remain unaffected on increase in concentration in ginger supplementation.

Elmakki *et al.* (2013) performed an experiment by taking 160 nos. of unsexed chicks. Ground ginger were offered @ 0, 0.25, 0.5, 0.75 % respectively. The result revealed best carcass & liver weight in ginger supplemented group than control.

Fakhim *et al.* (2013) evaluated the impact of powdery ginger supplementation on carcass traits of broiler.300 nos. of broiler chick were equally subjected to 20 floor pens for a 42 days experiment period. The birds were offered ginger extract @ 0, 0.25, 0.5, 0.75, 1% respectively in drinking water. The results showed ginger extract had significantly higher ($P<0.05$) influence on carcass yield.

Zomrawi *et al.* (2013) assessed the influence of ginger on carcass traits of broiler. The experiment consist 160 broiler chicks which were randomly allocated among four treatment group with 4 division in each group. The four groups were offered ginger @ 0, 1, 1.5, 2% respectively. Result revealed birds fed 2% ginger supplementation exhibit significantly ($P<0.05$) lower dressing percentage.

Baba *et al.* (2014) by taking 225 nos. of broiler in an experiment and came to the conclusion that bird fed with 0.5% ginger supplement showed significantly higher dressing % and breast weight than control.

Rafiee *et al*. (2014) observed the changes in carcass traits of broiler by supplying powdery ginger & cumin. 144 nos. of chicks were equally allocated among 4 treatments. T_1 groups birds offered only basal diet with no other supplementation kept as control and T_2, T_3 group birds were offered 0.2% ginger and cumin powder supplementation with basal diet respectively. The result revealed significant increase ($P<0.05$) in liver and heart weight in T_2 group.

Eltazi *et al*. (2014) observed the change in carcass parameters when broiler given different concentration of ginger in diet as natural feed additive. 200 unsexed broiler chicks were subjected to 6weeks experiment period which evenly distributed among 4 experiment group with 5 replicate having ten chicks in each. The ginger offered accordingly @ 0, 1, 1.5, 2% to four group with basal diet. The carcass traits were analyzed by sacrificing some birds from every group. At the end significantly higher ($P<0.05$) dressing percentage with commercial cut were witnessed in birds offered with 1% ginger .

Oleforuh-Okoleh *et al.* (2014) offered aqueous extract of ginger & garlic to broiler for analyzing its impact on carcass traits. The trial was performed by evenly distributing 100 birds among five groups. Next 2 group offered with ground ginger & garlic @ 14g/kg of diet. Similarly other two group offered with ginger& garlic water

based infusion @ 50 ml/lt in drinking water. The observation revealed bird fed with ginger & garlic in powdery form showed significantly higher ($P<0.05$) dressing percentage.

Fallah *et al.* (2015) evaluate the impact of ginger and protoxin probiotic supplementation upon carcass characteristics of broiler. 42 days period experiment was conducted by taking 240 nos. of Ross broiler, which were allocated indiscriminately into 4 treatment groups with six replicates in each. The treatment groups consist of first as control offered with only basal diet. Other three group offered 1.5 kg/ton ginger, 1.5 kg/ton protoxin probiotic, mixture of 1 kg/ton ginger & 1 kg/ton protoxin probioticin basal diet respectively. The outcome of experiment revealed mixed supplementation of ginger and protoxin probiotic increased ($P<0.05$) chicks total carcass weight, spleen, bursa of fabricius, gizzard and thymus weight and reduced abdominal fat relative weight ($P<0.05$) than control .

Qorbanpour *et al.* (2018) performed a 42 days experiment by taking 225 nos. of chick which were distributed to 5 treatment group having 3 replicate. First group taken as control offered only basal diet with no supplementation. Other groups were given Probiotic and 0.15, 0.20, 0.25% ginger powder in basal diet respectively. The outcome of experiment revealed no change in carcass traits ginger treated bird, however combined probiotic & ginger supplement manifested reduced gizzard weight abdominal fat than control.

Vidyarthi *et al.* (2019) evaluate the influence of ginger powder supplementation on carcass characteristics of broiler. 120 nos. of unsexed broiler chick of hybrid Cobb-400 strain were taken as experiment birds which were divided randomly in four treatments with five replications consisting six birds each. The chicks were provided with standard basal diet (starter broiler and finisher) from 0-21 and 22-42 day, respectively. The four experimental diets consisted of ginger powder at levels of 0, 2.5, 5.0 and 7.5 g/kg feed in T_1, T_2, T_3 and T_4, respectively. On 42 day, by sacrificing 3 birds from each group carcass traits were evaluated. By analyzing the data it was concluded that the values for dressing percentage and carcass weight were comparatively higher in T_4 than other groups.

CHAPTER-III

MATERIALS AND METHODS

The experiment on "Effect of dietary ginger on the performance of broiler chicken" was performed at the Department of Livestock Production and Management, C.V.Sc. & A.H, OUAT, Bhubaneswar. Effects of ginger on production, Hematological, biochemical, immunity, carcass quality parameters of broiler chicken were evaluated in this experiment. The details of the materials and methods are described below.

3.1 Selection of birds and different dietary treatments

One hundred twenty numbers of day old Black Rock broiler chicks were distributed to 04 groups having 30 birds in each. Each group consists of three replicates with 10 birds in each replicate

Table 3.1. Grouping of birds for experiment

Group	Dietary treatments
T_1	Basal Diet
T_2	Standard broiler ration + ginger powder @ 0.5%
T_3	Standard broiler ration + ginger powder@ 1%
T_4	Standard broiler ration + ginger powder@1.5%

*The required ginger was supplemented to the birds through feed.

3.2 Basal diet

The basal diets were prepared as per the BIS (2007) standards. The compositions of the basal diets are given in Table 3.2 and 3.3 respectively for prestarter, starter and finisher birds.

Table 3.2. Ingredient composition of basal diet

Sl. No.	Particulars	Prestarter (%) (1-14th day)	Starter (%) (15-21st day)	Finisher (%) (22-42nd day)
1.	Maize	51.50	53.50	56.50
2.	Soya bean meal	43.0	39.00	35.00
3.	Vegetable oil	2.0	4.0	5.0
4.	Dicalcium phosphate	1.83	1.83	1.83
5.	Limestone	0.97	0.97	0.97
6.	DL- Methionine	0.05	0.05	0.05
7.	L-Lysine	0.03	0.03	0.03
8.	Mineral premix	0.15	0.05	0.15
9.	Common salt	0.51	0.51	0.51
	Total	**100**	**100**	**100**

Table 3.3. Proximate composition of the basal diet

Sl. No.	Particulars	Prestarter (%)	Starter (%)	Finisher (%)
1.	Crude protein	22.85	20.57	19.32
2.	Ether extract	2.94	4.96	5.51
3.	Crude fibre	4.84	4.70	5.31
4.	Total ash	9.27	8.29	9.03
5.	Nitrogen free extract*	60.10	61.48	60.83
6.	Calcium	1.24	1.18	0.89
7.	Phosphorus	0.57	0.62	0.51
8.	Se (ppm)	0.025	0.020	0.018
9.	Metabolisable energy(kcal/kg)	2995	3140	3225

*Calculated value

3.3 Preparation of ginger powder

The freshly purchased ginger was washed and sliced. The sliced form of ginger was sun dried, ground and stored in poly bags. The ginger offered to the birds were analyzed for proximate principles as per A.O.A.C (1995).

Table 3.4. Composition of ginger (% DM basis)

Composition	Ginger
Moisture	73.82
Dry Matter	26.18
Crude Fat	5.03
Crude Protein	8.16
Total Ash	2.91
Crude Fibre	2.88
Nitrogen free Extract*	81.02

* Calculated value

3.4 Management of birds

At the initiation of the trial, the experimental shed was cleaned and disinfected. The pathogenic organisms present in the experimental shed were destroyed by using flame gun. Malathion (1%), formalin (10%) was sprayed outside the poultry house. Feeders and waterers were thoroughly washed with the help of potassium permanganate. Chicks procured from Central Poultry Development Organisation (CPDO) were weighed and wing banded at the first day of the experiment. By adopting deep litter system of housing litter materials, feeding and watering facility were kept ready before arrival of chicks. Clean drinking water was provided throughout the day. From 0-2 weeks, electric bulb was provided in sufficient quantity to maintain brooding temperature. The feeding schedule was categorized into three phases: prestarter phase (1-14day), starter phase (15-24day) and finisher phase (25-42day). Vaccination schedules of the Black Rock was presented in Table 3.5.

Table 3.5. Vaccination of the Black Rock birds

Age	Vaccine
0 Day	Marek's disease (HVT strain)
7^{th} day	Ranikhet Disease (Lasota strain)
14^{th} day	Ranikhet Disease (Booster)
21^{st} day	IBD (Intermediate strain)

3.5 Body weight recording

Individual body weights of the birds were measured by using electric pan balance at different weeks of the experiments. The initial body weight was subtracted from final to get the body weight gain.

3.6 Feed intake and feed conversion ration

Feed intake was calculated at weekly intervals by deducting the left over feed from the total feed supplied during that week. Feed intake from 1st week to the desired week was the cumulative feed intake. FCR was calculated as follows:

$$\text{Feed conversion ratio} = \frac{\text{Cumulative feed consumption in gram}}{\text{Cumulative body weight gain in gram}}$$

3.7 Chemical composition of experimental diet

The proximate composition of the basal diet was performed as per A.O.A.C (1995). Similarly the Ca and P was estimated as per Talapatra *et al*. (1940) and IS: 1374-1968 respectively.

