INFLUENCE OF GRADED LEVELS OF SHATAVARI ROOT MEAL ON PERFORMANCE OF COLOURED CHICKEN

THESIS

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OF

MASTER OF VETERINARY SCIENCE

IN

POULTRY SCIENCE

By

BINAY KUMAR YADAV

Enrolment No. V-1486/15

COLLEGE OF VETERINARY SCIENCE AND ANIMAL HUSBANDRY

U.P. Pandit Deen Dayal Upadhyaya Pashu-Chikitsa Vigyan Vishwavidyalaya

Evam Go Anusandhan Sansthan, (DUVASU),

Mathura – 281001

2017

CERTIFICATE

This is to certify that the Thesis entitled **"INFLUENCE OF GRADED LEVELS OF SHATAVARI ROOT MEAL ON PERFORMANCE OF COLOURED CHICKEN"** submitted by **Dr. Binay Kumar Yadav**, Enrollment No. V-1486/15 in partial fulfillment of requirements for the award of the Master of Veterinary Science in **Poultry science** of the **U. P. Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan, Mathura, 281001 (UP)**, India, is a bonafide research carried out by him under my supervision and guidance and no part of the thesis has been submitted for any other degree or diploma.

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Professor & Head
Department of Poultry Science

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Enrollment No. : V- 1486/15

Subject : Poultry Science

College : College of Veterinary Science and Animal Husbandry DUVASU, Mathura.

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Signature: 3/11/2017

Name: Dr. J. K. Bhardwaj
Designation: Director Frams, Livestock farm
Address of External Examiner:
Nanaji Deshmukh Veterinary Sciences University,
Adhartal, Jabalpur – 482004
Madhya Pradesh

3.11.17

HOD
Poultry Science

CERTIFICATE

It is certified that the thesis submitted by **Dr. Binay Kumar Yadav,** Enrollment No. [illegible], a Master's student of this department has been checked and found as per specifications of the format mentioned in the PG Academic Regulation-2009 (revised).

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Head of Department

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Binay K. Yadav.

Place: Mathura **(Binay Kumar Yadav)**

Date: 14/08/2017

%	:	percent
<	:	Less than
>	:	Greater than
°C	:	Degree celsius
ALP	:	Alkaline phosphatase
ANOVA	:	Analysis of variance
BSA	:	Bovine serum albumin
BIS	:	Bureau of standards
BW	:	Body weight
Ca	:	Calcium
CAT	:	Catalase
CF	:	Crude fibre
CMI	:	Cell mediated immune response
CP	:	Crude protein
CPDO	:	Central poultry development organization
CPK	:	Creatine phosphokinase
D	:	Day
dL	:	Decilitre
DM	:	Dry matter
Dpi	:	Day post immunization
DTH	:	Delayed-type hypersensitivity
EE	:	Ether extract
ELISA	:	Enzyme linked immunosorbent assay
et al	:	Et alli/alia
FCR	:	Feed conversion ratio
Fig	:	Figure
FWI	:	Foot web index
g	:	Grams
g/L	:	Grams per litre
GOT		Glutamate oxaloacetate transferase
GPT	:	Glutamate pyruvate transferase
HA		Haemagglutination
Hb	:	Haemoglobin
HI	:	Haemagglutination inhibition
Hr	:	Hour

IAEC	:	Institutional Animal Ethics Committee
i.e.	:	That is
Ig	:	Immunoglobulin
IL	:	Interleukins
IMP	:	Inosine Monophosphate
Inj	:	Injection
IU	:	International unit
K	:	Potassium
Kcal	:	Kilo calorie
Kg	:	Kilogram
M	:	Mole
T1	:	Treatment first
MCV	:	Mean corpuscular volume
MDA		Malondialdehyde
ME	:	Metabolizable energy
ME	:	Mercapto ethanol
MER	:	Mercapto ethanol resistance
MES	:	Mercapto ethanol sensitive
mg		Milligram
Mg	:	Magnesium
MIC	:	Minimum Inhibitory Concentration
Min	:	Minute
mL	:	Millilitre
mM	:	Millimole
mRNA	:	Messenger Ribosome Nucleotide
MTT	:	Microtitre
n	:	number
nM	:	Nanomole
P	:	Phosphorus
Pic	:	Picture
PHA-P	:	Phytohaemagglutinin
NS	:	Non significant
PBS	:	Phosphate buffer saline
PCV	:	Packed cell volume
pH	:	Potential of Hydrogen
PPM	:	Parts per minute

RPM	:	Revolution per minute
SEM	:	Standard error mean
T2	:	Treatment second
T3	:	Treatment third
T4	:	Treatment fourth
T5	:	Treatment fifth
T6	:	Treatment sixth
T7	:	Treatment seventh
Vit.	:	Vitamin
Vs	:	Versus
Viz.	:	Videlicit
WBC	:	White blood cell
WK	:	Week
µL	:	Microlitre
µM	:	Micromole
ad lib	:	Ad libitum or free choice
@	:	At the rate of

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INTRODUCTION

Poultry is one of the important components of farmer's economy. It provides additional income and job opportunities to a large number of rural population in shortest possible time. Poultry farming has assumed significant importance due to the growing demand of poultry products especially in urban areas because of their high food value.

Poultry production in India has witnessed a phenomenal growth from backyard farming to scientific poultry farming involving commercial egg and meat production. In spite of numerous hurdles, there has been a perceptible rapid stride towards development and production, mainly contributed by indigenous scientific methods and advancement in the technology of poultry production.

In India, backyard poultry has been a means for earning livelihood for the economically distressed farmers due to its promising results in productivity from the improved backyard birds. Poultry rearing is currently the fast growing industry in National livestock sector with its benefits in the form of increased and economic production and provision of proteinaceous food. In India, poultry industry is recognized as an important cottage as well as fast growing large commercial agriculture industry. Sustained economically viable poultry production demands the stringent control of various infectious diseases affecting the birds which result in huge economic losses to the poultry farm owners (Ganguly and Prasad, 2010).

The dynamic Indian poultry industry is growing at an estimated rate of 6-7 per cent for egg and 15-20 per cent for meat production per annum. During 2014-15, poultry population in India was estimated at 729.21 million, egg and chicken meat production has reached 697.31 million and 2.68 million tonnes respectively (Prabhakaran, 2016).

Though Indian poultry industry recorded phenomenal growth, it has been plagued by a series of problems due to high ambient temperature in the tropics accompanied by high relative humidity. Thus, backyard poultry farming is being promoted for sustainability of poultry production and up liftment of socio-economic condition of Indian farmers. Different Central Government agencies have developed several strains of poultry birds for backyard farming. Chabro is a breed, developed by Central Poultry Development Organization (CPDO) especially for the farmers of our country as it is comparatively more adaptive to climatic fluctuations and variable zoo sanitary conditions of the farm as compared to their broiler counterparts.

Chabro is a cross of Barred Plymouth Rock with Red Cornish. Birds are active, large in built, pugnacious in nature with contrast colour. Skin, beak and shank are yellow in colour. They are able to save themselves from their predators under free range and are adapted to all climatic zones of the country.

In the recent past, efforts have been made to counteract the adverse effects of various levels of stress and augment the production potential in broilers by using herbs possessing therapeutic potential. Number of herbal medicines has been studied on poultry species such as the herbal growth promoters which optimize hepatic functions of the birds. They help in better feeding, synthesis of amino acids as well as minimize the aflatoxin effect. The promoter improves the protein content with a significant decrease in blood cholesterol level. The herbal medicines like Liv-52 support the immune system of birds (Joshi and Kumar, 1987). The herbal feed supplements are known to improve feed intake by increasing the digestibility of feed (Kumar *et al*., 2006).

Shatavari (*Asparagus racemosus*) also known as the "Queen of herbs" is a woody climber growing 1- 2 m in height and the roots are finger-like and clustered. The leaves are like pine needles, small and uniform and the inflorescence has tiny white flowers in small spikes. This plant belong to *Liliaceae* family, common at low altitudes in shade and in tropical climates throughout India, Asia, Australia and Africa. Shatavari has been mentioned in Ayurvedic texts like the Charak Samhita, Susruta Samhita and Astanga Samgraha (Singh *et al*., 2009; Raghav and Kasera., 2012). Shatavari possesses nutritive, antistress, adaptogenic, immunomodulatory, galactogogue, anabolic and performance enhancing properties and are used in various medicinal preparations (Kamat *et al*., 2000; Chopra *et al*., 1956; Chopra *et al*., 1958; Mandal *et al.*, 2000; Bopna and Saxena., 2007).

According to recent chemical investigations, shatavari contains four steroid saponins: Shatavarins 1 to 4. Shatavarin 1 is the major glycoside of sarsasapogenin, the sugar moieties being 3 glucose and 1 rhamnose. Shatavari 4 is structurally related to shatavarin 1 and contains 2 glucose and 1 rhamnose. Overall Shatavari is a soothing tonic, alternative demulcent, refrigerant. It nourishes and rejuvenates the tissue, promotes vitality and strength. It is bitter, emollient, cooling, nervine, appetizer and astringent. It is used for diseases of blood and nervous disorders as well as general debility.

Considering these nutritional benefits of Shatavari (*Asparagus racemosus*) herb, efforts have been made to study the effect of dietary supplementation of Shatavari *(Asparagus racemosus)* root powder in the diet of broiler chicks to augment the growth of broilers (Sharma *et al.*, 1986; Mane *et al*., 2012). Recently, studies have also been undertaken to

assess the effect of Shatavari root meal on the immunity, blood biochemical attributes and carcass quality characteristics of broilers (Kant *et al*., 2014; Dahale *et al*., 2014).

However, detail studies are necessary to assess the efficacy of Shatavari root meal at various levels on the productive performance and immunity of different varieties of chicken. Hence, a study has been designed to study the efficacy of Shatavari root meal at graded levels on the performance of coloured chicken with the following objectives:

OBJECTIVES

1) To study the effect of feeding Shatavari root meal on growth performance of coloured chicken.
2) To study the effect of feeding Shatavari root meal on the immune competence and blood biochemical attributes of coloured chicken.
3) To study the carcass quality of coloured chicken fed on Shatavari root meal.

CHAPTER- 2

REVIEW OF LITERATURE

In recent years, there has been a steep rise in poultry production throughout the world. As a result, it is gradually becoming a major thrust in the world economy especially in the livestock sector. Rising prices of feeds certainly have reduced the profitable nature of broiler farming. For better utilization of feed and to improve feed efficiency, growth promoting feed additives *viz.* probiotics, prebiotics, herbal bioenhancers are added to poultry ration. Most of the information available in the scientific literature pertaining to use of herbal supplements have been found in various species of poultry and therefore work on coloured chicken has been reviewed based on the other poultry species. In this section, studies on Shatavari (*Asparagus racemosus*) in livestock and poultry have been described.

2.1 SHATAVARI

The genus *Asparagus* includes about 300 species around the world. The genus is considered to be medicinally important because of the presence of steroidal saponins and sapogenins in various parts of the plant. Out of the *22* species of *Asparagus* recorded in India, *Asparagus racemosus* is the one most commonly used in traditional medicine. Use of *Asparagus racemosus* was mentioned in the ancient literature of Ayurveda (Charak samhita).

Asparagus racemosus Wild (family *Asparagaceae*; *Liliaceae*), is commonly called Satavari, Satawar or Satmuli in Hindi; Satavari in Sanskrit; Shatamuli in Bengali; Shatavari or Shatmuli in Marathi; Satawar in Gujarati; Toala-gaddalu or Pilli-gaddalu in Telegu; Shimaishadavari or Inli-chedi in Tamil; Chatavalin Malayalam; Majjigegadde or Aheruballi in Kannada; Kairuwa in Kumaon; Narbodh or atmooli in Madhya Pradesh; and Norkanto or Satawar in Rajasthan (Anonymous 1987).

Taxonomy of *Asparagus racemosus*

Kingdom	:	Plantae
Phylum	:	Anthophyta
Class	:	Monocotyledons
Order	:	Liliales
Family	:	Liliaceae /Asparagaceae
Genus	:	*Asparagus*
Species	:	*racemosus*

2.1.1 Properties

Shatavari has been mentioned in Ayurvedic texts like the Charak Samhita and Susruta Samhita, and Astanga Samgraha (Singh *et al*., 2009; Raghav and Kasera, 2012).

Kashyap Samhita has evidently stated that Shatavari promotes maternal health and noted its meticulous use as a galactagogue (enhances breast milk secretion in lactating mothers). Ayurveda has called Shatavari the Queen of herbs and is the primary herb recommended for female health.

They exhibit immuno-modulatory activities. The root of *Asparagus racemosus* (commonly called 'Satavar') possesses antidiarrhoeal, anti-ulcerative, anti-spasmodic, aphrodisiac, galactogogue and other properties and has therefore gained its importance in Ayurveda, Siddha and Unani systems of medicine (Nadkarni, 1954).

