EFFECT OF DIETARY LEVELS OF AZOLLA (*Azolla pinnata*) IN BROILERS

BY

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May, 2015

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C E R T I F I C A T E

This is to certify that the thesis entitled, "**EFFECT OF DIETARY LEVELS OF AZOLLA (*Azolla pinnata*) IN BROILERS"** submitted to the Faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra state, in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture) in Animal Husbandry,** embodies the results of a piece of bonafide research carried out by **Mr. SHINDE PRATAP NAVANATH** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma or published in other form. All the assistance and help received during the course of investigation and sources of literature have been duly acknowledged by him.

Place: Dapoli
Date: , May 2015

(N.N. Prasade)
Chairman,
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ANIMAL HUSBANDRY

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Place: Dapoli

Date: ***(Mr. Shinde Pratap Navanath)***

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CHAPTER I

INTRODUCTION

Poultry industry is one of the most profitable business of agriculture, provides nutritious meat and eggs for human consumption within the shortest possible time. However, availability of quality feed at a reasonable cost is a key to successful poultry operation (Basak *et al.* 2002). Recently, broiler industry has become a rapidly developing enterprise among the other sector of poultry production. Large numbers of farms are being established in different parts of the country, which create employment opportunities to the people. The two major problems are higher price and non-availability of feed ingredients to the growth of commercial poultry enterprise.

India has emerged on the world poultry map as the 3rd largest egg (56 billion eggs) and 5th largest poultry meat (2.60 million tons) producer. Total chicken production has been registered an annual growth of 7.30 per cent in the last decade. Organized sector accounts for nearly 70 per cent of the total poultry output in the country. The current strength of layers and broilers in India is estimated to be 230 million and 2300 million, respectively. Poultry processing has also gone up to 20 per cent of total broiler production. The potential of poultry sector in employment generation and enhancing rural incomes is well-recognized. Over 5 million people are directly or indirectly engaged in poultry sector, apart from numerous small poultry keepers in rural and tribal areas of the country. The domestic broiler meat demand is expected to grow at around 15-18 per cent, while table egg demand is expected to grow at 5-7 per cent in medium to long term. Indian poultry industry is growing at an estimated rate of 6-7 per cent per annum for egg and 15-20 per cent for meat. India's contribution to world's egg production is 4 per cent and chicken production is 2 per cent. Whereas, poultry sector contributes 3 per cent to national GDP and 10 per cent of total livestock GDP (FAO, 2009).

Broilers are marketed at an age of around 42 days. These are chickens reared for meat production. Broiler production is a short-term enterprise. Therefore, a number of batches can be raised within a year, or it could be a part-time job. A number of strains exist in various regions of the country for broiler production, which have a genetic potential to achieve 2.0 kg live weight at the age of 42 days. Today, 75-80 per cent of eggs and poultry meat are consumed by just 25 per cent of the population in urban areas. Presently, the consumption of poultry eggs and meat in urban areas is 100 eggs and 1.2 kg poultry meat per capita per annum, respectively. Whereas, in rural areas the respective consumption values are 15 eggs and 0.15 kg of poultry meat (Hamra, 2010).

As the human population increases, the poultry industry continues to grow to meet the demand for poultry products in world markets. The importance of poultry farms lies in the quality of products that are provided to humans. Broiler farms provide meat that supplies the human body with high quality proteins. Layer farms provide eggs rich in proteins and vitamins, especially the fat soluble vitamins (A, D, E, and K). Poultry farms are fast-paced operations that can fulfill the demand for meat and eggs, and can be expanded easily to meet the ever-growing demand.

The magnificent expansion of industry is also due to the fact that it provides the main source of animal protein through meat and eggs at cheaper rate as compared to other sources of animal protein, low maintenance cost and minimum space requirements. Broilers adapt easily to almost any condition and profits are quite high. In a developing country like India, poultry plays an important role in improving nutritional status of masses, which are mostly suffering from malnutrition due to inadequate and inferior quality protein in their diet and augmenting the income of weaker sections.

The poultry industry has now emerged as a highly structured and market-oriented enterprise. Thus, the major objective of poultry farming is to increase the profit margin in poultry business by improving feed efficiency and growth rate.

Azolla is unique because it is one of the fastest growing plants on the planet. Azolla is a floating fern and belongs to the family of Azollaceae. Azolla hosts symbiotic blue green algae, *Anabaena azollae*, which is responsible for the fixation and assimilation of atmospheric nitrogen. Azolla is able to get it's nitrogen directly from the atmosphere. That means it is able to produce biofertilizer, livestock feed, food and biofuel exactly where they are needed and at the same time, draw down large amounts of CO_2 from the atmosphere, thus helping to reduce the threat of climate changes.

The Natural Resources Development Project (NARDEP) in India has been working on azolla for the last three to four years, studying it's potential as a feed for farm animals and exploring cost effective methods for the mass multiplication of azolla in farmers' homesteads. Azolla, in turn, provides the carbon source and favourable environment for the growth and development of the algae. It is the unique symbiotic relationship that makes azolla a wonderful plant with high protein content. Azolla is easy to cultivate and can be used as an ideal feed for cattle, fish, pigs and poultry, and also is of value as a bio-fertilizer for wet land paddy. Azolla is a potential feed ingredient for broilers (Singh and Subudhi 1978). It is rich in protein, total protein is 25-30 per cent. Other constituents in azolla are minerals, chlorophyll, carotenoids, amino acids, vitamins etc. It is also a potential source of nitrogen and is a potential feed ingredient for livestock (Lumpkin, 1984; Pannerker, 1988). Azolla can tolerate and survive within 14-40°C water temperature, but 20-

30°C temperature helps for it's high growth. Azolla was reported to attain maximum growth during September to January and decline during April to June due to high temperature (Watanabe, 1978).

Inclusion of aquatic plants at low levels in poultry diets had shown better performance, especially when they supply part of the total protein or when they are included as a source of pigment for egg and broiler skin. (Boyd, 1968; Subudhi and Singh 1977 and Maurice *et al.* 1984). There fore considering the nutritive value of azolla, it was decided to conduct study on "Effect of dietary levels of Azolla (*Azolla pinnata*) in broilers" with following objectives.