3.7.1 Dry matter (DM)

Weight of dried empty moisture cup was taken. Five gram of powdered feed sample was placed in moisture cup and dried with the help of hot air oven at 100^0C. The moisture cup with the dried sample was weighed and the DM was calculated as.

$$\text{DM \%} = \frac{\text{(Wt. of moisture cup with dried sample) – (Wt. of empty moisture cup)}}{\text{(Wt. of moisture cup with fresh sample) – (Wt. of empty moisture cup)}} \times 100$$

3.7.2 Crude protein (CP)

The total nitrogen present is estimated by Micro-Kjeldahl method. 100 mg of feed was digested for 45 to 60 minutes along with 2ml of conc. H_2SO_4 and 2g of catalyst (HgO: K_2SO_4: 1:4.75). The flask was cooed by rinsing the inner side of the flask after completion of digestion. Steam distillation of digested feed sample was done in Parnas and Wagnur apparatus. Into the distillation flask10 ml of NaOH-$Na_2S_2O_3$ solution was added and ammonia released is trapped by using saturated boric acid and mixed indicator. The ammonium borate was then titrated against 0.01 N HCl to get the nitrogen content of the feed.

$$N\ \% = \frac{(\text{ml of N/100 of HCl for sample} - \text{ml of N/100 HCl for blank}) \times 0.14}{\text{mg of sample taken}} \times 100$$

*Note: For calculating the crude protein content N percent was multiplied by 6.25

3.7.3 Ether extract (EE)

About 2g of dried feed sample was transferred into a cellulose thimble. The weight of the empty oil flask was measured. The dried material with the thimble was kept in extractor. Oil flask was fixed below the extractor then the condenser was fixed above Soxhlet's apparatus. From top end of Soxhlet's apparatus, the required quantity (about 150 ml) of petroleum ether (Boiling point 60^0C to 80^0C) was poured to fill $3/4^{th}$ of oil flask. At the temperature of 60^0C for 16 hours the feed sample was extracted. After the extraction was completed the oil flask is removed, keep it at room temperature followed by overnight drying in the oven at 100^0C. Measure the weight of the oil flask.

$$EE\ \% = \frac{(\text{Wt of the oil flask with extract}) - (\text{Wt. of the empty oil flask})}{\text{Wt. of the sample on DM basis}} \times 100$$

3.7.4 Crude fibre (CF)

Take 2gm ether extracted (fat free) dried feed sample was digested by using 200 ml of 1.25 % H_2SO_4, reflux for 30 minutes and with the help of suction pump, filter the content through a muslin cloth. Then digestion and filtration was out with 1.25 % NaOH (200 ml) and muslin cloth respectively. The filtrate was transferred to a sintered glass crucible and dried overnight in hot air oven. Record the weight of dried filtrate. Ignite it in a muffle furnace at 550^0C. The loss of weight is the crude fibre weight.

$$CF\ \% = \frac{(\text{Wt. of crucible + dry digested sample}) - (\text{Wt. of crucible + ash})}{\text{Wt. of sample on DM basis}} \times 100$$

3.7.5 Nitrogen-free extract (NFE)

This proximate was calculated mathematically as per the following formula.

$$NFE\ \% = 100 - (CP\ \% + EE\ \% + CF\ \% + TA\ \%)$$

3.7.6 Total ash

Dry the crucibles in hot air oven. Record the weight of empty crucible. Take 2-5gm of sample and record the weight accurately. Heat the sample over flame to make the sample smoke free. Then keep the crucible in muffle furnace at $550^0 \pm 10^0$C (below 600^0C) for six hours. Remove the crucible from the furnace, cool it in desiccator and weighted. The total ash was calculated as follows:

$$\text{Total ash} = \frac{\text{(Wt. of the crucible with ash) – (Wt. of the empty crucible)}}{\text{Wt. of sample taken on DM basis}} \times 100$$

3.7.7 Acid insoluble ash (AIA)

Take out the ash and add distilled water carefully drop by drop in the crucible. Transferred the content to a 250 ml beaker. Add 5ml of conc. HCl to the crucible and heated over flame and transferred to the beaker. Add 5 ml conc. HCl to the beaker followed by add distilled water up to 200 mark. On a hot plate, the beaker was kept for 30 minutes. Then through the Whatman No.1 filter paper, filter the content of the beaker. From the beaker to the filter paper, the residue was quantitatively transferred, washed free from acid with hot distilled water. In a 250 ml volumetric flask, the filtrate was collected. Make up the volume up to the mark of the volumetric flask. This filtrate was used as aliquot for estimation of minerals. In a previously weighed crucible, the residue along with the filter paper was dried in a hot air oven at 100^0C. Then in a desiccator, it was cooled and weighed. Percentage of acid insoluble ash was calculated by the formula.

$$\text{AIA\%} = \frac{\text{(Wt. of crucible with insoluble ash) – (Wt. of empty crucible)}}{\text{Wt. of sample taken on DM basis}} \times 100$$

3.8 Collection of serum

Five birds of each treatment were slaughtered at 42^{nd} day of the experiment to collect the blood. About 05 ml of blood was collected for estimation of blood hematology, antioxidants and blood biochemicals. For hematological parameters, blood was collected in heparinized vial. For blood biochemicals, blood samples were collected in sterilized centrifuge tube without adding anticoagulants. After collection, blood samples were kept in slanting position for 03 hours followed by centrifugation at 3000 rpm for 10 minutes. The harvested serums were stored at -20°C in 01 ml storing vials for further studies.

3.9 Serum biochemical analysis

Serum biochemical parameters were estimated by using the kit prepared by CPC diagnostic Ltd., Chennai, India, using Terbochem100 automated biochemistry analyser.

3.9.1 Serum globulin

Concentration of serum globulin was determined as follows:

Concentration of globulin (g/dl) = Conc. of total protein (g/dl) – Conc. of albumin (g/dl).

3.9.2 Albumin/Globulin ratio (A: G)

The A: G ratio of individuals in each group were estimated by serum albumin value and its corresponding globulin values

3.10 Haematological Parameter

3.10.1 Haemoglobin (Hb) (g %)

Estimation of hemoglobin was carried out as per Schalm *et al*. (1975) by using Hellige and Sahli's haemoglobinometer.

3.10.2 Packed cell volume (%)

PCV was estimated by using microhaematocrit method. Proper mixing blood was filled in the thin capillary tube followed by centrifugation with help of microhaematocrit centrifuge machine at 1200 Rpm for 2-3 minutes. Reading of the tube was done by observing the height of red cell layer.

3.10.3 Total erythrocyte count (TEC) (millions/ cubic mm)

Total red blood cell was estimated by using hemocytometer. With the help of RBC pipette blood was drawn up to 0.5 mark followed by RBC diluting fluid up to 101 marks. After proper rotating by keeping it between the fingers, the solution was charged in the counting chamber. After proper settled down, erythrocyte were counted in five squares. The counted number multiplied by 50 which gave the TLC (10^6 cells/ mm^3).

3.10.4 Mean cell volume

MCV is expressed as femtoliters and calculated as follows:

$$MCV = (PCV \div TEC) \times 10$$

3.10.5 Mean corpuscular haemoglobin concentration

MCHC is calculated as follows:.

$$MCHC = (Haemoglobin \div PCV) \times 100$$

3.11 Immunity parameters

3.11.1 Measure of cellular immunity

Cellular immunity was measured as Cutaneous Basophillc Hyper Sensitivity (CBH) test as per Edelman *et al*. (1986). Six birds from each group were injected intradermally into the foot web with 100 microgram of Phytohaemaglutinin-P (PHAP) at 42nd day of experiment. Thickness of foot web before and 24hr after injection was measured with help of digital slide caliper.

$$\text{CBH response} = \frac{\text{Post injection skin thickness}}{\text{Pre-injection thickness}} \times 100$$

3.11.2 Measure of humoral immunity

Humoral immunity was measured as per Abdallah *et al.* (2009) following hemagluttination test. Birds were immunized with sheep red blood cells at 42nd day for measurement of primary response. Blood collected after seven days were analysed to measure the antibody titre by using microtiter plate U shape of 96 wells. All HA antibody titres were expressed as $\log_2$ of the reciprocal of the highest serum dilution causing agglutination of sheep RBC.

3.12 Carcass characteristics

From each replicates 5 birds were sacrificed by Kosher method followed by bleeding for 02 minutes. Scalding was done at 60°C for 30 second. Picking and singeing was done as per the standard procedure. Parameters like Dressed weight**,** Giblet weight, Meaty cuts, Cut-up wings, Cut-up neck, Cut-up back, Cut-up breast, Cut-up drumsticks, Cut-up thighs was performed as per standard protocol. All the

above weights and cut-up chickens were used to get percentage yield. The calculations for different carcass parameters were expressed as:

1) Pre-slaughter weight or Live weight (g)

2) Dressing yield (%) $= \frac{\text{Dressing weight}}{\text{Live weight}} \times 100$

3) Eviscerated yield (%) $= \frac{\text{Eviscerated weight}}{\text{Live weight}} \times 100$

4) Giblet yield (%) $= \frac{\text{Giblet weight}}{\text{Live weight}} \times 100$

5) Neck yield (%) $= \frac{\text{Weight of the neck}}{\text{Eviscerated weight}} \times 100$

6) Wings yield (%) $= \frac{\text{Weight of the wings}}{\text{Eviscerated weight}} \times 100$

7) Back yield (%) $= \frac{\text{Weight of the back}}{\text{Eviscerated weight}} \times 100$

8) Breast yield (%) $= \frac{\text{Breast weight}}{\text{Eviscerated weight}} \times 100$

9) Thighs yield (%) $= \frac{\text{Weight of the thighs}}{\text{Eviscerated weight}} \times 100$

10) Drumsticks yield (%) $= \frac{\text{Weight of the drumsticks}}{\text{Eviscerated weight}} \times 100$

3.13 Statistical analysis

SPSS software (version 16.0) was used to analyze the data by using ANOVA. Charts and calculations were done with the help of Microsoft Excel Office 2007.