Asparagus root possesses aphrodisiac, demulcent, general tonic, diuretic, anti-inflammatory, antiseptic, anti-oxidant and antispasmodic properties. Regular use of asparagus root treats infertility, impotence, leucorrhea, menopause syndromes, hyperacidity and certain infectious diseases such as herpes and syphilis.

It is also useful in treatment of epilepsy, kidney disorders, chronic fevers, excessive heat, stomach ulcers and liver cancer, increases milk secretion in nursing mothers and regulates sexual behaviors.

These roots find use in various medicinal preparations (Mandal *et al.*, 2000; Bopna and Saxena, 2007). The stem is woody, climbing, whitish grey or brown colored with small spines. The plant flowers during February–March leaving a mild fragrance in its surrounding and by the end of April, fruits can be seen with attractive red berries. *Asparagus racemosus* is a plant used in traditional Indian medicine (Goyal *et al.*, 2003).

The root powder of *Asparagus racemosus* is used as herbal feed additive/supplement in poultry feed. Shatavari augments the appetite and stimulates the liver. The root is used to prepare medicine.

2.1.2 Chemical Constituents of Shatavari

The major active constituents of *Asparagus racemosus* are steroidal saponins named as shatavarin I and shatavarin IV which are present in the roots. Shatavarins are the glycoside of sarsasapogenin which are generally occurring in two types of skeletons furostanols and spirostanols rhamnose. 8-methoxy- 5, 6, 4'-trihydroxyisoflavone, a new isoflavone was isolated by roots of *Asparagus racemosus*. A noval oligospirostanosid 1,3-*O*-[α-L-3-rhamnopyronosyl - (1→2) - α- L – rhamnopyronosyl (1→4)-*O*-β-D-glycopyranosyl]

25(*S)*-5β Spirostan-3β-ol also known as immunoside was isolated by (Handa *et al.,* 2003) and it was biologically evaluated as an immunomodulatory agent.

Chemical structure of steroidal saponines of *Asparagus racemosus* has antioxidant compound named Racemofuran, together with known compounds asparagamine A, and racemosol (Wiboonpun *et al.,* 2004). Three steroidal saponins namely Racemosides A, B and C were isolated from the methanolic extract of fruit of *Asparagus racemosus* (Hayes *et al.,* 2006). Isolation and structural clarification of Asparinins, Asparosides, Curillins, Curillorides and shavatarins was performed along with isolation of a new steroidal saponin shatavarin V from *Asparagus racemosus* powdered roots (Hayes *et al.,* 2008). Five steroidal saponins VI-X together with five known saponins Shatavarin I, Shatavarin IV, Shatavarin V, Schidegerasaponin D5 Immunside were isolated from *Asparagus racemosus* roots (Hayes *et al.,* 2008).

2.1.3 POULTRY

2.1.4 Growth

Growth is often measured as live weight gain per unit time (Berg and Butterfield, 1976). Live weight could be a useful measure of growth as it is highly predictive of the amount of desirable edible products such as muscles. Growth and production traits of birds indicate its genetic constitution and adoption with respect to the specific environment. The knowledge of performance of economic traits in poultry is important for the formulation of breeding plans for further improvement in production traits. Therefore, growth trait has been the most important economic trait of poultry production.

2.1.5 Body Weight

Mane *et al*. **(**2012**)** reported that supplementation of Shatavari powder @ 10 kg/ton and Aswagandha powder @ 5 kg/ton to basal diet showed significantly ($P<0.05$) higher body weight.

Pandey *et al.* (2013) reported that herbal feed additive prepared from whole plants of Ashwagandha [*Withania somnifera*], Shatavari [*Asparagus racemosus*] and Kapikachhu [*Mucuna pruriens*] (50:25:25) and mixed as powder to basal diet @ 2% resulted in significant higher ($P<0.05$) body weight at 6^{th} week in the treated group as compared to control group.

Rekhate *et al.* (2010) reported significantly ($P<0.01$) higher live body weight in 0.5%, 1% and 1.5% *Asparagus racemosus* root powder supplemented groups as compared to control broilers.

2.1.6 Body Weight Gain

Dahale *et al.* (2014) observed significantly (P<0.05) higher body weight gain in 0.25% and 0.5% *Asparagus racemosus* (Shatavari) root powder supplemented groups as compared to control groups in broilers.

Gaikwad *et al*. (2014) observed significantly (P<0.05) higher body weight gain in 0.5% and 1% *Asparagus racemosus* (Shatavari) root powder supplemented groups as compared to control in broilers.

Gaikwad *et al*. (2015) observed significantly (P<0.05) higher body weight gain in 0.5% and 1% *Asparagus racemosus* (Shatavari) root powder supplemented groups as compared to control in broilers.

Mane *et al*. (2012**)** reported that supplementations of Shatavari powder @ 10 kg/ton and Aswagandha powder @ 5 kg/ton to basal diet showed significantly (P<0.05) higher body weight gain.

2.1.7 Feed Consumption

Gaikwad *et al*. (2014) reported that the cumulative feed consumption at sixth week of age was better in 0.5% and 1% *Asparagus racemosus* (Shatavari) root powder supplemented groups as compared to control in broilers.

Dahale *et al.* (2014) reported that the average feed consumption of 0% (control) and 0.25% *Asparagus racemosus* (Shatavari) root powder supplemented group was higher as compared to 0.5% shatavari supplemented group in broilers.

Kant *et al*. (2015) indicated that feed consumption was significantly (P<0.05) higher in 1.5% Shatavari root powder supplemented group as compared to other groups of broiler birds.

2.1.8 Feed Conversion Ratio

Kant *et al*. (2015) reported that feed conversion ratio was significantly (P<0.05) lower in Shatavari root powder as compared to control group in broilers.

Rekhate *et al.* (2010) noted that supplementation of Shatavari root powder at 0.5%, 1% and 1.5% resulted in better feed conversion efficiency.

Pandey *et al.* (2013**)** reported that herbal feed additive prepared from whole plants of Ashwagandha, Shatavari and Kapikachhu and mixed as powder to basal diet @ 2% resulted in better feed conversion ratio at 6^{th} week as compared to control group.

2.1.9 Immunocompetence Traits

Kumari *et al.* (2012) noted the immuno-modulatory effects of *Asparagus racemosus* extract treated feed which resulted in significant (P<0.01) higher humoral and cell mediated immune responses of the birds compared to control group.

Tekade *et al.* (2008) reported that the broilers treated with *Asparagus racemosus* alone as well as in different combinations with *Sida cordifoliawas* and *Levamisole* starting from 28th day of age for 2 weeks had higher antibody production than normal due to more stimuli to the immune system.

2.1.10 Biochemical Attributes

There are lot of reports indicating the positive effects of herbs like anti-coccidial, anti-oxidant, anti-fungi etc. Some of the medicinal effects of herbs are related to their secondary metabolites such as phenols, necessary oils, saponins etc. Consequently there is considerable research interest in the possible use of natural products, such as essential oils and extracts of edible and medicinal plants, herbs and spices, for the development of new additives in animal feeding. There are many blood biochemical parameters which in certain levels in blood are indicators of better health and performance. Various researches have been carried out in effect of supplementation of medicinal herbs on performance of chicken. Various studies have been conducted in different poultry species to determine the normal values of blood parameters and changes in values after feeding some feed additives.

Kant *et al*. (2015) reported blood glucose, calcium, and phosphorus were significantly (P<0.05) higher in Shatavari supplemented groups as compared to control group and highest in 1.5% Shatavari powder in broilers. Blood urea nitrogen and creatinine was found significantly (P<0.05) lower in Shatavari supplemented groups as compared to control.

Rekhate *et al.* (2010) reported that supplementation of Shatavari root powder at 0.5%, 1% and 1.5% level resulted in significantly (P<0.01) higher Hb, total serum protein, albumin and globulin value in chicken as compared to control.

Kant *et al*. (2014) reported that the Shatavari powder and vitamin E was added to the basal diet@ 0% and 0 mg/kg feed, 1% and 0 mg/kg feed, 1.5% and 0 mg/kg feed, 0% and 200 mg/kg feed, 1% and 200 mg/kg feed, 1.5% and 200 mg/kg feed. There was a significant (P<0.05) increase in hematological parameters like total erythrocyte counts, hemoglobin, packed cell volume, mean corpuscular volume, mean corpuscular Hb and mean corpuscular Hb concentration in Shatavari and vitamin E treated groups than control group. Total serum protein, albumin, globin were significantly (P<0.05) higher and cholesterol, alanine

aminotransferase and aspartate aminotransferase were significantly (P<0.05) lower in shatavari and vitamin E treated groups than control group.

2.1.11 Carcass Characteristic and Organometry

Dahale *et al.* (2014) reported that there was a significantly (P<0.05) higher percentage of dressing yield in 0.25% and 0.5% *Asparagus racemosus* (Shatavari) root powder supplemented groups as compared to control in broilers.

Kant *et al*. (2014) reported that the powder of Shatavari and vitamin E was added to the basal diet@ 0% and 0 mg/kg feed, 1% and 0 mg/kg feed, 1.5% and 0 mg/kg feed, 0% and 200 mg/kg feed, 1% and 200 mg/kg feed, 1.5% and 200 mg/kg feed. Carcass quality and organ weight was significantly (P<0.05) higher in treatment groups as compared to control, observed highest in Shatavari 1.5% and 200 mg/kg feed vitamin- E group of broiler chickens. Therefore, it was concluded that supplementation of Shatavari 1.5% and 200 mg/kg feed vitamin- E was observed more beneficial to remove cold stress and improve growth performance, carcass quality and organ weight of broiler birds.

CHAPTER -3

MATERIALS AND METHODS

The investigation was carried out to study the effect of Shatavari root meal as a dietary feed supplement in coloured chicken after due approval of IAEC. The experimental procedure and analytical techniques followed in the present study has been described in this chapter.

3.1 Determination of proximate composition

Raw Shatavari root was obtained from the Instructional Livestock Farm Complex Campus of the University. Fresh root was sun dried in a clean, dust free environment and ground to obtain fine powder. The powder formed was packed in an airtight container. Representative samples of grinded Shatavari root meal, broiler starter feed and broiler finisher feed was analyzed for their nutrient composition *viz.* dry matter, crude protein, total ash, crude fibre as per AOAC (1990).

3.2 Birds

Two hundred and ten straight run, day old Chabro chicks were divided into seven treatment groups comprising three replicates of ten chicks each. The chicks were wing banded, weighed individually and distributed randomly on uniform body weight basis in the treatment groups. The birds were housed in deep litter system. Water was offered *ad lib.* The experiment was conducted at Poultry Farm of Department of Poultry Science, DUVASU, Mathura.

3.3 Preparation of the experimental diet

The dietary treatments offered are detailed below:

T1- Basal or Control diet (BIS, 2007; broiler starter diet till 4 weeks and there after broiler finisher diet till eight weeks)

T2- Basal diet or Control diet + supplementation of 0.25% Shatavari root meal

T3- Basal diet or Control diet + supplementation of 0.5% Shatavari root meal

T4- Basal diet or Control diet + supplementation of 0.75% Shatavari root meal

T5- Basal diet or Control diet + supplementation of 1% Shatavari root meal

T6- Basal diet or Control diet + supplementation of 1.25% Shatavari root meal

T7- Basal diet or Control diet + supplementation of 1.5% Shatavari root meal

Fig. 3.1: Preparation of Shatavari root meal.

Fig. 3.2: Rearing of Coloured chabro birds.

3.4 Growth performance parameters

Weekly body weight, group feed consumption and mortality was recorded. Feed conversion ratio (basal feed: gain) of 0 to 8 weeks were calculated at end of the experiment.

3.5 Immunocompetence traits

The general innate immune-competence status of chabro birds was assayed by measuring two important immunocompetence traits as antibody response to SRBC and cell mediated immune response to PHA-P at 8 week of age (Corrier and De Loach, 1990).

3.5.1 Antibody response to sheep red blood cells (SRBC)

The microtitre plate haemagglutination procedure as described by (Siegel and Gross, 1980) with slight modifications was followed to measure total HA antibody titres in chabro birds on day zero and day 5 post injection. The procedure followed is described below.

3.5.2 Preparation of sheep red blood cells (SRBC) suspension

Blood from jugular vein was collected from healthy sheep in Alsever's solution. The red blood cells were washed thrice in PBS (phosphate buffer saline, pH 7.2). Finally 1% suspenstion of SRBC in PBS (V/V) was prepared.

3.6 Preparation of reagents

Alsever's solution and phosphate buffer saline (PBS) will be prepared as per the given composition:

A) Alsever's solution

Dextrose	2.05 g
Tri sodium citrate dehydrate	0.80 g
Sodium Chloride (NaCl)	0.42 g
Citric acid	0.055 g
Distilled water	100 ml

The pH of the solution will be adjusted to 6.5 by addition of citric acid and stored in refrigerator at 4^0C.