1. To study the chemical composition of experimental feed
2. To study the growth performance of broiler birds
3. To study the feed conversion ratio
4. To study the Haemato-biochemical parameters
5. To study the economics of the experimental feed

CHAPTER II

REVIEW OF LITERATURE

Available relevant literature on the "Effect of dietary levels of azolla (*Azolla pinnata*) in broilers" has been reviewed and presented in this chapter under following main heads.

1. Chemical composition of experimental feed
2. Growth performance of broiler birds
3. Feed conversion ratio
4. Haemato-biochemical parameters
    4.1 Serum protein
    4.2 Serum glucose
    4.3 Haemoglobin
5. Economics of the experimental feed

1. Chemical composition:

Subudhi and Singh (1977) observed that azolla contain ash 10.5 per cent, crude fat 3-3.36 per cent, crude protein 24-30 per cent, Nitrogen 4–5 per cent, Phosphorus 5-9 per cent, Calcium 0.4-1.0 per cent , Potassium 2-4.5 per cent, Magnesium 5-6.5 per cent, Manganese 11-16 per cent, Iron 06-26 per cent, soluble sugars 3.4-3.5 per cent, starch 6.5-6.54 per cent, chlorophyll 34-55 per cent.

Maricel *et al.* (1995) found that azolla had a mean dry matter content of 5.6 per cent, crude protein 26.7 per cent, crude fibre 11 per cent, ether extract 4.6 per cent, ash 15.1 per cent, Ca 0.8 per cent and total P 0.4 per cent (DM basis).

Manoochehri-Ardakani *et al.* (1996) determined the nutritive value of azolla in terms of its chemical composition. The mean values for crude protein, crude fiber, crude ether extract, Calcium, Phosphorus and gross energy, on DM basis were found to be 17.67, 21.5, 2.49, 3.2, 0.17 per cent and 3949 kcal/kg, respectively.

Islam *et al.* (1997) reported that chemical composition of duckweed as crude protein 20.27 per cent, crude fibre was 12.07

per cent, ether extract 2.00 per cent, ash 31.00 per cent and nitrogen free extract 24.76 per cent.

Basak *et al.* (2002) observed that azolla meal contained 25.78 per cent crude protein, 15.71 per cent crude fibre, 3.47 per cent ether extract, 15.76 per cent ash and 30.08 per cent nitrogen free extract on the air-dry basis.

Alalade and Iyayi (2006) evaluated the potential of azolla meal (*Azolla pinnata* R. Brown) as a feed resource in the diet of egg-type chicks. In a completely randomized design, 30; two weeks old Nera brown chicks were assigned to each of the four dietary treatments containing 0, 5, 10 and 15 per cent azolla meal. Chemical analysis indicated that azolla meal contained 21.4 per cent crude protein, 12.7 per cent crude fibre, 2.7 per cent ether extract, 16.2 per cent ash and 47.0 per cent carbohydrate (NFE).

Awodun (2008) observed that sundried azolla contain 10 per cent ash, 3-3.5 per cent crude fat, 20-25 per cent crude protein, 3-3.5 per cent soluble sugar, 6-6.5 per cent starch.

Joydev Maity and Bidhan Patra (2008) reported the chemical composition of sun dried azolla. In the proximate analysis they observed the sundried azolla contain 13.12 per cent moisture, 25.92 per cent crude protein and 4.79 per cent crude lipid.

Balaji *et al.* (2009) reported that the chemical composition of sun dried and ground azolla meal contained 24.5 per cent crude protein, 14.9 per cent crude fibre, 3.7 per cent ether extract, 17.0 per cent total ash and 39.90 per cent NFE on DM basis.

Indira *et al.* (2009) reported chemical composition of azolla as crude protein 28.24 per cent, crude fiber 22.25 per cent, ether extract 4.00 per cent, nitrogen free extract 30.71 per cent, total ash 14.80 per cent and acid insoluble ash 4.13 per cent.

Jeberlin Prabina and Kumar (2010) observed that azolla meal contained 26.4 per cent crude protein, 15.96 per cent crude fiber, 3.42 per cent ether extract 14.86 per cent ash and 41.06 per cent nitrogen free extract on the air-dry basis.

Sujatha *et al.* (2012) reported chemical composition of azolla as moisture 6.62 per cent, crude protein 21.17 per cent, ether extract 3.39 per cent, crude fibre 14.6 per cent and total ash 19.91 per cent.

Binodini Mishra (2013) observed that azolla meal contain 90.8 per cent dry matter, 25.78 per cent crude protein, 15.71 per cent crude fibre, 3.47 per cent ether extract, 30.08 per cent nitrogen free extract, 15.76 per cent total ash, on the dry basis.

Shamna *et al.* (2013) carried out the proximate analysis of dried azolla and observed that it contained 88.80 per cent dry matter (DM), 25.46 per cent crude protein (CP), 2.66 per cent ether extract (EE), 14.80 per cent crude fiber (CF), 41.58 per cent nitrogen free extract (NFE) and 15.50 per cent total ash.

Cherryl *et al.* (2014) analyzed sun dried azolla sample for proximate principles. The dry matter (DM) content of sun dried azolla meal was 89.73 per cent. It contained 75.73 per cent organic matter, 23.49 per cent crude protein, 14.70 per cent crude fiber, 3.70 per cent ether extract, 24.26 per cent total ash, 7.94 per cent acid insoluble ash, 2.58 per cent Calcium and 0.26 per cent Phosphorus.

2. Growth Performance

Basak *et al.* (2002) reported that the average weight of broilers at the time of seventh week was 1579.00, 1637.00, 1462.00

and 1394.33 g for T_1 (0 per cent), T_2 (5 per cent), T_3 (10 per cent) and T_4 (15 per cent) azolla respectively.

Samarth *et al.* (2002) carried out an experiment on forty day old broiler chicks, divided into two groups T_1 and T_2. Group T_1 was maintained as untreated (control) and T_2 was provided with Ashwagandha root powder @ 0.5 per cent as feed mix. It was observed that body weight gain was higher in treated group as compared to control group.

Khang *et al.* (2004) reported the effects of dietary protein level and a duckweed supplement on the growth rate of local breed chicks. 360 Tau Vang breed chicks at 1 day of age, were allocated in a completely randomized design to 6 treatments, with 3 levels of crude protein (on per cent DM) at 18, 20 and 22 with or without fresh duckweed (DW) (*Lemna minor*) *ad libitum*. They observed that chicks fed Duckweed had somewhat higher weight gains (8.3 g/day) compared with chicks fed the diets without duckweed (7.8 g/day) but there were no differences between diets with different CP levels.