Raw ginger

Ginger dried under sunlight

Ginger powder

Ginger powder mixed with feed

Brooding of chicks

Vaccination of chicks

T_1 (Control)

T_2 (0.5% Ginger)

T_3 (1 % Ginger)

T_4 (1.5% Ginger)

Body weight taken of birds

Feed weight taken

Blood collection from wing vein

Serum biochemical analysis

Cut up parts of bird

Organ weight of birds

PHAP injected to foot pad

CBH response

CHAPTER-IV

RESULTS

4.1 Effect on body weight

Average weekly body weights of experimental birds in all treatment groups up to the end of the experiment period has been depicted in Table 4.1. Body weights taken in initial days were similar in different ginger treated Black Rock birds. No significant difference observed in avg. chick body weight in 1st week. At the end of 2nd week T_3 group showed higher body weight. However, in 3rd week the T_1, T_2, T_3, T_4 avg. body weights were 398.70±17.30, 494±15.22, 533.50±15.70, 468.75±16.09 g, respectively. T_3 showed significantly (P<0.05) higher body weights than other. At 4th week of experiment, group T_3 was found to gain highest body weight (823.75±25.63) which was significantly (P<0.05) higher than T_1, T_2, T_4. At the end of 5th week, the avg. body weight of T_3 group manifested significantly (P<0.05) higher than remaining experimental group. Similarly, at last week of experiment, the avg. body weight of experimental birds in all treatment groups were 1281.20±15.97, 1396.10±23.52, 1478.20±27.27, 1375.60±26.37 g respectively. Body weight in T_3 (1478.20±27.27) manifested significantly (P<0.05) higher than other group indicating that supplementation of ginger @ 1% increased the body weight gain comparison to 0.5%, 1.5% and control birds.

Table 4.1. Weekly body weight (g) in broiler birds

Week	Treatments				P value
	T_1	T_2	T_3	T_4	
Initial	37.90±0.80	38.25±0.84	37.00±0.76	38.00±0.66	0.684
1st	90.70±2.33	97.75±5.92	101.90±9.81	93.80±3.15	0.082
2nd	214.50^{a}±11.56	244.25^{b}±10.54	267.00^{c}±12.97	233.70^{b}±12.34	<0.01
3rd	398.70^{a}±17.30	494.10^{b}±15.22	533.50^{c}±15.70	468.75^{b}±16.09	<0.01
4th	656.80^{a}±10.27	771.05^{b}±24.66	823.75^{c}±25.63	747.20^{ab}±26.51	<0.01
5th	948.10^{a}±15.74	1075.00^{b}±26.41	1136.00^{c}±17.14	1049.70^{b}±26.39	<0.01
6th	1281.20^{a}±15.97	1396.10^{b}±23.52	1478.20^{c}±27.27	1375.60^{b}±26.37	<0.01

^{abc} Values comprising different superscripts in a row differ significantly (P<0.05)

4.2 Effect on body weight gain

The cumulative body weight gain of birds has been presented in Table 4.2. The body weight gain was significantly (P<0.05) higher in treatment groups from 1st week to 6th week of age than control. Numerically higher cumulative body weight gain was observed in T_3 groups.

Table 4.2. Cumulative body weight gain (g) in broiler birds

Week	Treatments				P value
	T_1	T_2	T_3	T_4	
1st	$52.80^{a}\pm1.45$	$59.50^{ab}\pm0.89$	$64.90^{b}\pm1.19$	$55.80^{a}\pm0.93$	0.042
2nd	$176.60^{a}\pm1.68$	$206.00^{b}\pm1.58$	$230.00^{c}\pm2.64$	$195.30^{b}\pm2.31$	<0.01
3rd	$360.80^{a}\pm7.40$	$455.85^{b}\pm5.01$	$496.50^{c}\pm5.59$	$430.35^{b}\pm6.26$	<0.01
4th	$618.90^{a}\pm10.37$	$732.80^{bc}\pm4.38$	$786.75^{c}\pm5.59$	$708.80^{b}\pm6.67$	<0.01
5th	$910.20^{a}\pm15.47$	$1036.80^{b}\pm6.37$	$1099.00^{c}\pm7.16$	$1011.30^{b}\pm6.58$	<0.01
6th	$1243.20^{a}\pm15.71$	$1357.00^{b}\pm3.70$	$1441.20^{c}\pm7.38$	$1337.20^{b}\pm6.55$	<0.01

^{abc} Values comprising different superscripts in a row differ significantly (P<0.05)

4.3 Effect on cumulative feed intake

Cumulative feed intake of experimental birds in control and ginger supplemented groups up to the end of the experiment has been presented in Table 4.3. This parameter didn't differ significantly (P>0.05) between the treatment groups throughout the trial.

Table 4.3. Cumulative feed intake (g) in broiler birds

Week	Treatments				P value
	T_1	T_2	T_3	T_4	
1st	82.50±7.12	88.00±10.68	96.00±12.22	86.00±10.91	0.370
2nd	340.50±22.59	355.50±21.03	368.50±10.34	363.50±20.34	0.125
3rd	808.50±25.81	801.00±30.45	836.00±42.38	834.50±44.33	0.196
4th	1446.50±45.02	1447.50±48.37	1489.00±45.96	1486.50±44.70	0.174
5th	2249.50±55.70	2262.50±59.52	2287.00±55.27	2295.50±53.78	0.225
6th	3492.80±65.51	3620.40±71.06	3728.20±78.06	3633.10±89.40	0.290

4.4 Effect on cumulative feed conversion ratio (FCR)

The average cumulative FCR of experimental birds in all experimented groups has been shown in the Table 4.4. In 1st week average cumulative FCR was similar among the treatment groups. Avg. cumulative FCR of T_3 in 2nd week of experiment was found to be lower than other treatments. The cumulative FCR at 3rd wk of experiment ranged from 1.68 ±0.03 to 2.25±0.04 showing T_3 had lower FCR as compared to other treatments. At 4thweek of age T_3 group showed significantly ($P<0.05$) lower FCR. On 5th week of age the average cumulative FCR were ranged from 2.08±0.03 to 2.48±0.04. However T_3 manifested significantly ($P<0.05$) lower FCR. On final week of experiment the FCR of all the treatment groups were 2.81±0.02, 2.66±0.04, 2.58±0.03, 2.71±0.02 and respectively. The best numerical FCR 2.58±0.03 was witnessed in treatment T_3 that received 1% ginger which differed significantly ($P<0.05$) with respect to other dietary group.

Table 4.4. Cumulative FCR in broiler birds

Week	Treatments				P value
	T_1	T_2	T_3	T_4	
1st	1.57±0.03	1.48±0.02	1.48±0.02	1.55±0.03	0.109
2nd	1.92^{c}±0.01	1.72^{b}±0.01	1.60^{a}±0.01	1.86^{c}±0.02	<0.01
3rd	2.25^{d}±0.04	1.76^{b}±0.01	1.68^{a}±0.03	1.93^{c}±0.02	<0.01
4th	2.35^{c}±0.04	1.97^{a}±0.01	1.89^{a}±0.03	2.09^{b}±0.01	<0.01
5th	2.48^{c}±0.04	2.18^{b}±0.04	2.08^{a}±0.03	2.27^{b}±0.02	<0.01
6th	2.81^{c}±0.02	2.66^{b}±0.04	2.58^{a}±0.03	2.71^{b}±0.02	<0.01

^{abcd} Values comprising different superscripts in a row differ significantly ($P<0.05$)

4.5 Mortality %

There was no mortality in T_2, T_3, T_4 groups throughout the experiment. Single bird mortality occurred in T_1 group.

Table 4.5. Mortality of broiler birds on different dietary treatments at the end of 6th week of age

Groups	T_1	T_2	T_3	T_4
No. of bird housed	30	30	30	30
No .of birds alive(at 6th week)	29	30	30	30
Mortality%	3.34	0	0	0

4.6 Effect on hematological parameters

The haematological parameters with respect to Hb, PCV, TEC, TLC, MCV and MCHC at 6th week of age of birds are shown in Table 4.6. No significant (P>0.05) difference between the groups for any of the parameters was noticed.

Table 4.6. Hematological parameters of broiler birds (42nd day)

Parameters	Treatments				P value
	T_1	T_2	T_3	T_4	
Hb (%)	9.80±0.21	9.44±0.06	9.50±0.17	9.68±0.17	0.424
PCV %	30.68±1.57	28.36±1.10	28.42±1.70	28.61±0.80	0.575
TEC ($\times10^6$ /µl)	2.90±0.24	2.72±0.12	2.80±0.22	2.82±0.16	0.931
TLC ($\times10^3$ /µl)	19.53±1.67	20.05±1.96	19.90±1.94	19.55±1.92	0.251
MCV (fl)	109.52±12.34	104.26±1.67	105.47±13.57	102.96±7.35	0.969
MCHC %	32.40±2.35	33.51±1.36	33.79±1.61	33.88±0.63	0.91

4.7 Effect of ginger supplementation on blood biochemical parameters

Serum biochemical parameters viz., glucose, total protein, albumin, globulin, A/G ratio, urea, creatinine, cholesterol, triglycerides, ALT, AST, HDL, LDL at 6th week of Black rock broiler birds are depicted in Table 4.7. The value of serum glucose (mg/dl) ranged from 176.22±6.24 to 182.05±7.97 showing no significant (P>0.05) difference among the treatments. Serum total protein (g/dl), serum albumin (g/dl), serum globulin (g/dl) and A/G ratio ranged from 3.42±0.13 to 4.07±0.38, 1.78±0.05 to 2.04±0.21, 1.62±0.19 to 2.03±0.31, 1.07±0.16 to 1.29±0.15 respectively. Serum total protein, serum albumin, serum globulin levels remain unaffected (P>0.05). Serum cholesterol level (mg/dl) ranged from 129.43±2.87 to163.83 ±3.43 in which group T_3 and T_4 showed significantly lower (P<0.05) value. T4 group was found to have significantly (P<0.05) lower triglyceride value (35.18±1.18) mg/dl. The

mean serum HDL level (mg/dl) at 42nd days of age for control and three ginger supplemented group were 55.23±1.22, 65.41±1.70, 72.71±1.00 and 75.14±1.23 respectively. Highest HDL was observed in T_4 group. T_3 and T_4 group showed lower LDL values (mg/dl) 44.03±1.79 and 42.69±1.02, respectively.