B) Preparation of phosphate buffered saline (PBS)

Sodium Chloride (NaCl)	8.00 g
Potassium Chloride (KCl)	0.20 g
Potassium di- hydrogen phosphate (KH_2PO_4)	0.20 g
Di-sodium hydrogen phosphate (Na_2HPO_4, H_2O)	1.44 g
Distilled water	1000 ml
pH	7.20

Fig. 3.3: Determination of weekly body weight of coloured birds and feeding of Shatavari root meal.

Fig. 3.4: PHA-P solution injected to the birds for determination of cell mediated immune response.

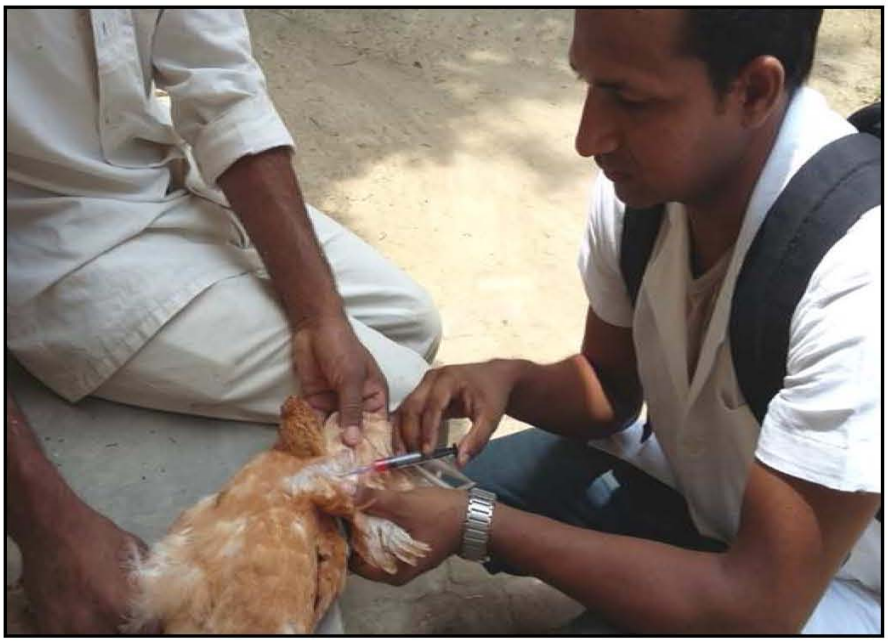

Fig. 3.5: 1% SRBC solution injected to the birds for determination of antibody response.

3.6.1 Immunization and harvesting of immune serum

1 ml of 1% (V/V) of SRBC suspension was injected to 6 birds of each treatment group. About 3 ml of blood on 0, and 5th day post immunization (dpi) were collected from jugular vein. The blood was endorsed to clot in an incubator T 37^{0}C for 1 hour. The blood was endorsed to retract after detaching it from sides of its container and left at 4^{0}C. Centrifugation of blood was carried out at 2000rpm for 5-10 minutes, it facilitated rapid collection of serum. Required quantity of immune serum was harvested and stored at-70^{0}C for subsequent testing.

3.6.2 Haemagglutination test (HA test) for total immunoglobulin (total HA titre)

The antibody titer was determined by HA methods (Vander Zijpp, 1983 & Siegel and Gross, 1980). The microtitre plates (U bottom) were cleaned, rinsed with PBS and dried. The HA test was done in duplicate for each sample.

Procedure

- 50 µl of PBS was distributed in each well of the micro titer plate.
- 50 µl of serum was added in the first well.
- Two fold serial dilutions were made up to row 11 & row 12 was kept as control.
- 50 µl of 1% SRBC was added in each well and mixed by gentle tapping.
- The plates were covered and then kept at 37^{o}C for 1 hour for incubation.
- The plates were read under bright light.
- The reciprocal of highest dilution showing clear agglutination was the end titer. The titers were expressed as log 2 value.
- The response titre were the result of the difference between HA titre before and after SRBC immunization.

3.6.3 2-Mercaptoethanol resistant antibodies (MER or IgG) against SRBC

Antibodies were determined by means of a mercaptoethanol (ME) HA test as per the method described by (Martin *et al.*, 1989) with slight modification. 0.2 M Mercaptoethanol (2ME) was prepared by adding 1.4 ml of 2-Mercaptoethanol to 98.6 ml of PBS. It can be stored at room temperature having shelf life for 5 days.

Procedure

- 50 µl of a 0.2 M solution of 2-ME in PBS was distributed in each well.
- 50 µl of test serum was added in the first well.
- After incubation for 30 minutes a room temperature, a serial dilution was made.
- 50 µl of a 1% SRBC in PBS was added to each well and mixed.

- The plates were covered with adhesive plastics.
- The microtitre plates were incubated for 1 hour at 37^{o}C and read under bright light as above and the titre was recorded as 2-ME resistant antibody and expressed as log 2 values.

3.6.4 Mercaptoethanol sensitive antibodies (MES or IgM) against SRBC

The reduction of total titre due to 2-ME treatment was called 2-ME sensitive antibody and the titre was expressed as log 2 value (Total HA titre-MER=MES).

3.6.5 *In vivo* Cell mediated immune response

The cellular immune response was assessed by cutaneous basophilic hypersensitivity test *in vivo* by using PHA-P (Phytohaemagglutinin, lectin from *Phaseolus vulgaris*). Coloured chiken were injected intra-dermally between 3rd and 4th toe of the right foot or on the wattle with 0.1 mg PHA-P in 0.1 ml of PBS (1 mg PHA-P/ml of PBS). The left foot received 0.1 ml of PBS and served as control. The thickness of inter-digital skin was measured using micrometer (AMES) at 0 and 24 hr after injection. The skin swelling was calculated by subtracting the skin thickness at 0 hr from that of after 24 hour of injection. The foot web index (FWI) or wattle index was determined as the difference between inter-digital and wattle swelling values of PHA-P injected and control foot or wattle.

Foot web index (in mm) = (thickness after 24 hrs inj of PHA-P of right foot or wattle-thickness before inj. of the same foot or wattle) - (thickness after 24 hrs of inj. of PBS of left foot or wattle - thickness before 24 hrs of inj. of PBS of the same foot or wattle)

3.7 Biochemical Parameters

Blood was collected from 6 birds of each group at the end of the biological experiment from the wing vein with the help of heparinized syringe and poured into a sterile tube. The blood samples were centrifuged for the 10-15 min at 2500 rpm. Plasma was separated and stored in refrigerator (-20^{0}C) until analyzed.

3.7.1 Plasma cholesterol

Plasma cholesterol was determined by standard diagnostic kit (Span Cogent Diagnostic s product). The procedure of the assay is mentioned below:

Cholesterol esters are hydrolyzed by Cholesterol Esterase (CE) to give free Cholesterol and Fatty acids. In subsequent reaction, Cholesterol Oxidase (CHOD) oxidizes the 3-OH group of free Cholesterol to liberate Cholest -4-en-3-one and Hydrogen Peroxide. In presence of Peroxidase (POD), Hydrogen Peroxide couples with 4-Aminoantipyrine (4-AAP)

Fig. 3.6: After 8 weeks of age, cell mediated immune response to PHA-P was studied.

Fig. 3.7: Determination of HA, IgG and IgM titre against 1% SRBC

and Phenol to produce red Quinoneimine dye. Absorbance of coloured dye is measured at 505 nm and is propotional to amount of Total Cholesterol concentration in the sample.

S. No.	Reagents	Composition
1	Cholesterol Reagent	Good's Buffer(pH 6.7) Cholesterol Esterase, Cholesterol Oxidasc Peroxidase, 4- Aminoantipyrine Stabilisers
2	Cholesterol Standard	Cholesterol Preservative Stabiliser

Procedure

Pipetted into tubes marked	Blank	Standard	Test
Plasma	-	-	10µL
Reagents 2	-	10µ	-
Reagents 1	1000µL	1000µL	1000µL

It was mixed well. Then it was incubated at room temperature for 30 minutes. The analyzer was programmed as per assay parameters.

1. The analyzer was blanked with Reagents Blank.
2. The absorbance of standard was measured followed by test.
3. Results were calculated as per given calculation formula.

Calculation

Cholesterol concentration (mg/100 ml) = Absorbance of Test/Absorbance of Standard X 200

3.7.2 Plasma protein

Plasma protein was established by standard diagnostic kit (Span Cogent Diagnostics product) as per modified Biuret method.

The Peptide bonds of Proteins react with Cupric in alkaline solution to form a coloured chelate, the absorbance of which is measured at 578 nm. The Biuret Reagent contains Sodium-Potassium tartrate, which helps in maintaining solubility of this complex at alkaline pH. The absorbance of final colour was proportional to the concentration of total protein in the sample.

$$\text{Protein} + \text{Cu}^{++} \xrightarrow{Alkalime\ pH} \text{Cu- Protein Complex}$$

Reagent No.	Reagent	Composition
1.	Biuret Reagent	Copper sulphate, disodium hydroxide, sodium-potassium tartate surfactant
2.	Protein Standard	BSA Preservative

Procedure

Pipette into tube marked	Blank	Standard	Test
Plasma	-	-	10µL
Reagent 2	-	10µL	-
Reagent 1	1000µL	1000µL	1000µL

It was mixed well and incubated at 37° C for 5 minutes. The analyzer was programmed as per assay parameters.

1. The analyzer was blanked with Reagent Blank.
2. Absorbance of the Standard was measured followed by the Test.
3. Results were calculated as per the given calculation formula.

Calculation

Total Protein concentration (g/dL) = Absorbance of test / Absorbance of Standard x 6.5

3.7.3 Plasma uric acid

Plasma uric acid was estimated by standard diagnostic kit (Span Cogent Diagnostics product). The procedure for assay has been mentioned below.

Uric Acid is oxidized to allantoin & hydrogen peroxide by the enzyme uricase. In presence of peroxidase, released hydrogen peroxide is coupled with aniline derivative and 4-amino antipyrine(4-AAP) to form coloured chromogen complex. Absorbance of coloured dye is measured at 550 nm and it is proportional to uric acid concentration in the sample.

$$\text{Uric acid} + 2H_2O \xrightarrow{Uricase} \text{Allantoin} + CO_2 + H_2O_2$$

$$H_2O_2 \text{ Aniline derivative} + \text{4- AAP} \xrightarrow{POD} \text{Chromogen Complex} + H_2O_2$$

Reagent No	Composition	Concentration
1	Uric acid Mono Reagent	Tris buffer (pH 8.25) Uricase, Aniline Derivative 4- Aminoantipyrine Peroxdase
2	Uric acid Standard	Uric Stabiliser Preservative

Procedure

Pipetted into tube marked	Blank	Standard	Test
Plasma	-	-	20µL
Reagent 2	-	20µL	-
Reagent 1	1000µL	1000µL	1000µL

It was mixed well and incubated at 37° C for 5 minutes.

The analyzer was programmed as per assay parameters.

1. The analyzer was blanked with Reagent Blank.
2. Absorbance of the Standard was measured followed by the Test.
3. Results were calculated as per the given calculation formula.

Calculation

Plasma Uric acid (mg/dL) = Absorbance of test / Absorbance of Standard × 6

3.7.4 Plasma GPT (ALT)

Plasma GPT was determined by standard diagnostic kit (Span Cogent Diagnostics product) as mentioned below.

Alanine aminotransferase (ALT) catalyses the transamination of L- Alanine and α-Ketoglutrate to form pyruvate and L- Glutamate. In subsequent reaction, lactate dehydrogenase (LD) reduces pyruvate to lactate with simultaneous oxidation of Nicotinamide Adenine Dinucleotide [reduced] (NADH) to Nicotinamide Adenine Dinucleotide (NAD). The rate of oxidation of NADH was measured kinetically by moitoring the decrease in absorbance at 340 nm. LD rapidly and completely reduces endogenous sample Pyruvate during the initial incubation period, so that it does not interfere with assay.

Sl. No.	Reagent	Compostion
1	Buffer	Tris buffer (pH7.5), L-Alanine, LD
2	Substrate	α- Ketoglutrate NADH

Procedure

Sl. No	Pipetted into tube marked	Test
1	Plasma	100 µL
2	Working ALT reagent	1000 µL

Mixed well and aspirated immediately for measurement.

The analyzer was programmed as per assay parameters.

1. The analyzer was blanked with purified water.
2. Absorbance was examined after 60 seconds. Reading was repeated after every 30 seconds i.e. up to 120 seconds at 340 nm wavelength.
3. Mean absorbance was determined as change per minute (Δ A/minute).

Calculation

ALT activity (IU/L) = Δ A/ minute × Kinetic factor where

Δ A/ minute= change in absorbance per minute

Kinetic factor (K) = 1768

3.7.5 Plasma GOT (AST)

Plasma GOT was determined by standard diagnostic kit (Span Cogent Diagnostics product) as mentioned below.