Alalade and Iyayi (2006) observed that average weekly weight gains were 95.43 g, 95.22 g, 98.62 g and 93.44 g for the treatment 0, 5, 10 and 15 per cent of azolla, respectively. Average weekly feed intake decreased ($p<0.05$) from 286.95 g/bird to 224.38 g/bird as the level of azolla increased to 15 per cent.

Alalade *et al.* (2007) reported the nutritive value of azolla (*Azolla pinnata*) meal in the diets of growing pullets and subsequent effects on the laying performance. Birds were reared to 18 weeks of age on diets containing 0, 5, 10 and 15 per cent azolla meal. They reported that the growth performance of the pullets (weekly body weight gain) fed on 0, 5, 10 and 15 per cent dietary levels of azolla meal were 95.02, 101.7, 92.2, and 91.4 g/bird/week, respectively.

Kagya-Agyemang *et al.* (2007) conducted five-week feeding trial using 180 Cobb commercial broiler chickens to study the inclusion of sun dried *Gliricidia sepium* leaf meal (GLM) in broiler diets. The 21-day-old chickens were randomly allocated to four dietary treatments. 0, 50, 100 and 150 g kg-1 levels of GLM were included in a nutritionally balanced diet. At the end of study the final weight of birds were 2.59, 2.51, 1.88 and 1.61 kg, respectively.

Dhumal *et al.* (2009) conducted an experiment on 225-day-old Vencobb broiler chicks reared on deep litter system of housing, to study the production performance of broilers fed on different levels of azolla for six weeks. The control group A was fed diet without azolla and group B and C were fed diet with Standard Broiler Mash (SBM) replacement with azolla meal @ 2.5 per cent and 5 per cent, respectively. There were no significant differences noted between the control and treated groups with regards to the body weights and weekly weight gain. However, the body weights at 6^{th} week for treatment groups were numerically higher than the control (A-1757.10, B-1845.80 and C-1892.40 g).

Jeberlin Prabina and Kumar (2010) reported that the average weight at the time of six week was 1935.26, 1993.50, 1992.63, 1679.70 g for T_1 (0 per cent azolla), T_2 (5 per cent azolla), T_3 (7.5 per cent azolla) and T_4 (10 per cent azolla), respectively.

Saeid and Al-Nasry (2010) conducted a trial to determine the effect of different levels of coriander seed supplementation in diets on performance and blood parameters in broilers. Birds were fed with diet supplemented with 0.1, 0.2 and 0.3 per cent of coriander seed. Birds that fed 0.3 per cent coriander seed diet exhibited the highest body weight gain, feed conversion ratio and carcass yield and decreased feed intake.

Essa *et al.* (2011) observed the potential effect of coriander oil on broiler performance and reported that there were no significant difference between the control and 0.5 per cent coriander oil in weekly feed intake, while, feed intake for both groups was significantly less feed as of that the 1.0 per cent coriander oil for the same period. By the sixth week of the study both 0.5 per cent and 1.0 per cent consumed significantly higher feed than 0 per cent group.

Farah (2011) investigated the potential effect of coriander seeds on physiological traits. Birds were fed experimental diets containing 0 (T_1), 1 (T_2), 2 (T_3) and 3 per cent (T_4) coriander seed. Results showed that two per cent (T_3) and three per cent (T_4) group showed better feed consumption and feed conversion ratio than control. It was observed that inclusion of coriander seeds at levels of two per cent have a positive effect on broiler performance.

Rajashree *et al.* (2012) conducted an experiment on broiler chicks. Three herbal formulations viz., Amla, Ashwagandha and Shatavari capsules were examined for general test parameters at different production stages and a few basic nutritive test parameters. The general test parameters and assays were found to be satisfactory and the nutritive values were found to be quite significant. This proved that the three formulations could be used as herbal medicines and the significant nutritive values proved that they could be used as dietary supplements.

Shamna *et al.* (2013) conducted experiment for six weeks (42 days) on 192, day-old Japanese quails (C*oturnix coturnix japonica)* randomly allotted to four treatments, with different levels of A*zolla pinnata* (A) in the diet, *viz.*, T_1 (0 per cent), T_2 (2.5 per cent), T_3 (5 per cent), and T_4 (7.5 per cent) with four replicates of twelve chicks in each group to evaluate its effect on growth. After six week

weight was 169.63 ± 0.97, 167.84 ± 3.10, 162.40 ± 2.05 and 156.57 ± 2.57 g for T_1, T_2, T_3 and T_4, respectively.

3. Feed conversion ratio:

Khatun *et al.* (1999) studied the feeding value of azolla (*Azolla pinnata*) in laying hens in two feeding trials of 8 and 16 weeks duration. Azolla meal was included at a level of 50 and 100 g kg^{-1} diet at the expense of sesame meal in diets formulated on a total protein and total amino acid, or digestible protein and digestible amino acid basis (Trial 1). In Trial 2, 150 and 200 g kg^{-1} azolla meal was included in diets formulated using a total protein and total amino acid, or digestible protein and digestible amino acid basis. L-lysine and DL-methionine were added to the diets formulated using digestible nutrients to adjust the digestible lysine and methionine contents to those in the wheat sesame meal based control diet. Better feed efficiencies were found when azolla meal was fed at 50 and 100 g kg^{-1} (Trial 1) but significantly improved over the control when fed at 150 and 200 g kg^{-1} when formulated on a digestible protein and digestible amino acid basis (Trial 2) but it was poorer when the diets were formulated on a total protein and total amino acid basis.

Basak *et al.* (2002) conducted an experiment with 120, seven days old Vencobb commercial broiler chicks and continued up to 42 days of age to determine the feasibility of azolla (*Azolla pinnata*) as a feed ingredient in broiler ration. Feed conversion ratio (FCR) improved significantly for treatment T_2 and T_1 which were 2.06 and 2.17, respectively during 2-6 weeks of age. FCR for treatment T_3 and T_4 were poorer i.e. 2.38 and 2.50, Survivability was distinctly better for all of the treatment groups, which indicate azolla had no toxic effect.

Odunsi *et al.* (2002) conducted an experiment with 72 laying hens. The birds were allotted to four dietary treatment containing 0, 5, 10 and 15 per cent gliricidia leaf meal (GLM), respectively in a complete randomized design; each treatment was replicated three times, feed and water were provided *ad libitum.* The inclusion of GLM in layer diets significantly ($p \leq 0.05$) reduced feed consumption in a linear fashion. Layer fed 0 and 5 per cent GLM had similar ($p \leq 0.05$) hen day egg production, body weight changes and feed conversion efficiency which less significantly at 10 and 15 per cent GLM levels.