Table 4.7. Serum biochemical profile of broiler birds (42nd Day)

Parameters	Treatments				P value
	T_1	T_2	T_3	T_4	
Glucose (mg/dl)	180.42±6.69	176.66±7.61	182.05±7.97	176.22±6.24	0.922
Total protein (g/dl)	3.55±0.29	3.61±0.22	3.42±0.13	4.07±0.38	0.405
Albumin (g/dl)	1.79±0.01	1.98±0.05	1.78±0.05	2.04±0.21	0.310
Globulin (g/dl)	1.75±0.28	1.62±0.19	1.64±0.10	2.03±0.31	0.614
A:G	1.21±0.30	1.29±0.15	1.09±0.06	1.07±0.16	0.845
Urea (mg/dl)	21.78±1.91	20.12±2.12	18.67±3.79	19.23±3.56	0.889
Creatinine (mg/dl)	0.38±0.06	0.39±0.03	0.33±0.10	0.39±0.09	0.944
Uric acid (mg/dl)	4.94±0.90	4.37±0.71	4.60±0.57	3.74±0.48	0.657
Cholesterol (mg/dl)	163.83^{b}±3.43	144.18^{ab}±5.05	137.26^{a}±4.27	129.43^{a}±2.87	<0.01
Triglyceride (mg/dl)	54.73^{d}±2.85	46.99^{c}±2.61	41.34^{b}±1.04	35.18^{a}±1.18	<0.01
ALT (U/l)	11.04±3.05	11.34±3.57	10.87±3.30	10.20±3.07	0.995
AST (U/l)	176.53±8.99	180.96±30.09	174.05±8.59	181.75±26.86	0.992
HDL (mg/dl)	55.23^{a}±1.22	65.41^{b}±1.70	72.71^{c}±1.00	75.14^{c}±1.23	0.031
LDL (mg/dl)	49.46^{b}±0.84	45.89^{ab}±1.84	44.03^{a}±1.79	42.69^{a}±1.02	0.024

^{abc} Values showing different superscripts in a row differ significantly (P<0.05)

4.8 Effect on immunity status

The antibody titres (log_2) against SRBC inoculation and CBH response at 42nd day of age of experimented birds are depicted in the Table 4.8. The antibody titers (log_2) against SRBC inoculation of 42nd day of age of broiler birds were 0.81±0.04, 1.47±0.07, 1.68±0.21 and 1.53±0.05 in the groups T_1, T_2, T_3 and T_4 respectively. T_3 & T_4 showed significantly (P<0.05) higher antibody titers (log_2) against SRBC inoculation compared to other groups.

The CBH response were 133.32±11.09, 181.96±4.79, 186.90±4.18 and 185.86±5.24 in the T_1, T_2, T_3 and T_4 group respectively. However, control group (133.32±11.09) showed significantly (P<0.05) lower CBH response than other dietary treatments.

Table 4.8. Immunity status of broiler birds (6th week)

Parameters	Treatments				P value
	T_1	T_2	T_3	T_4	
SRBC	0.81^{a}±0.04	1.47^{b}±0.07	1.68^{c}±0.21	1.53^{c}±0.05	<0.01
CBH	133.32^{a}±11.09	181.96^{b}±4.79	186.90^{c}±4.18	185.86^{c}±5.24	<0.01

^{abc} Values bearing different superscripts in a row differ significantly (P<0.05)

4.9 Effect of Ginger supplementation on carcass parameters (42nd days)

Numerically higher (1445.07±10.20) g pre slaughter weight was witnessed in T3 group. Dressing yield (%), Eviscerated yield (%), Giblet yield (%), Neck yield (%), Wing yield (%), Back yield (%), Breast yield (%), Thigh yield (%), Drum stick yield (%) of the experimental birds in all the group ranged from 71.40±0.49 to 73.38±0.49, 64.40±1.35 to 66.87±2.41, 6.51±0.16 to 7.12±0.35, 5.12±0.29 to 5.82±0.09, 7.82±0.45 to 8.56±0.28, 15.39±0.25 to 15.67±0.66, 29.39±0.35 to 29.73±0.41, 10.39±0.38 to10.98±0.33, 8.85±0.17 to 9.35±0.38, respectively in Table 4.9. The studied parameters were not affected by (P>0.05) dietary treatments.

Table 4.9. Carcass parameters (%) of broiler birds (42nd day)

Parameters	Treatments				P value
	T_1	T_2	T_3	T_4	
Pre slaughter weight (g)	1240.20^{a}±10.68	1360.20^{b}±12.51	1445.07^{c}±10.20	1340.20^{b}±11.20	0.031
Dressing yield (%)	71.40±0.49	73.35±0.61	72.75±1.01	73.38±0.49	0.186
Eviscerated yield (%)	64.40±1.35	66.48±1.60	65.63±1.89	66.87±2.41	0.820
Giblet yield (%)	7.00±0.19	6.87±0.23	7.12±0.35	6.51±0.16	0.401
Neck yield (%)	5.82±0.09	5.61±0.26	5.78±0.42	5.12±0.29	0.339
Wing yield (%)	7.82±0.45	8.31±0.23	8.12±0.38	8.56±0.28	0.513
Back yield (%)	15.67±0.66	15.50±0.56	15.62±0.39	15.39±0.25	0.979
Breast yield (%)	29.68±0.57	30.13±0.56	29.73±0.41	29.39±0.35	0.761
Thigh yield (%)	10.84±0.37	10.39±0.38	10.98±0.33	10.54±0.42	0.679
Drumstick yield (%)	9.27±0.50	9.22±0.30	8.85±0.17	9.35±0.38	0.770

^{abc} Values bearing different superscripts in a row differ significantly (P<0.05)

4.10 Effect on organ weight (%Body weight)

Kidney (%), liver (%), gizzard(%), brain (%), heart (%) and spleen (%) of the broiler birds in all experimented groups ranged from 0.66±0.04 to 0.70±0.08, 2.00±0.12 to 2.36±0.21, 1.71±0.11 to 2.14±0.10 ,0.17±0.006, 0.53±0.07 to 0.60±0.08 and 0.07±0.006 to 0.10±0.02 at 42 days of the experiments Table 4.10. None of the parameters was found significantly (P> 0.05) differed between the groups.

Table 4.10. Organ parameters (%Body weight) of broiler birds

Parameters	Treatments				P value
	T_1	T_2	T_3	T_4	
Kidney (%)	0.67±0.04	0.70±0.08	0.69±0.04	0.66±0.04	0.399
Liver (%)	2.07±0.18	2.36±0.21	2.02±0.10	2.00±0.12	0.409
Gizzard (%)	1.74±0.06	2.14±0.10	1.71±0.11	1.97±0.21	0.123
Brain (%)	0.19±0.02	0.24±0.02	0.17±0.006	0.21±0.01	0.220
Heart (%)	0.53±0.14	0.56±0.08	0.58±0.07	0.60±0.09	0.597
Spleen (%)	0.08±0.01	0.10±0.01	0.07±0.006	0.10±0.02	0.455

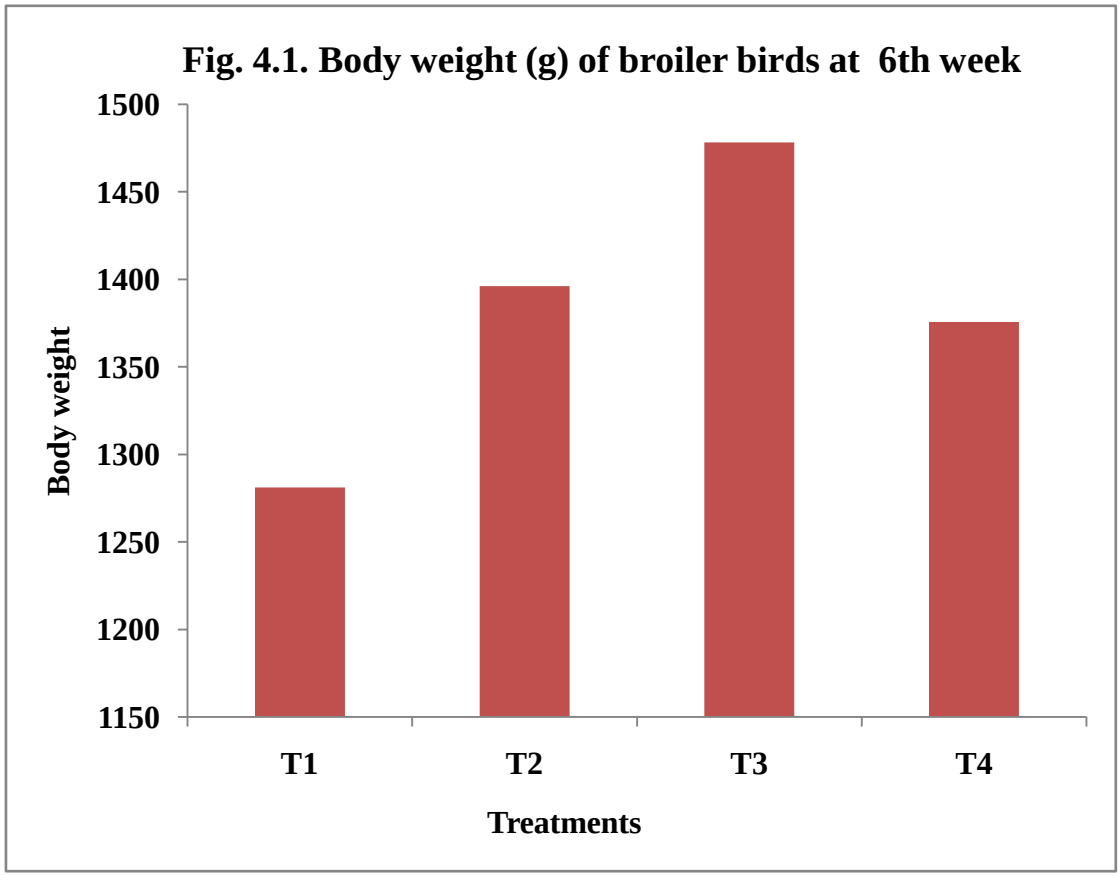


Fig. 4.1. Body weight (g) of broiler birds at 6th week
1500
1450
1400
1350
1300
1250
1200
1150
Body weight
T1
T2
T3
T4
Treatments