Aspartate aminotransferase (AST) catalyzes the transamination of L-Aspartate and α-Ketoglutrate to form L- Glutamate and Oxaloacetate. In subsequent reaction, Malate dehydrogenase (MDH) reduces Oxaloacetrate to Malate with simultaneous oxidation of Nicotinamide Adenine Dinucleotide [reduced] (NADH) to Nicotinamide Adenine Dinucleotide (NAD). The rate of oxidation of NADH is measured kinetically by monitoring the decrease in absorbance at 340 nm and is directly proportional to AST activity in the sample. Lactate dehydrogenase (LD) is added to enzyme system to prevent endogenous Pyruvate interference, which is normally present in the serum.

Sl. No.	Reagents	Composition
1	Buffer	Tris buffer (pH7.8), L-Aspartate, MDH, LD
2	Substrate	α- Ketoglutrate NADH

Procedure

Sl. No.	Pipetted into tube marked	Test
1	Plasma	100 µL
2	Working AST reagent	1000 µL

It was mixed well and aspirated immediately for measurement. The analyzer was programmed as per assay parameters.

1. The analyzer was blanked with purified water.
2. Absorbance was examined after 60 seconds. Reading was repeated after every 30 seconds i.e. up to 120 seconds at 340 nm wavelength.
3. The mean absorbance change per minute (Δ A/minute) was determined.

Calculation

AST activity (IU/L) = Δ A/ minute × Kinetic factor where Δ A/ minute= change in absorbance per minute

Kinetic factor (K) = 1768

3.7.6 Plasma Alkaline Phosphate Test

At pH 10.3, alkaline phosphate (ALP) catalyzes the hydrolysis of colourless p-Nitrophenyl Phosphate (pNPP) to yellow coloured p-Nitrophenol and Phosphate. Change in absorbance due to yellow colour formation was measured kinetically at 405 nm and was proportional to ALP activity in the sample.

$$\text{p-nitrophenyl Phosphate} + H_2O \xrightarrow{ALP} \text{P-Nitrophenol} + \text{Phosphate}$$

Sl. No.	Reagents	Composition
1	AMP (2-amino-2-methyl-1 propanol buffer)	AMP magnesium acetate zinc sulphate chelator
2	pNPP substrate	pNPP Stabiliser

Procedure

Sl. No.	Pipetted into tube marked	Test
1	Plasma	20 µL
2	Working AST reagent	1000 µL

It was mixed well and aspirated immediately for measurement. The analyzer was programmed as per assay parameters.

1. The analyzer was blanked with purified water.
2. Absorbance was examined after 30 seconds. Reading was repeated after every 30 seconds i.e. Up to 120 seconds at 405 nm wavelength.
3. The mean absorbance was determined as change per minute (Δ A/minute).

Calculations

ALP activity (IU/L) =Δ A/ minute × kinetic factor where Δ A/ minute = Change in absorbance per minute

Kinetic factor (K) = 2712

3.8 Carcass Quality Traits

At the time of slaughter, 2 male and 2 female birds from each group i.e. total 28 birds were sacrificed at 8 weeks of age for studying various slaughter traits *viz.* pre-slaughter fasting shrinkage in live weight (%), dressing(%), evisceration or ready-to-cook-yield(%), giblets yield (%), total ready-to-cook yield (%), development of digestive organs. Percent yield of cut-of-parts (thighs, drumsticks, breast, back, neck and wing) as a % of eviscerated carcass yield was calculated.

The birds were starved for12 hours before slaughter. However drinking water was provided *ad lib*. During the starvation period, their body weights were recorded after starvation. The birds were sacrificed by improved kosher method, bled for 1.5 to 2 minutes and defeathered. The birds were dressed by cutting the head at atlanto-occipital joint, leg at hock joint and oil gland located at the base of the tail and weighed.

Evisceration was done by making a slit opening at the neck skin to remove oesophagus and trachea, and vertical cut below the tip of breast bone to remove viscera. Heart, liver and gizzard were separated and cleaned. The internal lining of gizzard and pericardium of heart were removed before weighing them.

Further, the length and weight of different digestive organs (proventriculus, small intestine, large intestine and caecum) were calculated separately at 8 weeks of age.

3.9 Proximate composition of breast (*pectoralis major*) and thigh (*ilio tibialis*) muscle of chabro birds after 8 weeks of age

Samples of breast (*pectoralis major*) and thigh (*ilio tibialis*) muscles were processed and analyzed for dry matter (DM), crude protein (CP), ether extract (EE), total ash, Calcium and phosphorous (AOAC, 1990).

3.10 Mortality

There was no mortality in the experiment.

3.10 Statistical analysis

The data pertaining to various parameters were analyzed statistically as per the standard procedure (Snedecor and Cochran, 1994) and difference between the treatment means were obtained using Duncan multiple range test (Duncan, 1955).

Fig. 3.8: Proximate analysis of Shatavari root meal.

CHAPTER - 4

RESULTS

The present study was conducted to study the efficacy of Shatavari root meal as a dietary feed supplement in coloured chicken. Day old chicks were distributed into seven dietary treatment groups, having three replicates per treatment and ten birds per replicate. The study was conducted in coloured chicken during 0-8th week of age. During the experiment, the birds were fed basal ration (control) T1- (Broiler starter- ME, DM, total ash, EE, Calcium, Phosphorous, protein, crude fibre were 2820.47 kcal/kg, 88.5, 5.35, 3.15, 1.19, 0.69, 21.99, 3.59 respectively and broiler finisher - ME, DM, total ash, EE, Calcium, Phosphorous, protein, crude fibre were 2820.99 kcal/kg, 88.5, 4.94, 2.97, 1.10, 0.59, 17.69, 3.92 respectively). T2- basal ration was supplemented with 0.25% Shatavari root meal, T3- basal ration was supplemented with 0.5% Shatavari root meal, T4- basal ration was supplemented with 0.75% Shatavari root meal, T5- basal ration was supplemented with 1% Shatavari root meal, T6- basal ration was supplemented with 1.25% Shatavari root meal and T7- basal ration was supplemented with 1.5% Shatavari root meal.

The influence of various dietary treatment groups on growth, feed conversion ratio, development of digestive organs, immunocompetence traits, biochemical indices and carcass quality traits were studied.

4.1 Proximate Composition of Broiler Starter and Finisher Feed, Shatavari

Broiler starter and finisher feed were procured and analyzed for their proximate composition before the experiment was started. Shatavari root was obtained from the Instructional Livestock Farm Complex Campus of the University - DUVASU; Mathura and root meal was prepared and analyzed for its proximate composition. The proximate composition of broiler starter and finisher feed, Shatavari root meal have been presented in Table 4.1. The proximate principles i.e. DM, total ash, EE, Calcium, Phosphorous, protein, crude fibre were 88.5%, 5.35%, 3.15%, 1.19%, 0.69%, 21.99%, 3.59% respectively of broiler starter feed and 88.5%, 4.94%, 2.97%, 1.10%, 0.59%, 17.69%, 3.92% respectively of broiler finisher feed. DM, total ash, EE, Calcium, Phosphorous, protein, crude fibre of Shatavari root meal was 90.33%, 7.90%, 0.64%, 0.24%, 0.86%, 4.28%, 5.62% respectively.

4.2 Growth Performance

4.2.1 Body Weight

The body weight of coloured chicken from 0-8 weeks of age has been presented in Table 4.2 and graphically, it has been presented in figure 4.1. The initial body weight (day

Table 4.1: Proximate analysis of broiler starter feed, broiler finisher feed and Shatavari root meal.

Category	Dry Matter %	Total Ash %	Ether Extract %	Calcium %	Phosphorous %	Protein %	Crude Fibre %
Shatavari	90.33	7.90	0.64	0.24	0.86	4.28	5.62
Broiler Starter feed	88.5	5.35	3.15	1.19	0.69	21.99	3.59
Broiler Finisher feed	88.5	4.94	2.97	1.10	0.59	17.69	3.92

Table 4.2: Effect of dietary supplementation of Shatavari root meal on the average weekly body weight (g) of coloured chicken during 0-8 weeks of age.

Treatment	Day Old	1st wk	2nd wk	3rd wk	4th wk	5th wk	6th wk	7th wk	8th wk
T1	34.60	92.73	194.47	328.27	555.93	807.77	1054.43	1288.86	1571.80
T2	34.43	91.60	221.27	394.80	640.73	896.40	1143.30	1380.06	1697.50
T3	34.40	93.33	212.13	386.93	626.67	868.73	1101.80	1339.93	1636.00
T4	34.53	96.07	209.20	375.73	605.13	851.57	1093.83	1343.53	1550.52
T5	34.27	91.67	206.50	347.47	593.83	829.10	1073.13	1309.87	1584.47
T6	34.40	89.20	190.60	321.73	534.13	773.00	1002.90	1241.93	1509.47
T7	34.57	95.20	209.73	361.47	600.73	855.80	1081.70	1321.23	1588.80
Pooled SEM	0.05	0.99	3.26	8.11	12.20	14.28	14.17	15.90	22.39
Sig Level	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS: Not Significant (P>0.05) SEM: Standard Error of Means.

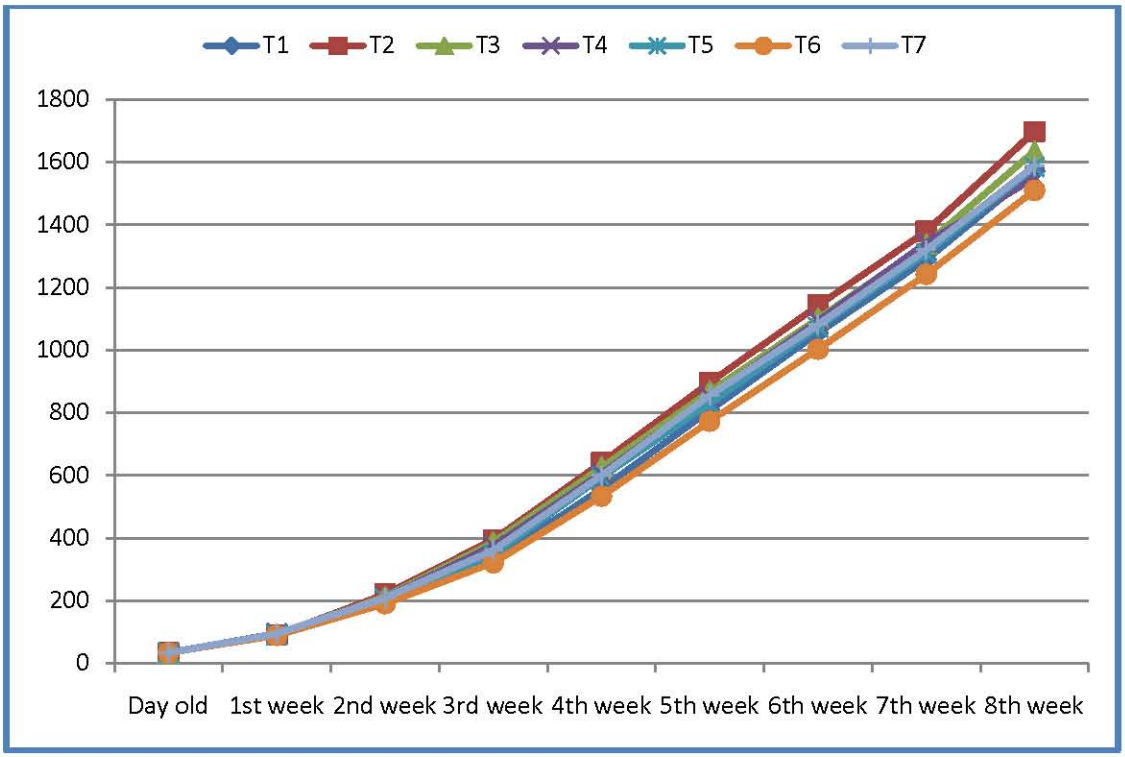

Fig. 4.1: Effect of dietary supplementation of Shatavari root meal on the average weekly body weight (g) of coloured chicken during 0-8 weeks of age