Samarth (2002) calculated 2.10 F.C.R for Ashwagandha root powder treated group whereas, 2.22 for control group in broilers.

Deka and Dutta (2003) conducted an experiment on 120 day old White Leghorn chicks fed with AD1 (the extract of *Withania somnifera*, *Ocimum sanctum* and *Mangifera indica*). It was observed that FCE (Feed Conversion Effeciency) was better in treated group as compared to control group.

Narayanswamy and Santoshkumar (2004) carried out an experiment on 200 (day old) broiler chicks. Chicks were divided into two groups, *viz.* control and Geriforte (antistress contains Ashwagandha) supplemented group. The birds from the Geriforte supplemented group were found to be the most efficient in terms of conversion of feed to live weight gain (1.87kg).

Alalade and Iyayi (2006) reported that average weekly feed intake (AWFI) was similar up to 5 per cent azolla inclusion in diets while 10 and 15 per cent azolla in diets significantly reduced AWFI. FCR decreased from 3.13 on control diet to 2.54 in birds fed 10 per cent azolla and increased to 2.55 on 15 per cent azolla.

Dhumal *et al.* (2009) observed the production performance of broilers fed on different levels of azolla for six weeks. The birds were randomly divided into three treatment groups of 75 chicks each viz., control A, B and C having three replicates. The control group A was fed diet without azolla and group B and C were fed diet with Standard Broiler Mash (SBM) replacement with azolla meal @ 2.5 per cent and 5 per cent, respectively. There were non-significant differences in weekly feed consumption and weekly feed conversion ratio at 6^{th} week of age. However, the feed consumption for treated groups was slightly higher than control (A-983.79, B-1045.00 and C-1009.00 g) and the feed conversion ratios of treated groups were better as compared to control (A- 1.95, B -1.93 and C- 1.91).

Rucha *et al.* (2009) conducted an experiment on broiler birds and revealed that the feed consumption was highest in 0 per cent tulsi leaf powder and lowest in 1.0 per cent tulsi leaf powder. Feed conversion ratio was significantly improved in 1.0 per cent tulsi leaf powder as compared to 0.5 per cent tulsi leaf powder.

Singh *et al.* (2009) studied the efficacy of polyherbal growth promoter and liver tonic product superliv concentrate premix simultaneously on performance of broiler chicks. Sixty day old unsexed commercial broiler chicks were divided randomly into two identical groups. Control group I was given standard basal diet only whereas, group II was given superliv conc. @ 500 g/tone of feed along with basal diet from 0-6 weeks of experimental study. It was observed that the mean total body weight gain and feed conversion ratio (FCR) were significantly higher in treated group compared to control.

Jeberlin Prabina and Kumar (2010) reported that feed conversion ratio obtained in the treatment T_3 (7.5 per cent azolla) was found to be the best 1.75 followed by T_2 (5 per cent azolla)

which was 1.81, poorest feed conversion ratio of 2.00 was observed in T_4 (10 per cent azolla).The FCR of the treatment T_1, T_2, T_3, were found to be close to the standard 1.87:1 as reported by Shalev and Pesternak, 2000.

Hassan *et al.* (2011) studied the potential effect of coriander oil on intestine histometrical traits in broiler. Birds were fed experimental diets containing 0 per cent, 0.5 per cent and 1 per cent coriander oil for six weeks. Results showed that feed conversion ratio was significantly higher in the T_2 and T_3 as compared to control treatment.

4. Haemato-biochemical parameters:

4.1. Serum protein:

Alka (1998) conducted an experiment on 24 White Leghorn of 32 weeks age divided into three groups *viz.* T_1-control, T_2-5 g Ashwagandha root powder and T_3- 10 g Ashwagandha root powder per kg of feed. Experimental period was 10 weeks. It was observed that average total serum protein level was 4.5 to 6 g /dl. It was noticed that there was a significant difference at 5 per cent level between the groups. The increase in total serum protein in Ashwagandha treated groups seems to have stimulated liver for increased protein anabolism and decreased protein catabolism.

Samarth *et al.* (2003) investigated that the blood protein values of T_1 (untreated) and T_2 (treated) ranged from 3.24 ± 0.30 to 3.44 ± 0.37g/dl and 3.28 ± 0.28 to 4.51 ± 0.42 g/dl, respectively. It was significantly higher in T_2 group as compared to T_1 group.

Wanjari (2004) revealed that there was significant increase in total serum protein (4.52 g/dl) in broiler chickes fed with combination of Ashwagandha and Amla than control group (4.29 g/dl).

Zeynep *et al.* (2005) conducted an experiment on 120 day old broiler chicks supplemented without or with ascorbic acid (100 mg/kg of feed). The total protein recorded for control and treated groups was 2.3 and 2.4 (g/dl), respectively.

4.2. Serum glucose:

Sankar Naryanan and Jolly (1993) found that the powdered mixture of fruits of *Emblica officinalis*, *Mammordica chaurntia* and rhizomes of *Curricuma longa* in equal proportion reduced blood sugar level in broiler birds.

Dhal *et al.* (1997) studied the effect of Zee tress on the performance of broiler chicks. It was observed that glucose content of experimental birds was higher (7.84 per cent) than that of control group though not statistically significant.

Alka (1998) conducted an experiment on 24 White Leghorn birds of 32 weeks age divided into three groups *viz.* T_1-control, T_2-5 g per kg of feed Ashwagandha root powder and T_3-10 g Ashwagandha root powder per kg of feed. Experimental period was 10 weeks. It was observed that glucose level was in the range of 160 to 200 mg/dl. The serum glucose did not differed significantly between the groups.

Samarth *et al.* (2003) conducted an experiment on day old broiler chicks divided into 2 groups (T_1 and T_2). Group T_1 was maintained as untreated (control) and T_2 was treated with Ashwagandha root powder. The blood glucose level in untreated group ranged from 221.55 to 228.03 mg/dl and in treated 228.70 to 219 mg/dl. Improvement in blood glucose was observed in T_2 than T_1 group.