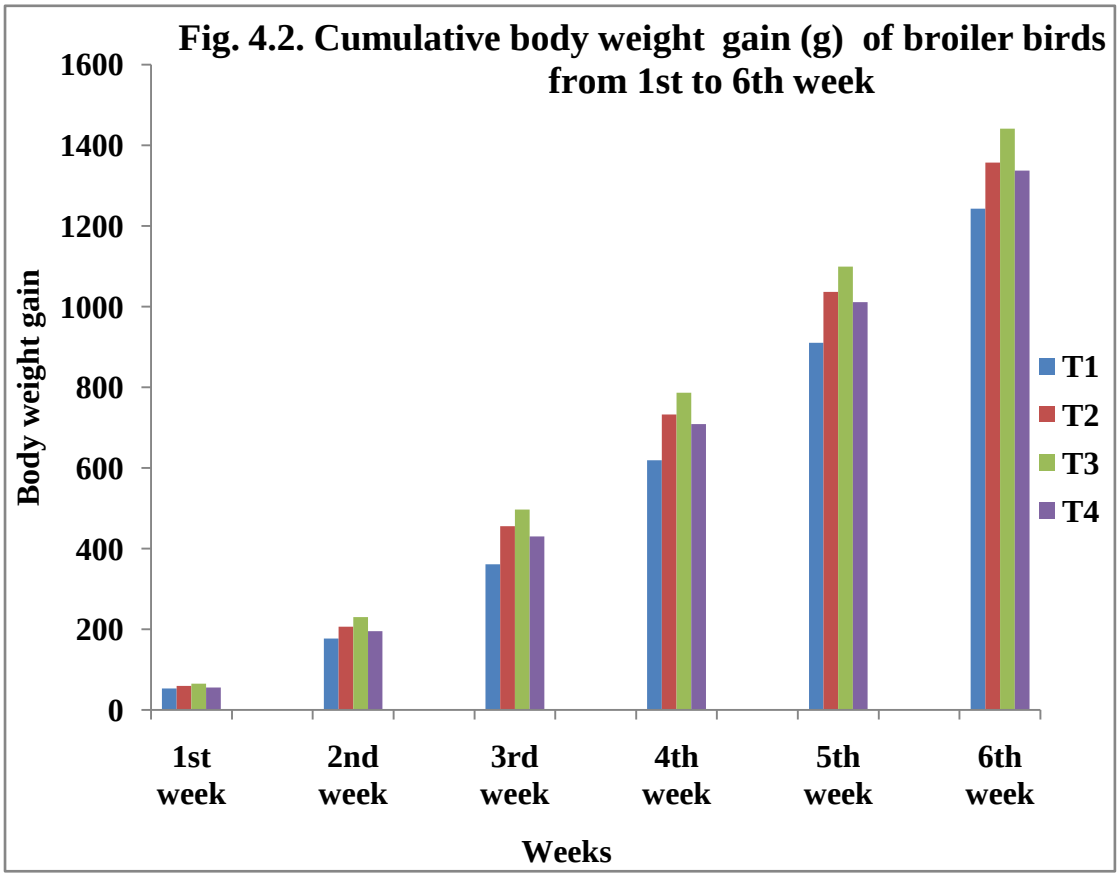


Fig. 4.2. Cumulative body weight gain (g) of broiler birds from 1st to 6th week
Body weight gain
1600
1400
1200
1000
800
600
400
200
0
1st week
2nd week
3rd week
4th week
5th week
6th week
Weeks
T1
T2
T3
T4

Fig. 4.3. Cumulative FCR of broiler birds at 6th week

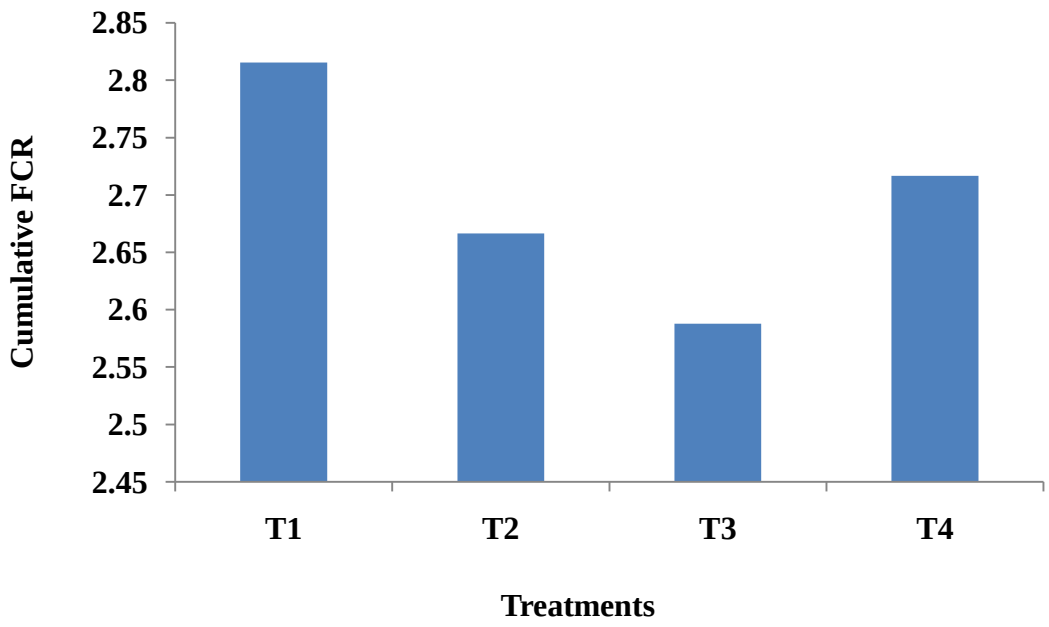


Fig. 4.4. Serum Cholesterol level of broiler birds on 42nd day

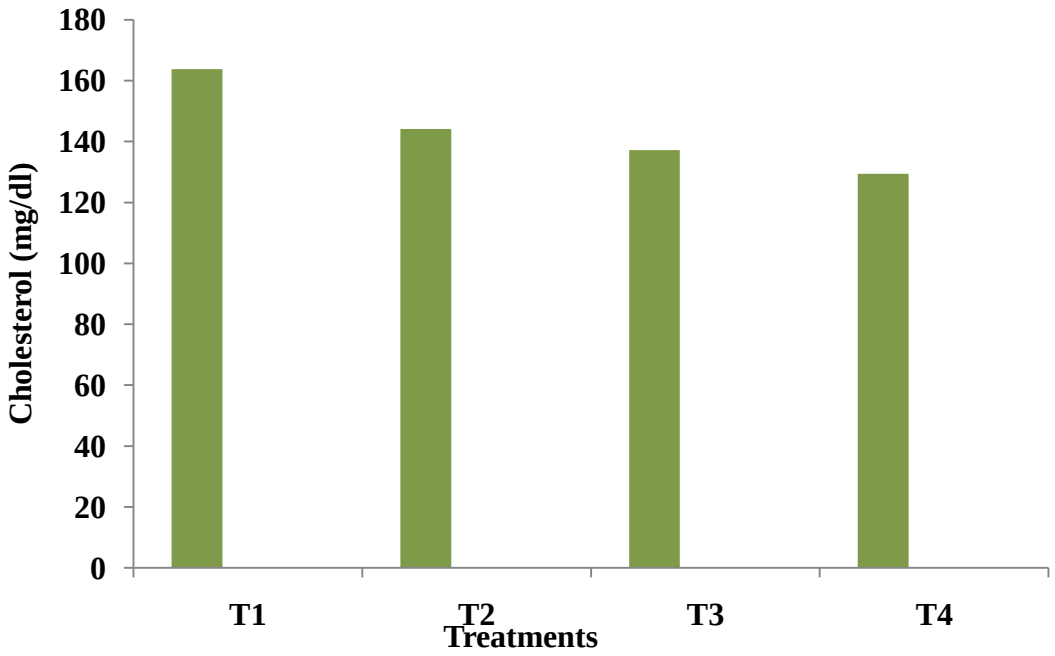
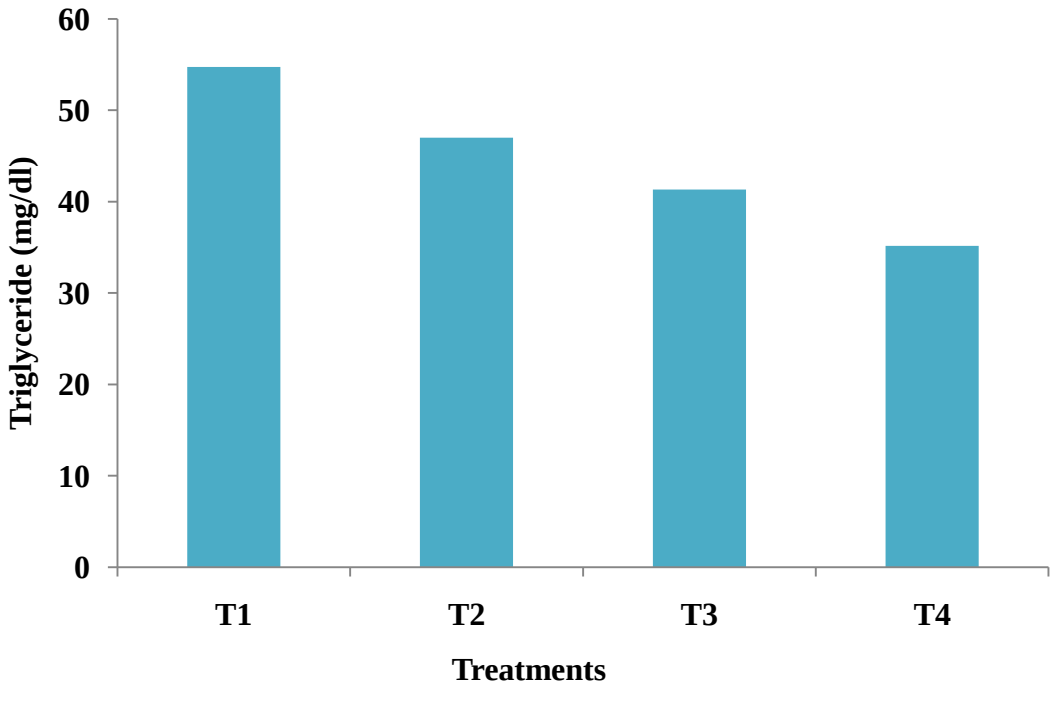