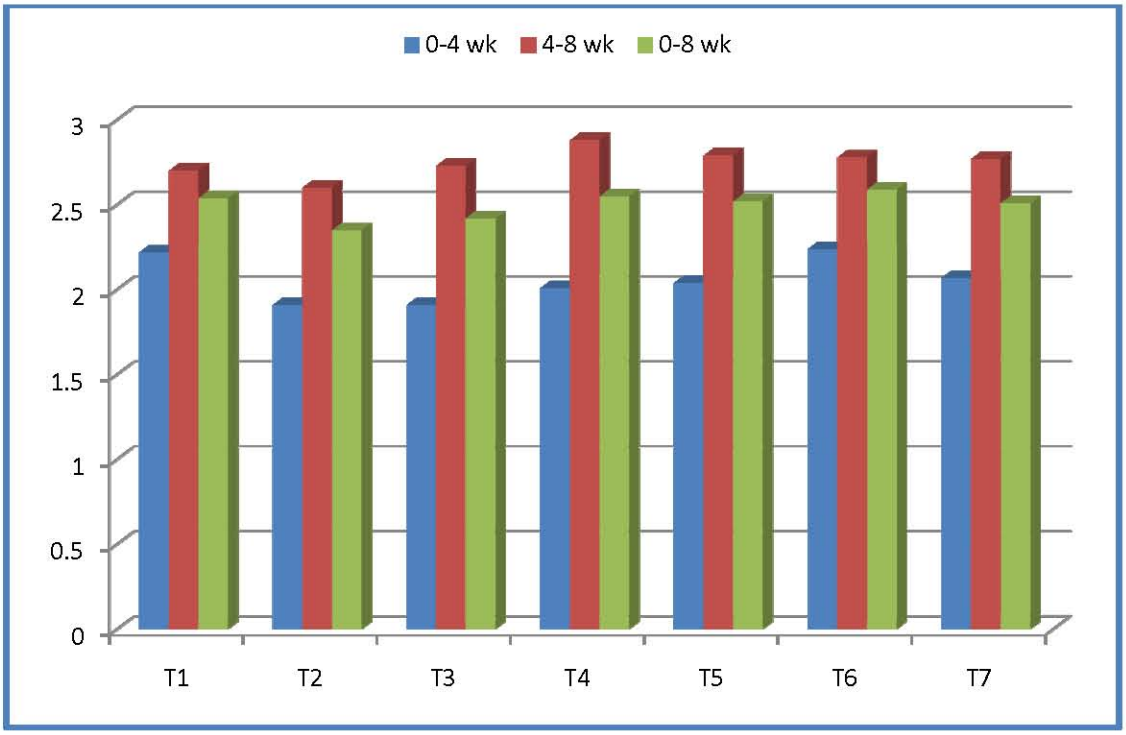

Fig. 4.2: Effect of dietary supplementation of Shatavari root meal on Feed Conversion Ratio of coloured chicken at different phases of growth during 0-8 weeks of age

old) of T1, T2, T3 , T4, T5, T6 and T7 were found to be 34.6, 34.43, 34.4,34.53, 34.26,34.40 and 34.56g respectively whereas, final body weight (8^{th} wk) were observed as 1571.8, 1697.5, 1636, 1550.53,1564.4,1509.46 and 1588.8g respectively. There was no significant difference among the different groups in the average weekly body weight during the entire experimental period. However, the T2 group birds had an apparently higher body weight compared to the other treatment groups throughout the experiment.

4.2.2 Average Body Weight Gain

The body weight gain of coloured chicken from 0-8 weeks of age have been presented in Table 4.3. Weekly body weight gain of all the treatment groups was found to numerically increase till 8^{th} week. The initial weekly body weight gain at 1^{st} week of T1, T2, T3, T4, T5, T6 and T7 were 58.13, 57.16, 58.93, 61.53, 57.40, 54.80 and 60.63g respectively, while final weekly body weight gain at 8^{th} wk were observed as 282.93, 317.43, 296.06, 207, 274.60, 267.53and 267.56g respectively. T2 coloured chicken had a significantly higher ($P<0.05$) body weight gain than T1 and T6 at 2^{nd} week of age (129.67 *vs.*101.73 and 101.40g). Further, T2 coloured chicken had an apparently higher body weight gain compared to the other treatment groups throughout the experiment.

4.2.3 Feed Consumption

The average weekly feed consumption of coloured chicken during 0-8 weeks of age has been tabulated in Table 4.4. Feed consumption of all the treatment groups was found numerically increase till 8^{th} week. The initial feed consumption (1^{st} wk) of T1, T2, T3,T4, T5, T6 and T7 groups were observed to be 89.36, 89.46, 89.46, 89.23, 88.97, 89.67 and 89.50g/wk respectively, where as final feed consumption (8^{th} wk) were 810, 807.67, 807.67, 805, 806.67, 805 and 807.50g/wk respectively. T1 and T7 group chicks had significantly higher ($P<0.05$) weekly feed consumption than T2, T3, T5 and T6 group chicks at 2^{nd} week of age (231.67 and 233.20 *vs.* 215.47, 215.47, 210.27 and 213.73g).

4.2.4 Feed Conversion Ratio

The weekly feed conversion ratio of coloured chicken from 0-8 weeks of age has been shown in Table 4.5. The initial FCR (1^{st} wk) of T1, T2, T3, T4, T5, T6 and T7 groups were recorded as 1.54, 1.58, 1.52, 1.45, 1.55, 1.64 and 1.49 respectively; FCR at 4^{th} wk in T1, T2, T3, T4, T5, T6 and T7 groups were recorded as 2.09, 1.99, 2.03, 2.12, 1.99, 2.20 and 2.04 whereas, final FCR at 8^{th} wk were observed as 2.86, 2.69, 2.75, 4.22, 2.96, 3.02, and 3.08 respectively. Results indicated that T2 coloured chicken had a significantly better ($P<0.05$) feed conversion ratio than T1, T6, T7 during 2^{nd} week. Further, feed conversion ratio was comparatively higher in the Shatavari root meal supplemented groups than the control group throughout the experiment.

Table 4.3: Effect of dietary supplementation of Shatavari root meal on the average weekly body weight gain (g) of coloured chicken during 0-8 weeks of age.

Treatment	1st wk	2nd wk	3rd wk	4th wk	5th wk	6th wk	7th wk	8th wk
T1	58.13	101.73[a]	133.80	227.66	251.83	246.66	234.43	282.93
T2	57.16	129.67[b]	173.53	245.93	255.67	246.90	236.77	317.43
T3	58.93	118.80[ab]	174.80	239.73	242.07	233.07	238.13	296.06
T4	61.53	113.13[ab]	166.53	229.40	246.43	242.27	249.70	207.00
T5	57.40	114.83[ab]	140.97	246.37	235.27	244.03	236.73	274.60
T6	54.80	101.40[a]	131.13	212.40	238.87	229.90	239.03	267.53
T7	60.63	114.53[ab]	151.73	239.27	255.07	225.90	239.53	267.56
Pooled SEM	0.97	2.73	5.347	5.56	3.71	3.37	4.13	11.82
Sig Level	NS	P<0.05	NS	NS	NS	NS	NS	NS

Means bearing different superscripts within a column differ significantly (P<0.05)
NS: Not Significant (P>0.05) SEM: Standard Error of Means

Table 4.4: Effect of dietary supplementation of Shatavari root meal on the average weekly feed consumption (g) of coloured chicken during 0-8 weeks of age.

Treatment	1st wk	2nd wk	3rd wk	4th wk	5th wk	6th wk	7th wk	8th wk
T1	89.36	231.67[bc]	360.00	476.60	622.60	622.13	690.00	810.00
T2	89.46	215.47[a]	336.90	484.73	629.60	624.17	690.00	807.67
T3	89.46	215.47[a]	336.90	484.73	629.60	624.17	690.00	807.67
T4	89.23	216.60[ab]	353.97	482.60	603.47	625.50	684.07	805.00
T5	88.97	210.27[a]	358.17	486.80	634.53	627.67	689.00	806.67
T6	89.67	213.73[a]	346.17	465.93	608.13	604.67	688.87	805.00
T7	89.50	233.20[c]	351.23	482.60	619.27	615.00	689.50	807.50
Pooled SEM	0.07	2.38	2.34	3.08	5.03	3.75	0.62	0.92
Sig Level	NS	P<0.05	NS	NS	NS	NS	NS	NS

Means bearing different superscripts within a column differ significantly (P<0.05)
NS: Not Significant (P>0.05) SEM: Standard Error of Means

Table 4.5: Effect of dietary supplementation of Shatavari root meal on the average weekly feed conversion ratio (FCR) of coloured chicken during 0-8 weeks of age.

Treatment	1st wk	2nd wk	3rd wk	4th wk	5th wk	6th wk	7th wk	8th wk
T1	1.54	2.29^{c}	2.69	2.09	2.47	2.53	2.94	2.86
T2	1.58	1.70^{a}	2.08	1.99	2.41	2.57	3.00	2.70
T3	1.52	1.82^{ab}	1.94	2.03	2.60	2.68	2.89	2.75
T4	1.45	1.92^{ab}	2.16	2.12	2.46	2.59	2.75	3.13
T5	1.55	1.83^{ab}	2.62	1.99	2.72	2.58	2.91	2.96
T6	1.64	2.13^{bc}	2.66	2.20	2.55	2.63	2.89	3.03
T7	1.49	2.06^{bc}	2.34	2.04	2.43	2.73	2.88	3.08
Pooled SEM	0.03	0.05	0.09	0.04	0.04	0.04	0.05	0.09
sig level	NS	P<0.05	NS	NS	NS	NS	NS	NS

Means bearing different superscripts within a column differ significantly (P<0.05)
NS: Not Significant (P>0.05) SEM: Standard Error of Mean

Table 4.6: Effect of dietary supplementation of Shatavari root meal on the FCR of coloured chicken at different phases of growth.

Treatment	0 to 4 wk	5 to 8 wk	0 to 8 wk
T1	2.22	2.70	2.54
T2	1.91	2.60	2.35
T3	1.91	2.73	2.42
T4	2.01	2.88	2.55
T5	2.04	2.79	2.52
T6	2.24	2.78	2.59
T7	2.07	2.77	2.51
Pooled SEM	0.04	0.03	0.03
sig level	NS	NS	NS

NS: Not Significant (P>0.05) SEM: Standard Error of Mean

4.2.5 Phase-wise Feed Conversion Ratio

The feed conversion ratio (FCR) of coloured chicken at different phases 0-4th week, 4-8th week and 0-8 week of growth have been tabulated in Table 4.6 and are presented graphically in figure 4.2. During 0-4th week of growth phase, FCR of T1, T2, T3, T4, T5, T6 and T7 groups were recorded as 2.22, 1.91, 1.91, 2.01, 2.04, 2.24, and 2.07, while during 5th-8th week of growth phase, FCR of T1, T2, T3, T4, T5, T6 and T7 groups were observed as 2.70, 2.60, 2.73, 2.88, 2.79, 2.78 and 2.77 and overall FCR of T1, T2, T3, T4, T5, T6 and T7 groups were recorded as 2.54, 2.35, 2.42, 2.55, 2.52, 2.59 and 2.51 respectively. Data on FCR indicated that there was no significant difference in FCR among the treatment groups during 0-8 week of age. FCR of T2 was apparently better compared to the other treatment groups during 0-4, 4-8 and 0-8th week of growth phase.

4.3 Immuno Competence Traits

4.3.1 Humoral Immune Response

The humoral immune response (response to 1% SRBC HA titre) of the treatment groups have been compiled in Table 4.7. Total immunoglobulin titter values in T1, T2, T3, T4, T5, T6 and T7 were observed as 8.33, 9.67, 8.50, 7.17, 7.50, 10 and 6.20; while IgG & IgM titre values were recorded as 2.67, 3.33, 3.50, 2.50, 4.50, 5.50, 2.40 and 5.67, 6.33, 5, 4.67, 3, 4.50, 3.80 respectively. Statistical analysis of the data revealed that no significant difference was observed in HA and IgM response to 1% SRBC (log2 titre) among the various treatment groups. Further, the HA and IgM response to 1% SRBC was comparatively better in the T6 and T2 group respectively compared to the other treatment groups.

4.3.2 Cell-Mediated Immune Response

Effect of Shatavari root meal feeding on cell mediated immune response to PHA-P was determined as FWI (Foot Web Index). Foot web index in T1, T2, T3, T4, T5, T6 and T7 were recorded as 0.41, 0.69, 1.01, 0.48, 0.29, 0.83 and 0.53 respectively.T3 group birds had a significantly higher ($P<0.01$) foot web index compared to T1, T4, T5 and T7 (1.01 *vs.* 0.41, 0.48, 0.29 and 0.53) in response to PHA-P (Table 4.8) and are presented graphically in figure 4.3.

4.4 Blood Biochemical Parameters

Effect of Shatavari root meal supplementation in feed on total plasma protein, total plasma cholesterol, plasma uric acid, plasma GOT (Glutamate Oxaloacetate Transaminase), plasma GPT (Glutamate Pyruvate Transaminase) and plasma ALP (Alkaline Phosphatase) have been presented in Table 4.9.

Table 4.7: Effect of dietary supplementation of Shatavari root meal on the humoral immune responses [antibody titer (log 2) values] to 1% SRBC in coloured chicken at 8 weeks of age.

Treatment	Total immunoglobulins	IgG	IgM
T1	8.33	2.67	5.67
T2	9.67	3.33	6.33
T3	8.50	3.50	5.00
T4	7.17	2.50	4.67
T5	7.50	4.50	3.00
T6	10.00	5.50	4.50
T7	6.20	2.40	3.80
Pooled SEM	0.42	0.39	0.36
Sig Level	NS	NS	NS

NS: Not Significant (P>0.05) SEM: Standard Error of Means

Table 4.8: Effect of dietary supplementation of Shatavari root meal on the cell mediated immune response (Foot Web Index) to PHA-P in coloured chicken at 8 weeks of age.