Wanjari (2004) observed that broiler fed with Ashwagandha and Amla (T_3 group) had more glucose (275.21 mg/dl) as compared

to control group (T_0) (266.11 mg/dl). Group T_2 fed with Amla also showed significant increase in glucose (274.08 mg/dl), as compared to T_0 (266.11 mg/dl) group.

Farah (2011) investigated the potential effect of coriander seeds on physiological traits. 18 day-old Arbor Acer broiler chicks which were randomly assigned to four dietary treatments with three replicate pens (15 birds/pen).Birds were fed experimental diets containing 0 (T_1), 1 (T_2), 2 (T_3) and 3 per cent (T_4) coriander seed. Results showed that Serum glucose was lower in two per cent coriander seed (T_3) than all other groups.

Tawfeek and Mustafa (2012) studied the effect of coriander on some biochemical parameters in broiler chickens. Day old one hundred forty four broiler chickens were divided in to three treatment groups of control, full dose of coriander (1500 mg/kg Bwt) and coriander with sodium tungstate (750 mg/kg Bwt + 15 mg/kg Bwt) which was further divided into five sub-groups of 6-15 chickens each. The result showed that the liver glycogen concentration (LGC), serum enzymes Alanine transaminase (ALT) and Aspartate transaminase (AST) level got decreased in group II than control. Whereas group III showed nonsignificant effect.

4.3. Haemoglobin:

Samarth *et al.* (2003) observed increase in haemoglobin concentration (9.71± 0.49 to 11.33 ± 0.35 g/dl) in broiler chicks of group T_2 which was treated with Ashwagandha root powder as compared to T_1 group maintained as untreated (9.33± 0.37 to 9.79 ± 0.73 g/dl).

Wanjari (2004) conducted an experiment on day old broiler chicks. The chicks were divided into four groups *viz.* T_o - control, T_1-fed with Ashwagandha, T_2-fed with Amla and T_3-fed with combination of Ashwagandha and Amla. It was recorded that the

average means haemoglobin for 6 weeks of experimental period were 9.98, 10.27, 10.82 and 10.7 g/dl in T_o, T_1, T_2 and T_3 groups, respectively. T_2 group showed highest amount of haemoglobin (10.82 g/dl) amongst all groups.

Mehmat *et al.* (2005) carried out an experiment on 300 (7 day old) Japanese quails divided into three groups provided with 0, 500 and 1000 mg ascorbic acid per kg of feed, respectively. It was resulted that haemoglobin was not affected by the dietary ascorbic acid in Japanese quails reared under hot condition.

Alalade *et al.* (2007) investigated the nutritive value of azolla (*Azolla pinnata*) meal in the diets of growing pullets and subsequent effects on the laying performance .From the results obtained in treatments 0, 5, 10 and 15 per cent, apparent differences in packed cell volume (PCV) reported as 27.7, 28.3, 27.3 and 26.3 per cent, respectively. Whereas, in red blood cell (RBC) it was denoted that 2.01, 2.94, 2.33 and 1.98 x $10^6/mm^3$, respectively. Haemoglobin (Hb) content of blood were 8.47, 8.53, 7.80 and 7.20 g/dl, respectively, and white blood cell (WBC) were reported as 18.8, 17.3, 19.0 and 20.0 x $10^6/mm^3$, respectively.

Swathi *et al.* (2012) conducted study on 216 day old Vencobb broiler chicks in two batches for six weeks. Each batch consist of 108 chicks divided into 9 dietary treatment groups viz, T_1-fed on basal diet (BD) alone; T_2-BD + Vitamin E (200mg/Kg); T_3-BD + Vitamin E (200mg/Kg) + Selenium (0.15 ppm); T_4-BD + Tulsi (0.25 per cent); T_5–BD + Tulsi (0.5 per cent); T_6-BD + Turmeric (0.2 per cent); T_7-D + Turmeric (0.4 per cent); T_8-BD + Tulsi (0.25 per cent) + Turmeric (0.2 per cent); T_9-BD + Tulsi (0.5 per cent) + Turmeric (0.4 per cent). The result showed that, RBC and Hb were significantly lower than all group.

5. Cost of feeding

Parthasarathy *et al.* (2001) studied the economics of utilizing a water fern, *Azolla* sp. in broiler rations. Azolla was incorporated at 0, 5, 10, 15 and 20 per cent levels to replace a protein mix containing wheat bran and groundnut cake (53:47) up to 5 weeks of age in the first trial and to replace a protein mix containing wheat bran and fish meal (52:48) up to 8 weeks of age in the second trial. The birds receiving 5 per cent azolla in both the trials performed significantly well ($P<0.01$) and gave better economic returns viz. 15 and 16 per cent gain over other groups. The findings of this study indicated that the incorporation of *azolla* as a feed ingredient at 5 per cent level in broiler rations could provide promising economic returns.

Basak *et al.* (2002) conducted an experiment with 120, seven days old Vencobb commercial broiler chicks and continued up to 42 days of age to determine the feasibility of azolla (*Azolla pinnata*) as a feed ingredient in broiler ration. They reported that the average feed cost for the diets D_1, D_2, D_3 and D_4 were 39.00, 37.57, 36.99 and 36.35 (Tk/ bird).

Patil Savitri (2005) studied the effect of different herbal and non-herbal anti stress agent on the performance of White Leghorn and found that, average total feed cost in T_0, T_1, T_2, T_3 and T_4 in Herbal and Non-herbal anti stress agent were Rs. 319.05, 317.74, 317.90, 315.82 and 317.74, respectively.

Shisodiya *et al.* (2008) conducted an experiment on 225 day old broiler chicks to study the effect of Ashwagandha on economics of broiler production. The result showed that the group treated with Ashwagandha has more net profit (Rs. 26.77/-) than that of control group (Rs. 15.01/-).

Rucha *et al.* (2009) conducted an experiment on broiler birds and revealed that the net production cost per bird was 57.75, 59.76 and 63.30 for 0 (T_1), 0.5 (T_2) and 1 per cent (T_3), respectively for tulsi leaf powder fed in diet. Net profit per bird was 12.53, 15.72 and 14.54 Rs/- for 0 (T_1), 0.5 (T_2) and 1 per cent (T_3) respectively.