Fig. 4.5. Serum Triglyceride level of broiler birds on 42nd day



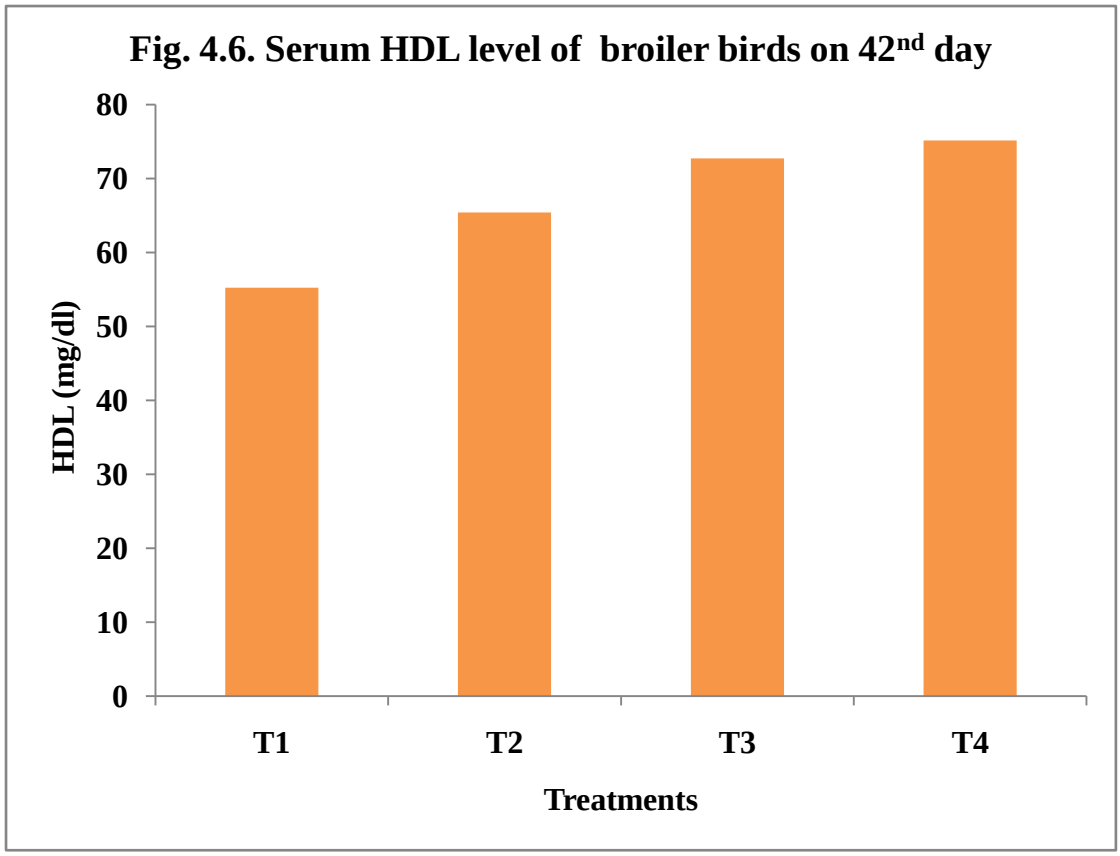


Fig. 4.6. Serum HDL level of broiler birds on 42nd day

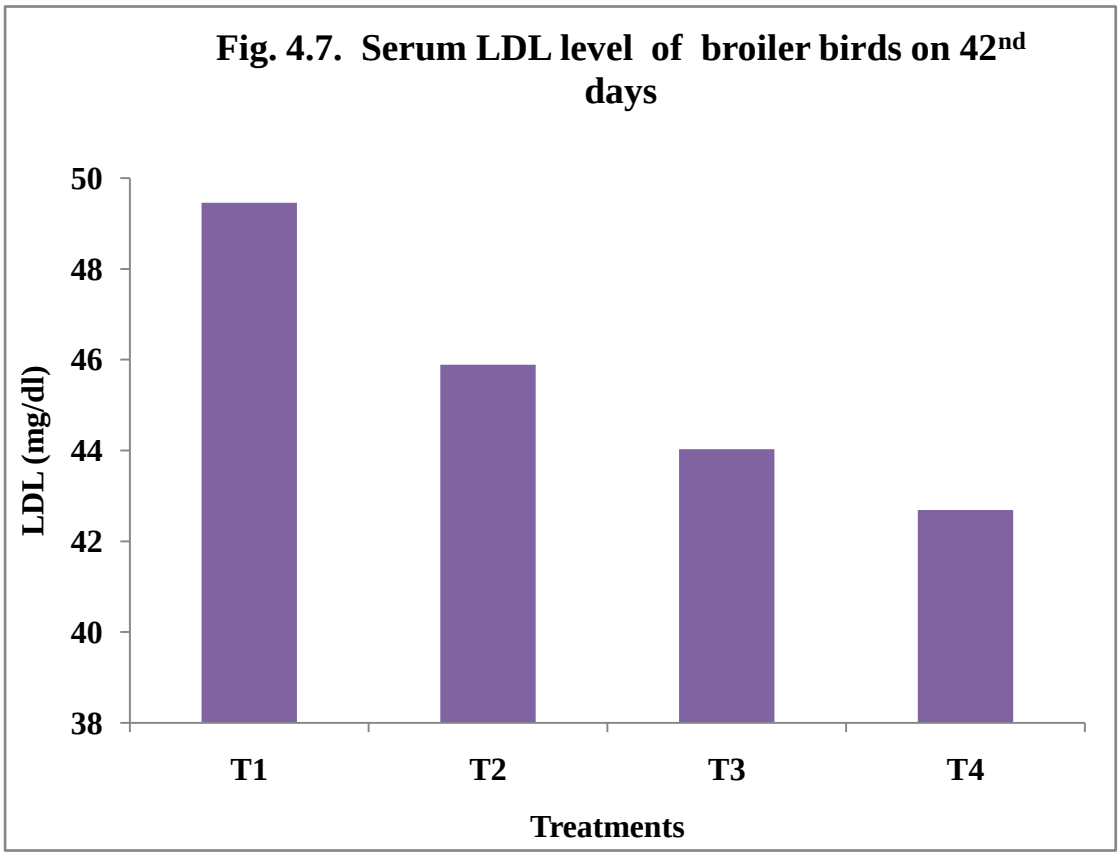


Fig. 4.7. Serum LDL level of broiler birds on 42nd days

Fig. 4.8. Humoral immune response against SRBC of broiler birds at 6th week of age