Treatment	Foot web index
T1	0.41^{ab}
T2	0.69^{abc}
T3	1.01^{c}
T4	0.48^{ab}
T5	0.29^{a}
T6	0.83^{bc}
T7	0.53^{ab}
Pooled SEM	0.06
Sig Level	P<0.01

Means bearing different superscripts within a column differ significantly (P<0.01)
SEM: Standard Error of Means

Table 4.9: Effect of dietary supplementation of Shatavari root meal on blood biochemicals (protein, uric acid, SGOT, SGPT, Cholesterol and alkaline phosphatase) of coloured chicken at 8 weeks of age.

Treatment	Protein (g/dL)	Cholestrol (mg/dl)	Uric acid (mg/dL)	ALP (IU/L)	AST (IU/L)	ALT (IU/L)
T1	5.26^{a}	153.815^{b}	4.88	972.48^{b}	5.30	30.35
T2	5.13^{a}	138.24^{ab}	4.42	1165.48^{b}	4.57	27.85
T3	5.15^{a}	133.02^{a}	4.63	1118.92^{b}	4.12	28.58
T4	6.17^{b}	131.32^{a}	3.73	1023.32^{b}	4.42	23.87
T5	6.23^{b}	126.04^{a}	4.28	1049.09^{b}	4.27	31.23
T6	6.61^{b}	124.81^{a}	5.41	345.10^{a}	3.98	27.26
T7	6.65^{b}	120.70^{a}	3.86	357.30^{a}	3.39	29.17
Pooled SEM	0.12	2.48	0.16	70.03	0.35	0.73
Sig Level	P<0.01	P<0.01	NS	P<0.01	NS	NS

Means bearing different superscripts within a column differ significantly (P<0.01), (P<0.05)
NS: Not significant (P>0.05) SEM: Standard Error of Means

Table 4.10: Effect of dietary supplementation of Shatavari root meal on the carcass quality characteristics of coloured chicken at 8 weeks of age (% live weight).

Treatment	Shrinkage %	Dressing %	Ready to cook %	Heart %	Liver %	Gizzard %
T1	7.94	71.75	58.93	0.44^{a}	1.69	2.35
T2	8.98	72.47	59.70	0.44^{ab}	1.71	2.03
T3	8.45	71.93	61.12	0.55^{c}	1.57	1.75
T4	8.74	71.51	58.61	0.47^{ab}	1.68	2.59
T5	8.37	69.55	57.59	0.45^{ab}	1.70	1.92
T6	8.81	70.53	57.44	0.46^{ab}	1.65	2.35
T7	7.89	71.89	58.33	0.49^{b}	1.79	2.23
Pooled SEM	1.25	0.31	0.45	0.01	0.02	0.08
Sig Level	NS	NS	NS	P<0.01	NS	NS

Means bearing different superscripts within a column differ significantly (P<0.05)
NS: Not Significant (P>0.05) SEM: Standard Error of Mean

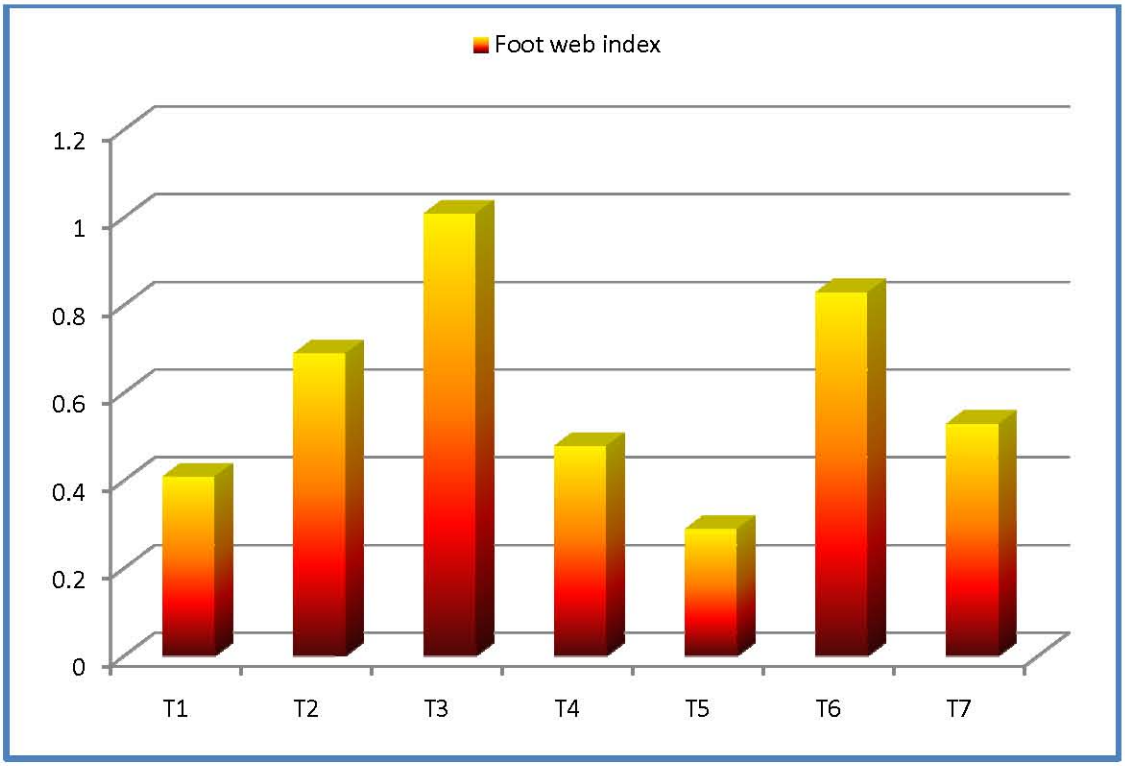

Fig. 4.3: Effect of dietary supplementation of Shatavari root meal on the cell mediated immune response (Foot Web Index) to PHA-P of coloured chicken at 8 weeks of age.

4.4.1 Total Plasma Protein

Total plasma protein (g/dL) values in T1, T2, T3, T4, T5, T6 and T7 treatment groups were 5.26, 5.13, 5.15, 6.17, 6.23, 6.61 and 6.65 respectively. However statistical analysis of data revealed that plasma protein was significantly higher ($P<0.05$) in T4, T5, T6 and T7 than T1, T2 and T3.

4.4.2 Total Plasma Uric Acid

The recorded uric acid (mg/dL) values in T1, T2, T3, T4, T5, T6 and T7 groups were 4.88, 4.42, 4.63, 3.73, 4.28, 5.41 and 3.86 respectively. Data on Plasma uric acid indicated that there was no significant difference in plasma uric acid among the treatment groups at 8 weeks of age.

4.4.3 Total Plasma Cholesterol

The calculated total cholesterol (mg/dL) values in T1, T2, T3, T4, T5, T6 and T7 groups were 153.81, 138.24, 133.02, 131.32, 126.04, 124.81 and 120.69 respectively. Results indicated that plasma cholesterol levels was significantly higher ($P<0.05$) in T1 than T3, T4, T5, T6 and T7 at 8 weeks of age in coloured birds.

4.4.4 Plasma AST/GOT (Plasma Glutamate Oxaloacetate Transaminase)

The recorded GOT (IU/L) values in T1, T2, T3,T4, T5, T6 and T7 groups at 8 weeks of age were 5.30, 4.57, 4.12, 4.42, 4.27, 3.98 and 3.39 respectively. Results indicated that there was no significant difference in total plasma GOT (plasma glutamate Oxaloaacetate Transaminase) values among the treatment groups.

4.4.5 Plasma ALT/GPT (Plasma Glutamate Pyruvate Transaminase)

The recorded GPT (IU/L) values in T1, T2, T3, T4, T5, T6 and T7 groups were 30.35, 27.85, 28.58, 23.87, 31.23, 27.26 and 29.17 respectively. Results indicated that there was no significant difference in the total plasma GPT (plasma glutamate pyruvate transaminase) values among the treatment groups, at 8 weeks of age in coloured birds at 8 weeks of age in coloured birds.

4.4.6 Plasma ALP (Plasma Alkaline Phosphatase)

The calculated ALP (IU/L) values in T1, T2, T3, T4, T5, T6 and T7 groups were 972.48, 1165.48, 1118.92, 1023.32, 1049.09, 345.10 and 357.30 respectively. It was observed that ALP values were significantly lower ($P<0.01$) in T6 and T7 compared to other treatment groups at 8 weeks of age in coloured birds.

4.5 Carcass Quality Characteristics

Effect of Shatavari root meal supplementation in feed on the carcass quality characteristics have been shown in Table 4.10. Percent heart weight was significantly higher ($P<0.05$) in T3 than other treatment groups (0.55 *vs.* 0.44, 0.44, 0.47, 0.45, 0.46 and 0.49). But no significant differences were observed in other slaughter traits among treatment groups at 8 weeks of age in coloured birds.

4.6 Yield of Cut-up-Parts

Results pertaining to yield of cut-up-parts of the carcass at 8 weeks of age have been expressed as percent yield of eviscerated weight of the carcass in Table 4.11. The drumstick percent range was 15.07 to 15.88 and (15.88%) highest in 1.5% Shatavari root meal supplemented group. Statistical analysis of the data revealed that there was no significant difference in cut-up-parts yield such as thighs, breast, back, neck, drumstick and wings, among the various treatment groups.

4.7 Development of Digestive Organs

The effect of feeding Shatavari root meal on the length and weight of digestive organs at 8 weeks of age has been presented in Table 4.12. The range of small intestine weight was 2.52 to 2.94 g/100g similarly the range of large intestine weight was 0.13 to 0.18 g/100g. No significant difference was recorded in any of the digestive organs among the treatment groups at 8 weeks of age in coloured birds.

4.8 Proximate Analysis of Breast (*Pectoralis major*) Muscle

Results pertaining to yield of proximate analysis of breast (*Pectoralis major*) muscle of the carcass at 8 weeks of age have been expressed as percent yield of breast muscle of the carcass in Table 4.13. Percent protein was significantly lower ($P<0.01$) in T4 than other treatment groups T1, T2, T3, T5, T6, T7 (16.79 *vs.* 20.73, 21.85, 22.17, 19.91, 22.28 and 19.96) respectively. Percent calcium was significantly lower ($P<0.05$) in T4 than T2, T3, T5 and T6 (2.70 *vs.* 4.32, 4.69 and 4.58). Percent ether extract was significantly higher ($P<0.01$) in T1 than T6 and T7 (0.22 *vs.* 0.16 and 0.16).However there was no significant difference among other proximate values *viz.* Moisture, Phosphorus and total ash among the different treatment groups.

4.9 Proximate Analysis of Thigh (*Ilio tibialis*) Muscle

Results pertaining to yield of proximate analysis of thigh (*Ilio tibialis*) muscle of the carcass at 8 weeks of age have been presented as percent yield of thigh muscle of the carcass in Table 4.14. Percent moisture in thigh (*Ilio tibialis*) muscle of coloured chicken after 8 weeks of age was significantly higher ($P<0.05$) in T5 as compared to other treatment groups. Percent ether extract in thigh (*Ilio tibialis*) muscle of coloured chicken at 8 weeks of age was

Table 4.11: Effect of dietary supplementation of Shatavari root meal on the cut up-parts of coloured chicken at 8 weeks of age (% dressed weight)

Treatment	Breast %	Back %	Neck %	Wings %	Drumstick %	Thigh %
T1	27.28	25.13	5.14	10.45	15.21	16.79
T2	28.79	24.37	5.23	10.22	15.31	16.07
T3	27.15	24.36	5.59	11.35	15.07	16.48
T4	27.01	25.68	4.99	10.51	14.89	16.90
T5	26.07	26.06	5.14	10.76	15.18	16.79
T6	28.53	23.45	5.56	10.81	15.32	16.32
T7	28.77	22.79	5.92	9.48	15.88	17.14
Pooled SEM	0.38	0.41	0.18	0.21	0.18	0.17
Sig Level	NS	NS	NS	NS	NS	NS

NS: Not Significant (P>0.05) SEM: Standard Error of Mean

Table 4.12: Effect of dietary supplementation of Shatavari root meal on the development of digestive organs of coloured chicken at 8 weeks of age.