Sunbul *et al.* (2010) studied the potential effect of coriander seed as growth promoting substance in broiler chicks. One hundred and eighty day old Arbor Acer broiler chicks were randomly assigned to four dietary treatments with three replicate pens (15 birds/pen). Birds were fed experimental diets containing 0 per cent (T_1), 1 per cent (T_2), 2 per cent (T_3) and 3 per cent (T_4) coriander seed. Feeding broiler chicks 2 per cent coriander seed as a diet ingredient resulted in a significant improvement in performance parameter by lowering their cholesterol, feed consumption and increasing their body weight.

Sanjyal *et al.* (2011) studied the comparative effect of antibiotic (chlortetracycline) and probiotic (*Lactobacillus acidophilus*) with three herbal growth promoters, Amla (*Emblica officinalis),* Tulsi (*Ocimum sanctum),* and Ashwagandha (*Withania somnifera),* on growth performance, feed consumption, feed conversion efficiency, carcass characteristics and economics of broiler production. The control group received basal diet. Whereas, in the treatment groups, the basal diet was supplemented with one of the following: antibiotic, probiotics, Tulsi, Amla, and Ashwagandha and also in combination of herbs, forming eight treatments respectively. Results showed the highest income over expenditure (Rs.26.36) and benefit cost ratio (1.19) was recorded in birds fed diet supplemented with Tulsi. Whereas, it was minimum (1.12) in Amla supplied diet.

Sujatha *et al.* (2012) conducted a study on the production performance and feed cost benefit with fresh azolla supplementation

in the feed of native local ducks. Forty indiscriptive local ducks of 20 weeks age were randomly divided into two groups with two replicates of each. Two replicates were assigned to each of the two dietary treatments in a completely randomized design, in such a manner that standard layer mash (control group) and commercial layer mash + 200 g fresh azolla (azolla group). The feed consumption was considerably low with azolla supplementation as against control group. Results revealed that there was no significant difference in egg productivity between azolla supplemented and control group. A significant amount of 30 per cent feed savings lead to reduced feed cost. Egg weight and other quality parameters were similar to control group.

Shamna *et al.* (2013) studied the broiler characteristics of Japanese quails *(Coturnix japonica)* at different levels of diets substitution with *Azolla pinnata.* This experiment was conducted for six weeks (42 days) on 192 day-old Japanese quails (C*oturnix coturnix japonica)* randomly allotted to four treatments, with different levels of *Azolla pinnata* (A) in the diet, *viz.*, T_1 (0 per cent azolla), T_2 (2.5 per cent azolla), T_3 (5 per cent azolla) and T_4 (7.5 per cent azolla) with four replicates of twelve chicks in each group to evaluate its effect on important broiler characteristics like growth, feed utilization and cost efficiency. It was found that the cost incurred on the treatment T_3 (8.13) was less as compared to T_4 (8.16), T_2 (8.18) and T_1 (8.27) in six weeks, resulting in higher saving (1.69 per cent) over the treatment T_2 (1.08 per cent) and T_4 (1.33 per cent).

CHAPTER III

MATERIAL AND METHODS

The present investigation was conducted during 12th January, 2015 to 23th February, 2015 at Poultry Unit of the College of Agriculture, Dapoli. Dapoli is situated at 17° North latitude and 73° East longitude on the west coast of Maharashtra at 280 meters above mean sea level. The climate is warm and humid with the annual average rainfall of 3500 mm. The relative humidity ranges

from 55 to 96 per cent. The details of the material and methodology used during research work is given in this chapter.

3.1. Experimental birds:

The trial was conducted with 120 day old 'Vencobb' broiler chicks. The birds were from the same hatch and were reared under uniform management condition up to seven weeks of age. On arrival, the chicks were weighed individually and randomly divided into four groups of thirty each with five replications. The 'Vencobb' broiler chicks were obtained from M/S Venkateshwara Hatcheries Pvt. Ltd., Pune.

3.2. Design of experiment and dietary treatments:

The experiment was conducted in a Randomized Block Design with following dietary treatments.

T_0 - Control (Basal feed)

T_1 - Basal feed + 5 percent Azolla meal (50 g/ kg of feed)

T_2 - Basal feed + 10 per cent Azolla meal (100 g/kg of feed)

T_3 - Basal feed + 15 per cent Azolla meal (150 g/kg of feed)

3.3. Feed:

For the experiment, readymade commercial broiler starter and broiler finisher mash was used. The chemical composition of broiler starter and finisher mash is indicated below.

Chemical composition of the broiler mash (%)

Proximate principle	Broiler starter	Broiler finisher
Dry Matter	91.24	88.96
Crude protein	21.28	19.34
Crude fibre	6.59	5.63
Crude fat	4.56	4.73
Nitrogen free extract	65.65	68.55
Ash (Acid insoluble)	1.92	1.75

3.4. Feed additives:

Azolla was cultivated at dairy farm and after sun drying meal was prepared and mixed in commercial broiler feed as per different treatment levels.

3.5. Management practices:

The experimental birds were reared on deep litter system up to seven weeks of age. Before the arrival of chicks, the pens, brooders, waterers and feederers were thoroughly cleaned, washed and disinfected. Thirty chicks per treatment were reared separately in deep litter system up to the age of seven weeks. The brooding was carried out during first 9 days. The brooding temperature was regulated to 85-95^{0}F (30 to 35^{0}C).

All the birds irrespective of their treatments were fed commercial broiler 'starter' mash from 1st day to 3rd week of age followed by broiler 'finisher' mash till 6th week. The birds of different groups were fed separately throughout the experimental period,

daily at 8.30 hours. Weighed quantity feed was offered and the left over was collected and weighed next day morning at 8.30 hours to determine the daily feed consumption. Fresh and clean water was offered *ad libitum* to all the birds. Adequate health cover was provided to all the birds.

At the end of 42th day of age, one bird from each replicate was randomly picked up; blood samples were collected for measuring serum biochemistry.

3.6. Parameters studied:

3.6.1. Feed consumption:

The daily feed consumption of each group was estimated as difference between the total quantity of feed offered and quantity of feed left over during 24 hours period. Feed consumption so recorded was added together for seven days of the week and was considered as weekly feed consumption.

3.6.2. Live weight gain:

The growth rate of the birds is reflected through the weekly live weight gain. Individual body weight of the birds from each group was taken at weekly intervals, starting from the day old stage. The birds were weighted during morning hours before feeding. The average weekly weight gain of the birds of the different groups was calculated by subtracting the previous week average weight of the group of the birds from the present weekly average weight of the group of birds.

3.6.3. Feed conversion ratio:

The amount of feed consumed per unit gain (feed conversion ratio) was calculated as the ratio of feed consumption to weight gain during the experimental period.