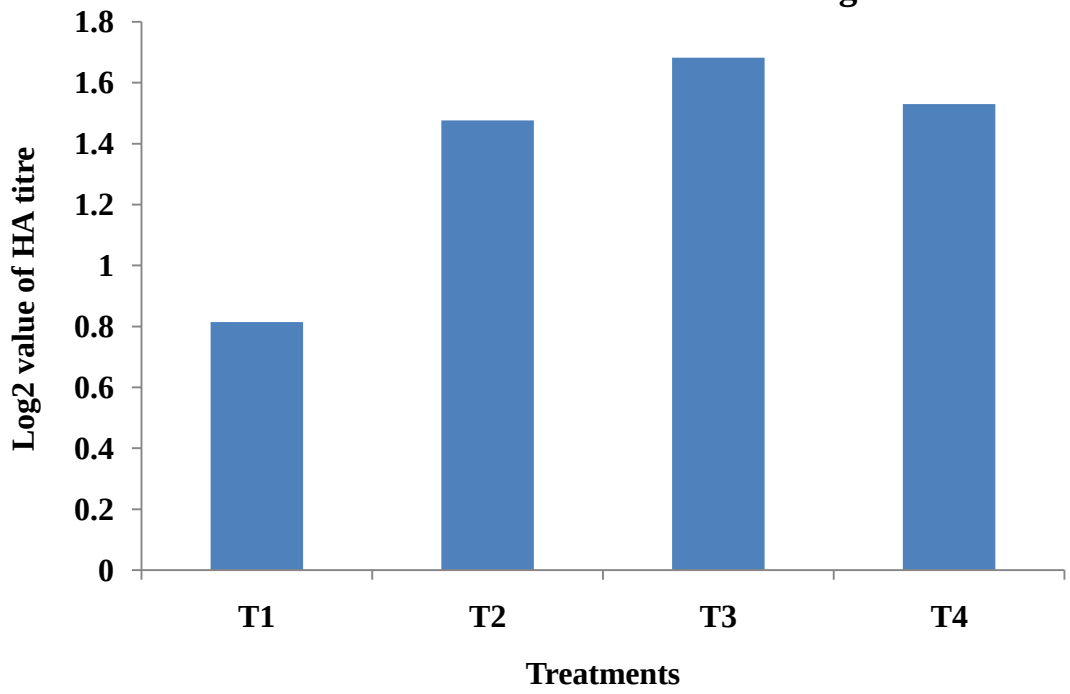
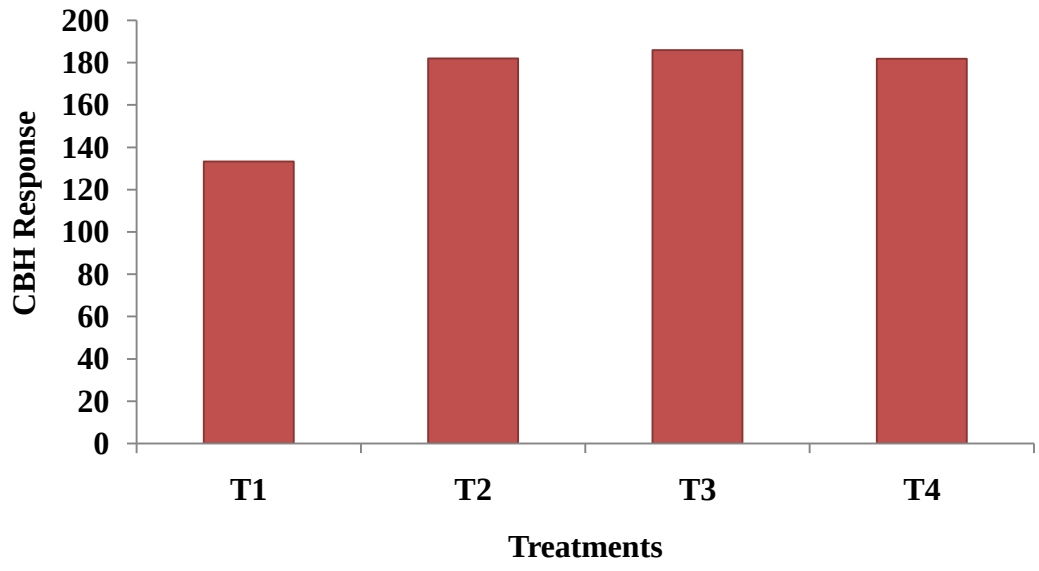


Fig. 4.9. CBH response of broiler birds at 6th weeks of age



CHAPTER-V

DISCUSSION

5.1 Effect on body weight

Body weight during 1st week of the experiment showed no significant (P>0.05) increase in T_2, T_3, T_4 than control. The average weekly body weight of chicks in 2nd week showed a significant increase in body weight in T_3 group than all other treatments. Similarly, after 2nd week the body weight is comparatively higher in all other treatments than control. The body weight in the last week of the experiment showed that T_3 attended highest body weight in comparison to all other treatments. It may be concluded that addition of ginger @ 1% in the diet of chicken improved the body weight & body weight gain than control. The increase in body weight might be due to proper secretion of digestive enzyme with better absorption, neutralization of bacterial toxin and stomach acids leading to better results. Present experiment coincides the result of Karangiya *et al*. (2016) who disclosed that body weight gain was significantly higher in ginger supplementation. The result found in his experiment are in concurrence with findings of Arshad *et al.* (20l2) and Rafiee *et al.* (2014) who opined significant (P<0.05) increase in body weight gain in broilers supplemented with ginger . Eltazi *et al.* (2014) reported significant (P<0.05) increase in BW and BW gain in ginger added diet @ 1 & 1.5% than control but lower body weight reported with 2% ginger powder supplementation. Weight gain in supplemented group might be attributed to the beneficial effects of the ingredients present in Ginger i.e. gingerol, gingerdiol, gingerdione and their sole properties like antimicrobial, antioxitative and pharmacological effect (Ali *et al.,* 2008). The increased body weight might be due to increase in villus height, area of intestine with standard improve in cell mitosis (lncharoen *et al.,* 2010).

Contrary to the foresaid findings Zhang *et al.* (2009) mentioned no significant weight gain effect, when ginger powder supplemented in feed @ 5g/kg. Moorthy *et al.* (2009) narrated ginger supplementation had no gain effect on body weight in broiler. Similarly Fakhim *et al.* (2013) observed no significant difference in ginger added diet. Qorbanpour *et al.* (2018) also showed no significant (P>0.05) effect of ginger supplementation on body weight gain of birds. The differences in the reported

findings may be attributed to the differences in bird type, their physiological status, plane of feed and environmental conditions.

5.2 Effect on cumulative feed intake

The average cumulative feed intake (g) of the broiler birds did not differ significantly (P>0.05) in the experiment periods. The outcome of present trial could be correlated to the results of Fakhim *et al.* (20l3) who reported that the feed intake did not differ among treatment groups. Similar to this result Qorbanpour *et al.* (2018) also showed no significant influence on daily feed intake of birds with ginger powder supplementation. Doley *et al.* (2005) observed non significant differences in feed intake of broilers given ginger extract for 6 weeks. It may be concluded that supplementation of ginger up to 1.5% in the diet have no adverse effect on the taste of feed in chicken. Contrary to this Barazesh *et al.* (2013) who observed significant (P<0.05) increased in feed intake in 1% ginger supplemented birds than control birds.

5.3 Effect on cumulative feed conversion ratio (FCR)

No significant difference was observed in average cumulative FCR in the 1^{st}week. Average cumulative FCR from 2^{nd} week up to the completion of experiment showed that addition of ginger powder significantly (P<0.05) lowered the FCR value, thereby increased the efficiency of nutrient utilization. In this study, birds offered 1 percent ginger had significantly (P<0.05) better FCR in comparison to all other treatments and control birds. The present finding equates with the findings from Mohamed *et* al. (2012) who recorded significantly (P<0.05) lower FCR in birds offered with 0.2% ginger supplementation. Similarly, Barazesh *et* al. (2013) and Shweita *et al* (2018) reported better FCR value in chicken supplemented with ginger powder. Contrary to this, Fakhim *et al. (2013)* and Zomrawi *et al.* (20l3) observed no significant difference in FCR in broiler birds supplemented with graded level of ginger powder. Better FCR value may be due to ginger causing nutrient sparing effect as their herbal antibiotic property might establish a stable microbial population by evading the harmful microorganism (Hays, 1978).

5.4 Effect on blood hematology

The present study pointed out that Hb, RBC, WBC and PCV were not affected by ginger supplementation. Similarly, MCV and MCH showed no change in

experimental birds in comparison with control. The present result was similar with those of Zomrawi *et al.* (2012*)* and Zomrawi *et al.* (2013) who detected blood parameters remaining unaffected in ginger supplementation with respect to Hb, RBC and PCV percentages. However contradictory results were revealed by Moramadhi *et al*. (2010) who observed significant increase ($P<0.05$) in haemoglobin concentration and packed cell volume in treatment group as compared to control.

Onu (2010) observed no significant difference ($P>0.05$) in estimated values of MCV and MCH upon ginger supplementation to broilers starting from starter period to finisher. The normal range PCV, Hb and other hematological parameters are the indicators of nutritional status of birds in a direction towards physiologically boost up nourishment (Church *et al.*, 1984).

5.5 Effect on biochemical parameters

The mean serum glucose, total protein, albumin and globulin levels remain unaffected in ginger treatments. The present study is in correlation with the findings of Ebrahimnezhad *et al.* (2014). Similarly, Jamel *et al.* (2010) found non significant difference in serum total protein, globulin and albumin in broilers supplemented with ginger. The findings of Mohamed *et al.* (2012) corroborated these findings. They reported that serum protein concentration remain unaffected in 0.1 and 0.2% ginger supplementation. In contrast, Zhang *et al.* (2009) revealed higher serum total protein and globulin in broiler offered with 5g/kg of ginger in diet. Rehman *et al.* (2011) also found higher serum total protein in broiler fed with aqueous ginger extract with aloevera and garlic mixture diet.

The cholesterol and triglyceride value varied significantly ($P<0.05$) among the treatments. This finding was in accordance with the results of Bhandari *et al.* (2005) who found that ethanolic extract of ginger not only significantly reduced the serum cholesterol and triglycerides but also shot up the high density lipid (HDL) cholesterol with dynamic protective effect on lipid peroxidation of the tissue in diabetic rats. Furthermore, Fuhrman *et al.* (2000) stated that ginger decreased the low-density lipid (LDL) cholesterol, very low-density lipid cholesterol (VLDL cholesterol) and triglycerides level in apoprotein-E deficient mice. Similarly, significant lowering down trend of cholesterol and triglyceride were studied in serum of broilers (Ademola

et al., 2009). Zhang et al. (2009) pointed out that ginger powder added feed increased ($P<0.001$) the action of superoxide dismutase and glutathione peroxidase with reduction in malondialdehyde and cholesterol ($P< 0.01$) in serum of broilers 21 and 42 days old. The effect of squeezing down the cholesterol level in serum could be traced to the presence of two important constituents in ginger, ginerols and shagols with inhibition upon lipid peroxidation (Ashani and Verma, 2009).