Treatment	Proventiculus weight (g/100g)	Spleen weight (g/100g)	Bursa (g/100g)	Small intestine length (cm/100g)	Small intestine weight (g/100g)	Large intestine length (cm/100cm)	Large intestine weight (g/100g)	Average ceacal length (cm/100g)	Average ceacal weight (g/100g)
T1	0.40	0.16	0.20	7.78	2.86	0.39	0.13	0.82	0.58
T2	0.37	0.13	0.23	7.46	2.74	0.42	0.18	0.88	0.47
T3	0.41	0.15	0.24	7.79	2.52	0.37	0.13	0.94	0.64
T4	0.41	0.14	0.24	7.71	2.94	0.35	0.13	0.91	0.55
T5	0.46	0.16	0.22	8.33	2.75	0.34	0.15	0.92	0.66
T6	0.39	0.14	0.26	8.18	2.76	0.45	0.18	0.91	0.66
T7	0.42	0.14	0.31	7.98	2.70	0.45	0.15	0.96	0.56
Pooled SEM	0.01	0.00	0.01	0.19	0.06	0.02	0.01	0.03	0.03
Sig Level	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS: Not Significant (P>0.05) SEM: Standard Error of Mean

Table 4.13: Effect of dietary supplementation of Shatavari root meal on the Proximate analysis of breast (*Pectoralis major*) muscle of coloured chicken at 8 weeks of age.

Treatment	Moisture (%)	Ether Extract (%)	Protein (%)	Total Ash (%)	Calcium (mg/100g)	Phosphorus (mg/100g)
T1	74.80	0.22^{c}	20.73^{b}	1.71	3.31^{ab}	173.38
T2	74.15	0.19^{bc}	21.85^{b}	2.03	4.32^{b}	194.44
T3	71.21	0.21^{c}	22.17^{b}	1.61	4.69^{b}	219.62
T4	75.56	0.18^{c}	16.79^{a}	1.45	2.70^{a}	195.63
T5	74.36	0.20^{c}	19.91^{b}	1.88	4.58^{b}	158.96
T6	74.38	0.16^{a}	22.28^{b}	1.69	4.24^{b}	285.65
T7	73.97	0.16^{b}	19.96^{b}	1.51	3.44^{ab}	170.26
Pooled SEM	0.41	0.01	0.43	0.06	0.19	18.42
Sig Level	NS	P<0.01	P<0.01	NS	P<0.05	NS

Means bearing different superscripts within a column differ significantly {(P<0.05), (P<0.01)}
NS: Not Significant (P>0.05) SEM: Standard Error of Mean

Table 4.14: Effect of dietary supplementation of Shatavari root meal on Proximate analysis of Thigh (Ilio tibialis) muscle of coloured chicken at 8 weeks of age.

Treatment	Moisture (%)	Ether Extract (%)	Protein (%)	Total Ash (%)	Calcium (mg/100g)	Phosphorus (mg/100g)
T1	68.04^{a}	1.51^{d}	24.77^{bc}	1.33^{a}	6.06	236.40^{c}
T2	67.56^{a}	1.46^{d}	22.11^{b}	1.43^{a}	5.14	259.20^{c}
T3	67.56^{a}	1.37^{cd}	27.78^{c}	1.44^{a}	5.64	233.69^{c}
T4	70.95^{ab}	1.19^{abc}	18.23^{a}	1.34^{a}	3.83	228.46^{bc}
T5	76.44^{c}	0.99^{a}	18.03^{a}	1.26^{a}	3.64	167.22^{a}
T6	72.26^{b}	1.14^{ab}	22.11^{b}	1.32^{a}	4.01	187.10^{ab}
T7	68.61^{ab}	1.30^{bcd}	24.43^{bc}	1.77^{b}	5.42	217.951^{bc}
Pooled SEM	0.73	0.04	0.76	0.04	0.29	7.37
Sig Level	P<0.01	P<0.01	P<0.01	P<0.01	NS	P<0.01

Means bearing different superscripts within a column differ significantly {(P<0.05), (P<0.01)}
NS: Not Significant (P>0.05) SEM: Standard Error of Mean

significantly higher (P<0.01) in T1 as compared to T4, T5 and T6 treatment groups (1.51 *vs.* 1.19, 0.99, 1.14). Percent protein in thigh (*ilio tibialis*) muscle of coloured chicken after 8 weeks of age was significantly higher (P<0.01) in T3 as compared to T2, T4, T5 and T6 (27.78, *vs.* 22.11, 18.23, 18.03, 22.11). Percent total ash was significantly higher (P<0.01) in T7 as compared to T1, T2, T3, T4, T5, T6 treatment groups (1.77 *vs.* 1.33, 1.43, 1.44, 1.34, 1.26, 1.32). Percent phosphorus was significantly higher (P<0.01) in T1, T2 and T3 as compared to T5 and T6 (236.40, 259.20, 233.69 *vs.* 167.22, 187.10).

4.10 Mortality

There was no mortality in the experiment.

CHAPTER - 5

DISCUSSION

5.1 Proximate Composition of Broiler starter feed, broiler finisher feed and Shatavari root meal.

The proximate composition of broiler starter and finisher feed and Shatavari root meal have been presented in Table 4.1. The proximate values of Shatavari root meal were in order as reported by Berhane M. (2000), Kar and Choudhary (1994) and Kumari and Gupta (2016). The proximate values of broiler starter and finisher feed were in the same ranges as reported by Ru *et al.* (2003). The ration was adequate in all the nutrients as per BIS (2007) requirement.

5.2 Growth Performance

5.2.1 Body Weight

Data on body changes indicated that there was no significant difference in body weight among the treatment groups during 0-8 weeks of age (Table 4.2). These observations suggested that Shatavari root meal when supplemented in the diet of coloured chicken had no adverse effect on body weight. However, 0.25% level of Shatavari root meal supplemented group birds had an apparently higher body weight compared to the other treatment groups from 2nd week onwards till the end of the experiment. The results collaborate well with the findings of Dahale *et al*. (2014), who also reported that there was no significant difference in treatment groups during 6 weeks trial. However, at 4th week, broilers in 0.25% level of Shatavari root meal supplemented group grew faster than the birds in groups 0% and 0.5% Shatavari root meal supplemented group. In contrast, other researchers reported increase in body weight with supplementation of *Asparagus racemosus* root powder as a herbal growth promoter at higher level of 0.5, 1 and 1.5% (Rekhate *et al*., 2004; Pedulwar *et al*., 2007; Bhardwaj *et al*., 2009). Mane *et al*. (2012) reported that the weight of chickens increased after feeding with Shatavari root meal at the level of 10 kg/t of feed compared to the control group for 42 days. Pandey *et al.* **(**2013) reported that the body weight of broiler chicken was increased after feeding with the medicinal plants, such as Ashwagandha (*Withania somnifera),* Shatavari (*Asparagus racemosus*) and Kapikachhu (*Mucuna pruriens*).

5.2.2 Body Weight Gain

0.25% level of Shatavari root meal supplemented group birds had a significantly higher ($P<0.05$) body weight gain than control group at 2nd week of age. Further, 0.25% Shatavari root meal supplemented group had an apparently higher body weight gain compared

to the other groups from 2nd week onwards till the end of the experiment (Table 4.3). The results are in the line with the findings of Dahale *et al*. (2014), who reported that supplementation of Shatavari root meal @ 0.25% and 0.5% significantly (P<0.05) increased the body weight gain compared to treatment group 0% (control).Further, the body weight gains in group 0.25% and 0.5% were similar. In other studies too, supplementation of *Asparagus racemosus* root powder @ 0.25 and 0.5% resulted in faster growth as compared to birds in 0% (control) group without supplement (Pedulwar *et al*. ,2007; Bhardwaj *et al*., 2009). Mane *et al*. (2012), reported that the body weight gain of chickens increased after feeding with Ashwagandha and Shatavari root meal at the level of 10 kg/t of feed compared to the control group for 42 days.

5.2.3 Feed Consumption

Data on feed consumption revealed that 0.25%, 0.5%, 1%, 1.25% Shatavari root meal supplemented coloured chicken had a significantly lower (P<0.05) weekly feed intake compared to the control group and 1.5% shatavari root meal supplemented group at 2nd week of experiment in (Table 4.4). Further, data on feed consumption of all seven treatment groups also pointed out that there was no adverse effect of Shatavari root meal feeding on the feed consumption. The results of the present study are in accordance with the findings of other studies (Dahale *et al.,* 2014; Gaikwad *et al.,* 2014; Mane *et al*., 2012; Gaikwad *et al.,* 2015). Gaikwad *et al.* (2014) also reported that supplementation of Shatavari root meal @ 0.5% and1% level significantly decreased the feed consumption compared to 0% (control) group. Dahale *et al.* (2014) reported that the Shatavari supplemented groups @ 0.25% and 0.5% showed apparently more gain in weight with less feed consumption as compared to 0% (control) indicating added advantage of Shatavari root powder at the rate of 0.25% and 0.5% level.

5.2.4 FCR (Feed Conversion Ratio)

Results indicated that 0.25% Shatavari root meal supplemented group coloured chicken had a significantly better (P<0.05) FCR during 2nd week of age as compared to 0%, 1.25%, 1.5% Shatavari root meal supplemented group (1.70 vs.2.29, 2.13, 2.06*)* (Table 4.5). Further, FCR was comparatively better in 0.25% Shatavari root meal supplemented group than other treatment groups during 0-4 weeks growth phase, 4-8 weeks growth phase and 0-8 weeks growth phase. (Table 4.6). The results of the present study are in accordance with the findings of Dahale *et al.* (2014),who reported that at the end of 6th week, 0.25% and 0.5% Shatavari root meal supplemented group showed significantly (P<0.05) better FCR as compared to 0% (control) group. Mane *et al.* (2012) reported that supplementation of Shatavari root meal leads to better feed conversion ratio of broilers in Shatavari root meal

supplemented group @ 10 kg/t as compared to those in Aswagandha powder @ 5 kg/t, Ashwagandha and Shatavari @ 10 kg/t T2, T4 and 0% (control) groups.

5.3 Immunocompetence Traits

5.3.1 Humoral Immune Response

No significant differences were observed in HA and IgM response to 1% SRBC (log2 titre) among the treatment groups. The results of the present study revealed that there was no adverse effect of Shatavari root meal on the immune system of coloured chicken. However, Kumari *et al.* (2012) reported that dietary supplementation of *Asparagus racemosus* extract treated feed resulted in significant (P<0.01) increase in humoral immune response against sheep red blood cells.

5.3.2 Cell Mediated Immune Response

Results indicated that 0.5% coloured bird had a significantly better (P<0.01) cell mediated response to PHA-P compared to T1, T4, T5 and T7 (Table 4.8). The results of the present study are in accordance with the findings of Kumari *et al.* (2012), where in it was reported that dietary supplementation of *Asparagus racemosus* extract treated feed had significant (P<0.01) increase in cell mediated immune response of broilers.

5.4 Blood Biochemical Parameters

Effect of Shatavari root meal feeding on total plasma protein, total plasma cholesterol, plasma uric acid, plasma GOT, GPT and ALP has been presented in table 4.9. Plasma protein was significantly higher (P<0.01) in 1.5% than 0%, 0.25%, 0.5% Shatavari root meal supplemented groups (6.65 *vs.* 5.26, 5.13, 5.15). The results of the present study are in accordance with the findings of Kant *et al.* (2014), who reported that biochemical parameters like total serum protein were significantly (P<0.05) higher in 1.5% Shatavari root powder + 200 mg/kg feed vitamin E supplemented group than control group. Plasma cholesterol was significantly higher (P<0.01) in control group than 0.5%, 0.75%, 1%, 1.25% and 1.5% Shatavari root meal supplemented groups (153.81 *vs.* 133.02, 131.32, 126.04, 124.81 and 120.69). The results of the present study are in accordance with the findings of Kant *et al.* (2014), who reported that biochemical parameters like cholesterol, alanine aminotransferase and aspartate aminotransferase were significantly (P<0.05) lower in 1.5% Shatavari root powder + 200 mg/kg feed vitamin E supplemented group than control group respectively. Bhosale *et al.* (2012) reported that addition of *Asparagus racemosus* root powder at 5 gm% and 10 gm% levels as feed supplement reduced the plasma cholesterol levels in hyperlipidemic rats. It was also noted that the phytosterol and saponin contents of *Asparagus racemosus* root (besides polyphenols, flavonoids, and ascorbic acid could be

responsible for decreased cholesterol levels in the hyperlipidemic rats. Phytosterols compete and displace cholesterol from the intestinal bile acid micelles and in this way decrease the cholesterol circulation in rats.

Further, plasma ALP value was significantly higher ($P<0.01$) in control group than 1.25% and 1.5% Shatavari root meal supplemented groups (972.48 *vs.* 345.10 and 357.30). This shows the hepatoprotective effect of Shatavari root meal when supplemented at higher levels. In addition, plasma uric acid, AST, ALT values were comparatively higher in the control group than other treatment groups.

5.5 Carcass Quality Characteristics

There was no significant difference in slaughter traits *viz*. dressing weight, percent shrinkage, liver weight and total ready-to-cook yield among treatment groups (Table 4.10) except, percent heart weight. Percent heart weight of birds in 1.5% Shatavari supplemented group was significantly higher ($P<0.05$) than control group. Similar findings were also reported by Kant *et al.* (2015), who also noted that heart % was significantly ($P<0.05$) higher in 1.5% Shatavari root powder +200 mg/kg feed vitamin E supplemented group in comparison to other treatment groups of broiler chickens.