Feed consumption and weight gain for each week were worked out for each treatment separately.

$$\text{Feed conversion ratio} = \frac{\text{Quantity of feed consumed (g) in week}}{\text{Gain in body weight (g) in week}}$$

3.6.4. Mortality:

Incidence of death of chicks during the experimental period was recorded.

3.7. Collection of blood samples:

The blood samples were collected at six weeks of age from the wing vein with syringe from one bird in each replication. The blood collected in sterilized glass test tube keeping in a slant position and serum was separated. All the serum samples were stored in a deep freeze at -20 °C until it processed.

3.8. Dressed yield (%):

Dressing percentage was calculated as per the following formula

$$\text{Dressing percentage} = \frac{\text{Dressed mass}}{\text{Live weight}} \times 100$$

3.9. Carcass yield:

The carcass evaluation was carried out the birds were randomly selected from each group for dressed yield and edible carcass yield studies. At the end of experiment the birds were kept separately and fasted for a period of 12 hours. Prior to their slaughter the live weight of the birds were recorded. After removal of feathers and complete bleeding, the dressed yield of each bird was recorded. The complete digestive tract, legs and head were removed to calculate edible carcass yield of individual bird. Heart, liver, and gizzard were also weighed individually and the average yield of each of these organs was recorded for the respective groups. The

percentage of dressed yield, edible carcass yield and weight of different organs were calculated over live weights.

3.10. Vaccination and medication:

All the chicks were vaccinated with `F` strain of 'Lassota' vaccine on the 6th day of hatching and vaccination against 'Gumboro' disease was done on 18th day of hatching. In addition all the birds were given medicine Groviplex for three days from second day and on 20th day onward for three days through fresh water @ 1ml/lit. of water.

3.11. Economics of production:

The economics of broiler was calculated by taking into consideration inputs viz., cost of day old chicks, cost of feed and azolla additives. The prevailing market rates of feed and azolla additives were considered for this purpose.

3.12. Feed analysis:

Analysis of feed was carried out as per the method given in A.O.A.C (1970).

3.13. Statistical analysis:

The statistical analysis of the data obtained for average feed consumption, live weight, gain in weight, feed conversion ratio was carried out as per Snedescor and Cochran (1994) using Randomized Block Design.

CHAPTER IV

RESULTS AND DISCUSSION

The present investigation was undertaken with a view to study the effect of dietary levels of azolla (*Azolla pinnata*) in broilers. After doing the analysis, the findings of the present investigation are presented and discussed in this chapter under the following main-heads.

1. Feed composition
2. Feed consumption
3. Live body weight
4. Live weight gain
5. Feed conversion ratio
6. Morbidity and mortality
7. Serum lipid profile
8. Dressing percentage
9. Carcass weight
10. Cost of production

4.1. Feed composition

Commercial broiler starter, broiler finisher and azolla meal were used for this experimental trial. The chemical composition of broiler starter, broiler finisher and azolla meal is indicated in Table 4.1

4.1.1. Broiler starter

The broiler starter contained 91.24 per cent dry matter, 21.28 per cent crude protein, 4.56 per cent crude fat, 65.65 per cent NFE, 6.59 per cent crude fibre, 1.92 per cent total ash, respectively.

4.1.2. Broiler finisher

In broiler finisher contained 88.96 per cent dry matter, 19.34 per cent crude protein, 4.73 per cent crude fat, 68.55 per cent NFE, 5.63 per cent crude fibre, 1.75 per cent total ash, respectively.

4.1.3. Azolla meal composition

The azolla contained 89.91 per cent dry matter, 21.56 per cent crude protein, 3.37 per cent crude fat, 43.69 per cent NFE, 15.05 per cent crude fibre and 16.33 per cent total ash.

The composition of azolla observed in the present investigation was in agreement with the results reported by Sujatha *et al.* (2012) as 21.17, 3.39, 14.6 and 19.91 per cent crude protein, ether extract, crude fibre and total ash, respectively.

Table 4.1: Chemical composition of experimental feed (%DM basis)

oximate Principle	**Broiler starter**	**Broiler finisher**	**Azolla meal**
y matter	91.24	88.96	89.91
ude protein	21.28	19.34	21.56
ude fat	4.56	4.73	3.37
rogen Free Extract	65.65	68.55	43.69
ude fibre	6.59	5.63	15.05
tal ash	1.92	1.75	16.33

Nearly similar composition of azolla meal was observed by Alalade and Iyayi (2006) who reported that azolla meal contained 21.4 per cent crude protein, 12.7 per cent crude fibre, 2.7 per cent ether extract, 16.2 per cent ash and 47.0 per cent NFE and Balaji *et al.* (2009) also reported the chemical composition of sun dried and ground azolla meal contained 24.5 per cent crude protein, 14.9 per

cent crude fibre, 3.7 per cent ether extract, 17.0 per cent total ash and 39.90 per cent NFE on DM basis.

4.2. Feed consumption

The average weekly feed consumption of broilers in different treatment is presented in Table 4.2 and graphically presented in Fig.1.

In the present investigation, average weekly feed consumption was 713.57, 723.96, 709.84 and 706.01 g in treatments T_0, T_1, T_2 and T_3, respectively. Treatments T_0, T_1, T_2 and T_3 were at par with each other. Treatment T_1 resulted in higher in feed consumption than T_0 (control). It was found that the average weekly feed consumption increased as the increase in the age of birds.

Table 4.2: Average weekly feed consumption (g/bird) of broilers

Treats.	Weeks						Mean
	I	II	III	IV	V	VI	
T_0	132.2	294.2	560.2	887.9	1126.37	1280.67	713.57
T_1	132.4	291.5	579.6	906.9	1155.93	1277.50	723.96
T_2	133.4	303.6	557	882.8	1125.60	1256.63	709.84
T_3	134	305.6	558.2	889.9	1105.97	1242.37	706.01
S.E.±	1.97	4.46	5.59	5.50	10.69	12.62	6.80
C.D. at 5%	6.07	13.74	17.23	16.96	32.95	38.88	N.S.

The statistical analysis revealed that, in broiler azolla meal had non-significant influence on total feed consumption and all treatments were at par with each other. The variation in feed consumption amongst weeks irrespective of treatments was insignificantly different.