Recently, in an extensive research, it had been confirmed that ginger essential oil supplementation to broilers lowered ($P<0.05$) the serum cholesterol as well as LDL significantly (Ghasemi and Taherpour, 2015). The result is in close proximity with our experimental finding. Oleforuh-Okoleh *et al.* (2015) found that ginger and garlic aqueous filtrate inclusion in ration alone of broiler significantly ($P< 0.05$) decreased the plasma cholesterol. The lowering of cholesterol and triglycerides in broiler chicken at 6 weeks of age may be due to reduction of the activities of hepatic lipogenic and cholesterogenic enzymes viz., fatty acid synthase, malic enzyme, 3-hydroxy-3-methyl- glutaryl-CoA (HMG CoA) reductase and glucose-6-phosphate dehydrogenase (Yeh and Liu 2001). Gingerols and shagols decrease the lipid peroxidation which leads to lowering of cholesterol level in birds fed with ginger (Verma *et al.,* 2004; Ashani and Verma, 2009).

5.6 Effect on immunity status

The present research result has shown conspicuous enhancement in immunity status when tested with foot pad infusion of PHA-P and subsequent swelling thickness estimation. The significant response to foreign antigen might be attributable to the T lymphocyte increase and antigen representing cell helper -T cells. Contents of ginger might be responsible for foreign antigen attack and significant response upon injection of agent. Establishment of stable intestinal ecosystem of micro-flora in intestine might be responsible for the CBH response so intense and significant. Similarly, antibody titre finding showed that supplementation of ginger in the diet of birds enhanced the humoral immunity of birds. Pathogens induce restraint to low gastric pH and rapid transit out of the digestive tract were the cause behind establishment of infection through colonization, and additives like herbal extracts of ginger intensified the host cell mediated immune system (Patterson and Burkholder, 2003). The immune enhancer property of phytogenic organoleptic substances present

in herbs is due to the establishment of stable microflora ecosystem and deliberately reducing their growth reduction toxin production capability in the intestine (Windisch *et al.,* 2008). Ginger is one of the phytobiotics with several compounds such as gingerol, gingerdiol and gingerdione that possess strong antioxidant (Kiruzaki *et al.,* 1995; Zhao *et al.,* 2001) and antibacterial activities (Meena and Sethi, 1994; Akoachere *et al.,* 2002; Ali *et al.,* 2007).

5.7 Effect on carcass characteristics and organ weight

No significant difference was observed in carcass trait. This implied that supplementation of ginger at 0.5, 1.0 and 1.5% level had no significant effect on the carcass characteristics of experimental broiler birds. The supplemented groups, however, showed numerically higher values for dressed yield and eviscerated yield.

Moorthy *et al.* (2009) mentioned relative increase in weight of giblet upon ginger additive feed supplementation. On contrary, Zhang *et al.* (2009) observed significant increase in carcass weight of broiler fed on ginger added ration. Dressing percentage, breast weight and drum stick weight were significantly higher when aqueous extract of ginger added to plant mixture supplements in broiler (Javed *et al.,* 2009). Red ginger added ration supplementation to broiler resulted in higher carcass weight in broiler (Herawati and Marjuki, 2011). Ginger addition in powder form had a significant effect on broiler dressing percentage (Oleforuh-Okoleh *et al.,* 2014).

For the weights of the organs (% live weight basis), remain unchanged with respect to the weight of kidney, liver, heart, gizzard, brain and spleen among the groups. Fallah *et al.* (2015) showed that diet supplementation with ginger powder increased total carcass weight, spleen, bursa of fabricious, gizzard and thymus relative weight ($P>0.05$) and reduced abdominal fat weight ($P<0.05$) than control. Qorbanpour *et al.* (2018) detected that the carcass traits and growth remained unaffected but significant decrease of gizzard weight and abdominal fat in birds supplemented 0.15, 0.20 and 0.25% ginger in the diet.

CHAPTER-VI

SUMMARY AND CONCLUSION

The present research which entitled "Effect of dietary ginger on the performance of broiler chicken" was undertaken to determine the effect of ginger supplementation on growth performance, feed consumption, FCR, carcass traits, haematological parameters, lipid profile and immunity of broiler birds. The study has been conducted at the Department of Livestock Production and Management, C.V. Sc & A.H, OUAT, Bhubaneswar.

One hundred and twenty, day old colour synthetic Black Rock broiler chicks were allotted to four dietary treatment groups with three replications of 10 chicks in each. On standard protocol basis broiler birds were managed from 0-6 wk in deep litter system of housing. The prestarter ration was fed during 1-2nd weeks contain 22.85% CP and 2995 Kcal/kg ME and starter given during 2^{nd} -3^{rd} weeks containing 20.57 % CP and 3140 Kcal/kg ME and lastly the finisher diet given from 4^{th}-6^{th} week having 19.32 % CP and 3225 Kcal/kg ME.

The control (T_1) was without ginger powder while (T_2) was having 0.5 per cent ginger powder. One per cent ginger powder was supplemented in (T_3) while (T_4) was containing 1.5% ginger powder in the feed of experiment birds.

The average body weights for groups T_1, T_2, T_3 and T_4 at the end of experiment were 1281.20, 1396.10, 1478.20 and 1375.60 g respectively, which revealed highest body weight of birds in 1% ginger powder supplementation (T_3) than others.

The cumulative body weight gain were significantly ($P<0.05$) higher in treatment group than control in entire experiment period. Numerically higher cumulative body weight gain was observed in T_3 group offered with 1% ginger powder.

The cumulative feed intake(g) of bird were 3492.80, 3620.40, 3728.20 and 3633.10 in T_1, T_2, T_3 and T_4 groups, respectively but this parameter remain unaffected

among the dietary treatment groups during the entire experiment period. The FCR recorded on last week of experiment in T_1, T_2, T_3 and T_4 were 2.81, 2.66, 2.58 and 2.71 respectively. The FCR was better ($P<0.05$) in T_3 in comparison with other groups.

The mean Hb (%), PCV (%), TEC ($\times 10^6/\mu l$), TLC ($\times 10^3/\mu l$), MCV (fl), MCHC (%) at 6^{th} week of Black rock broiler birds in all the groups ranged from 9.44±0.06 to 9.8±0.21, 28.36±1.10 to 30.68±1.57, 2.72±0.12 to 2.90±0.24, 19.53±1.67 to 20.05±1.96, 102.96±7.35 to 109.52±12.34 and 32.40±2.35 to 33.88±0.63. None of the studied parameter was influenced by dietary treatments. .

The average level of serum glucose (mg/dl) ranged from 176.22±6.24 to 182.05±7.97 showing non significant difference among the treatments. Serum total protein (g/dl), serum albumin (g/dl), serum globulin (g/dl) and A/G ratio ranged from 3.42±0.13 to 4.07±0.38, 1.78±0.05 to 2.04±0.21, 1.62±0.19 to 2.03±0.31, 1.07±0.16 to 1.29±0.15 remain unaffected in treatments. The serum cholesterol for T_4 (129.43mg/dl) group fed 1.5 % ginger powder was the lowest followed by group T_3 (137.26 mg/dl) fed 1% ginger powder, T_2 (144.18mg/dl) fed 0.5% ginger powder and T_1 (163.83 mg/dl) control group . The birds in T_3 and T_4 group showed significantly ($P<0.05$) lower cholesterol. T_4 showed significantly ($P<0.05$) lower triglyceride value. Highest HDL observed in T_4 group followed by T_3 .T_3 and T_4 group showed lower LDL value like 44.03±1.79 and 42.69±1.02 mg/dl, respectively.

The immunity status of the bird evaluated at 42^{nd} day of the experiment by using sheep RBC (SRBC) and cutaneous basophilic hypersensitivity (CBH) response study. The antibody titers (log_2) against SRBC inoculation was significantly ($P<0.05$) higher in T_3 and T_4 and lowest was observed in control.

The carcass parameters like dressing yield(%), Eviscerated yield (%), Giblet yield (%), neck yield (%), wing yield(%), Back yield (%), breast yield (%), thigh yield (%), drum stick yield (%) of the experimented birds in all the group ranged from 71.40±0.49 to 73.38±0.49, 64.40±1.35 to 66.87±2.41, 6.51±0.16 to 7.12±0.35, 5.12±0.29 to 5.82±0.09, 7.82±0.45 to 8.56±0.28, 15.39±0.25 to 15.67±0.66, 29.39±0.35 to 29.73±0.41, 10.39±0.38 to10.98±0.33, 8.85±0.17 to 9.35±0.38 respectively. None of the studied parameter were affected by ($P>0.05$) dietary treatments. Kidney (%), liver

(%), gizzard (%), brain (%), heart (%) and spleen (%) of the broiler birds in all experimented groups ranged from 0.66±0.04 to 0.70±0.08, 2.00±0.12 to 2.36±0.21, 1.71±0.11 to 2.14±0.10, 0.17±0.006, 0.53±0.07 to 0.60±0.08, 0.07±0.006 to 0.10±0.02 at 42nd days of the experiments. None of the studied parameters viz. Kidney (%), liver (%), gizzard (%), brain (%), heart (%) and spleen (%) was influenced by ($P > 0.05$) dietary treatments.

CONCLUSION

It was concluded that supplementation of ginger powder at 1.0% level in the ration resulted in,

- Improvement in body weight gain and feed conversion ratio
- Reduction in serum cholesterol and triglyceride levels
- Improvement in the immunity status

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