5.6 Yield of Cut-up-Parts

Results pertaining to yield of cut-up-parts of the carcass at 8 weeks of age revealed that there was no significant difference in the yield of individual cut-up-parts such as thighs, breast, back, neck and wings among the various treatment groups (Table No. 4.11). The results of our study clearly indicated that there was no adverse effect of Shatavari root meal on the carcass quality characteristics and cut up parts of coloured chicken at 8 weeks of age. The drumstick percent range is 15.07 to 15.88 and (15.88%) highest in 1.5% Shatavari root meal supplemented group. However, Dahale *et al.* (2014) reported that there was significantly ($P<0.05$) higher drumstick yield for 0.25% and 0.5% Shatavari root meal supplemented group than the control.

However, Kant *et al.* (2015) concluded that supplementation of Shatavari 1.5% and 200 mg/kg feed Vitamin E resulted in significantly ($P<0.05$) higher carcass quality of broiler chicken compared to control group.

5.7 Development of Digestive Organs

No significant difference was found in any of the digestive organs among the treatment groups at 8 weeks of age (Table 4.12). The results of our study clearly indicated that there was no adverse effect of Shatavari root meal on the digestive organs of coloured chicken at 8 weeks of age.

5.8 Proximate Analysis of Breast (*Pectoralis major*) Muscles and Thigh (*Ilio tibialis*) Muscles

No significant difference was observed in the proximate analysis of breast (*Pectoralis major*) muscles of coloured chicken except protein percent and calcium percent. Percent protein was significantly lower (P<0.01) in 0.75% Shatavari root meal supplemented group than other Shatavari root meal supplemented groups 0%, 0.25%, 0.5%, 0.75%, 1%, 1.5% (16.79 *vs.* 20.73, 21.85, 22.17, 19.91, 22.28 and 19.96) respectively. Percent calcium was significantly lower (P<0.05) in 0.75% Shatavari root meal supplemented group than 0.25%, 0.5%, 1% and 1.25% Shatavari root meal supplemented group (2.70 *vs.* 4.32, 4.69 and 4.58) respectively at 8 weeks of age (Table 4.13). The findings of control group value are fall in line with the findings of (Swamy and Upendra, 2013).

Percent phosphorus in thigh was significantly higher (P<0.01) in T1, T2 and T3 as compared to T5 and T6 (236.40, 259.20, 233.69 *vs.* 167.22, 187.10). The calculated percent calcium values in T1, T2, T3, T4, T5, T6 and T7 groups were 6.06, 5.14, 5.64, 3.83, 3.64, 4.01 and 5.42(mg/100g) respectively. Data of the control group (Calcium percent 3.90 mg/100g and Phosphorus percent 181.3mg/100g) are in close agreement with that of Zarkadas *et al*. (1987).

CHAPTER - 6

SUMMARY AND CONCLUSION

In recent years, coloured chicken farming has been adopted in our country as a part of diversified poultry farming. Feed plays a pivotal role in determining the cost of production of a poultry farm. Hence, utilization of feed for optimum production is needed. In recent past, several feed additives and supplements have been added in the poultry feed to optimize productivity and production in birds. Few studies have been undertaken on supplementation of Shatavari root meal in broiler feed. However, comprehensive studies on Shatavari root meal in coloured chicken as a feed supplement are lacking. Thus, the present study was designed to assess the effect of dietary Shatavari root meal supplementation on the performance of coloured chicken with the objectives; to see their effect on growth performance, feed conversion efficiency, immunocompetence, blood biochemical attributes and carcass quality of coloured chicken. Day old coloured chicken were randomly distributed into seven dietary treatments having three replicates each with ten coloured chicken. The birds of the control group (T1) were fed a basal diet (Broiler starter- DM, total ash, EE, Calcium, Phosphorous, protein, crude fibre were 88.5, 5.35, 3.15, 1.19, 0.69, 21.99, 3.59 respectively and broiler finisher - DM, total ash, EE, Calcium, Phosphorous, protein, crude fibre were 88.5, 4.94, 2.97, 1.10, 0.59, 17.69, 3.92 respectively), while T2 group was supplemented with 0.25% Shatavari root meal in basal diet, T3 group was supplemented with 0.5% Shatavari root meal in basal diet, T4 group was supplemented with 0.75% Shatavari root meal in basal diet, T5 group was supplemented with 1% Shatavari root meal in basal diet, T6 group was supplemented with 1.25% Shatavari root meal in basal diet T7 group was supplemented with 1.25% Shatavari root meal in basal diet.

There was no significant difference among the different groups in the average weekly body weight during the entire experimental period. However, the T2 group birds had an apparently higher body weight compared to the other treatment groups throughout the experiment. T2 coloured chicken had a significantly higher ($P<0.05$) body weight gain than T1 and T6 at 2^{nd} week of age. Further, T2 coloured chicken had an apparently higher body weight gain compared to the other treatment groups throughout the experiment.

T1 and T7 group chicks had significantly higher ($P<0.05$) weekly feed consumption than T2, T3, T5 and T6 group chicks at 2^{nd} week of age. However, no such observation was made there after among the different treatment groups.

T2 birds had a significantly better ($P<0.05$) FCR at 2nd week as compared to T1, T6 and T7. Further, FCR was comparatively better in the T2 group birds as compared to the other

group birds at 2nd week of age. FCR was comparatively better in T2 as compared to other treatment groups during 0-4 wks, 4-8 wks and 0-8 wks of growth phase.

There was no significant difference in HA, IgG and IgM response to 1% SRBC (log 2 titre) among the different treatment groups after 8 weeks of age. T3 coloured birds had significantly better (P<0.01) cell mediated immune response than T1, T4, T5 and T7 and comparatively better immune response than the other treatment groups after 8 weeks of age.

Plasma protein was significantly higher (P<0.01) in T4, T5, T6 and T7 than T1, T2 and T3 after 8 weeks of age. T1 and T2 had significantly higher (P<0.01) plasma cholesterol than the other treatment groups. T1, T2, T3, T4 and T5 had significantly higher (P<0.01) plasma ALP values than T6 and T7. However, no such difference was observed in plasma uric acid, ALT and AST among the different treatment groups.

No significant difference was observed in the development of digestive organs among the different treatment groups.

No significant difference was observed on the carcass quality parameters and cut up parts among the different treatment groups.

T1, T2, T3, T5, T6 and T7 had significantly higher (P<0.01) protein and Ca percent in breast meat as compared to T4. Similarly, T1, T2, T3, T5, T6 and T7 had significantly higher (P<0.05) P percent in breast meat as compared to T4.

T1, T2, T3, T4, T6, T7 thigh meat had significantly higher (P<0.01) moisture as compared to T5. EE percent of thigh meat of T1, T2, T3 was significantly higher (P<0.01) as compared to T5. Similarly, protein percent in thigh meat of T1, T2, T3, T6, T7 was significantly higher (P<0.01) compared toT4 and T5. Total ash percent in thigh meat of T7 was significantly higher (P<0.01) as compared to other treatment groups. Thigh meat of T1, T2, T3, T4, T7 had significantly higher (P<0.01) P percent as compared to T5.

From the present study it may be concluded that:

1) The dietary supplementation of Shatavari root meal @ 0.25% although not significant but increased the growth performance and improve feed conversion ratio in coloured chicken.
2) Shatavari root meal feeding did not have any adverse effect on the immunocompetence traits of coloured chicken.
3) Further, dietary supplementation of Shatavari meal @ 0.5% and above may reduce plasma cholesterol in chicken.

ABSTRACT

Present study was conducted to evaluate the efficacy of Shatavari root meal as a dietary feed supplement in coloured chicken. Day old coloured chicken (Chabro) were distributed into seven dietary treatments having three replicates each with ten birds. The study was conducted in coloured chicken during 0-8 weeks of age. During the experiment, the birds were fed basal ration, (control) T1 - (broiler starter diet till 4 weeks and there after broiler finisher diet till eight weeks), T2- basal ration was supplemented with Shatavari root meal @ 0.25%, T3- basal ration was supplemented with Shatavari root meal @ 0.5%, T4- basal ration was supplemented with Shatavari root meal @ 0.75%, T5- basal ration was supplemented with Shatavari root meal @ 1%, T6- basal ration was supplemented with Shatavari root meal @ 1.25%, T7- basal ration was supplemented with Shatavari root meal @ 1.5%. There was no significant difference in the weekly body weight among the treatment groups. However, T2 birds had apparently higher body weight compared to other treatment groups at 2nd week of age and this trend was maintained there after throughout the experiment. T2 coloured chicken had a significantly higher ($P<0.05$) body weight gain than T1 and T6 at 2nd week of age (129.67 *vs.*101.73 and 101.40g). Further, T2 coloured chicken had an apparently higher body weight gain compared to the other treatment groups throughout the experiment. T1 group chicks had significantly higher ($P<0.05$) weekly feed consumption than T2, T3, T5 and T6 group chicks at 2nd week of age (231.67 and 233.20 *vs.* 215.47, 215.47, 210.27 and 213.73g). T2 coloured chicken had a significantly better ($P<0.05$) feed conversion ratio than T1, T6, T7 during 2nd week. FCR was comparatively better in T2 as compared to other treatment groups during 0-4 wks, 4-8 wks and 0-8 wks of growth phase. There was no significant difference in HA, IgG and IgM response to 1% SRBC (log 2 titre) among the different treatment groups at 8 weeks of age. T3 coloured birds had significantly better ($P<0.01$) cell mediated immune response than T1, T4, T5 and T7 and comparatively better immune response than the other treatment groups at 8 weeks of age. Plasma protein was significantly higher ($P<0.01$) in T4, T5, T6 and T7 than T1, T2 and T3 at 8 weeks of age. T1 and T2 had significantly higher ($P<0.01$) plasma cholesterol than the other treatment groups. T1, T2, T3, T4 and T5 had significantly higher ($P<0.01$) plasma ALP values than T6 and T7. However, no such difference was observed in plasma uric acid, ALT and AST among the different treatment groups. No significant difference was observed in the development of digestive organs among the different treatment groups. No significant difference was observed on the carcass quality parameters and cut up parts among the different treatment groups. However, Percent heart weight was significantly higher ($P<0.05$) in T3 than other treatment groups (0.55 *vs.* 0.44, 0.44, 0.47, 0.45, 0.46 and 0.49). T1, T2, T3, T5, T6 and T7 had significantly higher ($P<0.01$) protein and Ca percent in breast meat as compared to T4. Similarly, T1, T2, T3, T5, T6 and T7 had significantly higher ($P<0.05$) P percent in breast meat as compared to T4. T1, T2, T3, T4, T6, T7 thigh meat had significantly higher ($P<0.01$) moisture as compared to T5. EE percent of thigh meat of T1, T2, T3 was significantly higher ($P<0.01$) as compared to T5. Similarly, protein percent in thigh meat of T1, T2, T3, T6, T7 was significantly higher ($P<0.01$) compared toT4 and T5. Total ash percent in thigh meat of T7 was significantly higher ($P<0.01$) as compared to other treatment groups. Thigh meat of T1, T2, T3, T4, T7 had significantly higher ($P<0.01$) P percent as compared to T5. Thus, it may be concluded that supplementation of dietary supplementation of Shatavari root meal @ 0.25% although not significant but increased the growth performance and improve feed conversion ratio in coloured chicken. Dietary supplementation of Shatavari root meal did not have any adverse effect on the immunocompetence traits of coloured chicken. Further, dietary supplementation of Shatavari root meal @ 0.5% and above may reduce plasma cholesterol in chicken.

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CV OF STUDENT

NAME	:	**BINAY KUMAR YADAV**
DATE OF BIRTH	:	8 Dec, 1986
PLACE OF BIRTH	:	AZAMGARH
MOTHER'S NAME	:	Smt. SHANTI DEVI
FATHER'S NAME	:	Shri. JAIMURAT YADAV
PERMANENT ADDRESS	:	Vill: Bhilihili, PO: Tarwa, Teh: Lalganj Distt: Azamgarh U.P
MOBILE	:	08273680283
EMAIL	:	yadavbinay11 @gmail.com

ACADEMIC QUALIFICATION:

Degree	University/Board	Year of Passing	Percentage of marks	Subjects
High school	CBSE	2003	58.8	English, Hindi, Mathematics, Science & Social Science
Senior Secondary	UP BOARD	2006	67.83	English, Physics Chemistry, Biology,
B.V. Sc. & A.H.	SVVU, TIRUPATI	2014	73.3	All Veterinary & Animal Sci. Subjects

EXTRA-CURRICULAR ACTIVITY:

- Participated in all extracurricular activities like Cricket, Football and won accolade.
- Actively participated as a volunteer in successful organization of various national conferences, workshop and seminar held at the university.

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Binay K. yadav.

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