Higher results were obtained by Dhumal *et al.* (2009) who observed feed consumption for groups treated with azolla meal was slightly higher than control (A-983.79, B-1045.00 and C-1009.00 g.)

The results of Alalade and Iyayi (2006) were contradictory than the results of present investigation who observed the average weekly feed intake as 286.95 g, 270.73 g, 231.28 g and 224.38 g for T_0 (0 % azolla), T_1 (5 % azolla), T_2 (10 % azolla) and T_3 (15 % azolla), respectively.

4.3. Live weight changes

The experimental birds were weighted at weekly intervals throughout the experimental period. The average weekly live weights were recorded from day old to six weeks of age of broiler from different groups. The average weekly body weight of broiler is presented in Table 4.3 and graphically presented in Fig. 2.

Table 4.3: Average weekly body weight (g/bird) of broilers

Treat.	Day old	Weeks						Mean
		I	II	III	IV	V	VI	
T_0	45.7	125.03	373.17	816.07	1268.50	1924.60	2344.20	1141.93[b]
T_1	45.3	126.23	377.83	825.43	1351.43	2039.53	2507.37	1204.64[a]
T_2	45.7	126.47	371.53	815.70	1289.03	1868.50	2285.50	1126.12[b]
T_3	45.8	125.63	373.67	814.90	1258.93	1815.17	2244.03	1105.39[c]
S.E.±		0.76	2.28	2.55	7.39	7.73	10.40	5.18
C.D. at 5%		2.36	7.02	7.86	22.79	23.83	32.05	15.98

Means having different superscript differ significantly.

The average body weights of broiler at the end of 6th week were 2344.20, 2507.37, 2285.50, and 2244.03 g in T_0, T_1, T_2, and T_3

treatments, respectively. The highest body weight was observed in T_1 followed by T_0, T_2 and T_3 treatments, respectively.

The average weekly live weights of broilers were 1141.93, 1204.64, 1126.12 and 1105.39 g in T_0, T_1, T_2 and T_3 treatments, respectively. The average weekly body weight was highest (1204.64 g) in T_1 group as among the all groups. It may be because of azolla meal containing higher protein percentage while treatment T_0 (1141.93 g) and T_2 (1126.12 g) were at par with each other.

The statistical analysis revealed that the average live weight obtained in T_1 treatment significantly ($P<0.05$) increased as compared to other treatments. This indicated that supplementation of azolla at level of 5 per cent significantly improved the average weekly weight than the other group. However, the 15 per cent azolla supplementation was found significantly lower effect than control, T_1 (5% azolla meal) and T_2 (10% azolla meal).

Similar findings were observed by Basak *et al.* (2002) and reported, that the average weight at seventh week was 1579.00, 1637.00, 1462.00 and 1394.33 g for T_1 (0 % azolla meal), T_2 (5 % azolla meal), T_3 (10 % azolla) and T_4 (15 % azolla meal), respectively.

The findings of Jeberlin Prabina and Kumar (2010) were in consistence with the present research. They reported, the average weight at sixth week 1935.26, 1993.50, 1992.63, 1679.70 g for T_1 (0 % azolla), T_2 (5 % azolla), T_3 (7.5 % azolla) and T_4 (10 % azolla), respectively.

The findings of present study were in accordance with the results of Dhumal *et al.* (2009) as they observed the body weights at 6^{th} week for treatment groups A 1757.10, B 1845.80 and C 1892.40 g while the control group (A) was fed diet without azolla and group B and C were fed diet with Standard Broiler Mash (SBM) replacement with azolla meal @ 2.5 per cent and 5 per cent, respectively.

Significant increase in weight gain was reported by Alalade and Iyayi (2006) and Alalade *et al.* (2007) for azolla (*Azolla pinnata*) meal in the diets of layers as compared to control.

4.4. Live weight gain

The data on average weekly gain in weight of broiler from first to six th week of age are presented in Table 4.4 and graphically presented in Fig. 3.

As observed in Table 4.4, the average gains in live weight were 383.08, 410.74, 373.30 and 366.36 g for T_0, T_1, T_2 and T_3 treatments, respectively.

Table 4.4: Average weekly gain in body weight (g/bird) of broilers

Treat.	Weeks						Total	Mean
	I	II	III	IV	V	VI		
T_0	79.33	248.13	442.90	452.43	656.10	419.60	2298.49	383.08[b]
T_1	80.93	251.60	449.83	526.17	688.10	467.83	2464.46	410.74[a]
T_2	80.77	245.07	444.17	473.33	579.47	417.00	2239.81	373.30[b]
T_3	79.77	248.03	441.23	444.03	556.23	428.87	2198.16	366.36[b]
S.E.±	22.45	2.23	4.47	5.65	6.80	4.83	46.43	7.74
C.D. at 5%	69.19	6.89	13.78	17.40	20.95	14.88	143.09	23.85

Means having different superscript differed significantly.

The statistical result denoted that average gain in body weight in treatment T_1 (5 % level of azolla meal) was significantly ($P<0.05$) higher over other treatments. The highest gain in body weight was observed in T_1 followed by T_0, T_2 and T_3, treatments, respectively. Treatment T_0, T_2 and T_3 were at par with each other.

The gain in body weights of present investigation were found to be higher than the results of Jeberlin Prabina and Kumar (2010) who observed average weekly weight gain as 322.54 g, 332.25 g, 321.05 g and 279.95 g for treatments 0, 5, 7.5 and 10 per cent, respectively and Alalade *et al.* (2007) reported improved nutritive value of azolla (*Azolla pinnata*) meal in the diets of growing pullets fed 0, 5, 10 and 15 per cent dietary levels of azolla meal and observed weekly body weight gain as 95.02, 101.7, 92.2, and 91.4 g/bird/week, respectively.

The result of present findings were also higher than the reports of Alalade and Iyayi (2006) in average weekly weight gains as 95.43 g, 95.22 g, 98.62 g and 93.44 g for the treatment 0, 5, 10 and 15 per cent of azolla, respectively. Therefore, results of the present study were superior to the earlier reports in average weekly weight gain.

4.5. Feed Conversion Ratio:

Average weekly feed conversion ratio in terms of feed intake per unit weight gain for different groups is presented in Table 4.5 and depicted in fig 4.

The average weekly feed conversion ratio for treatments T_0, T_1, T_2 and T_3 was 1.81, 1.70, 1.82 and 1.84, respectively.

Significantly lower feed conversion ratio was observed in T_1 (5 % azolla) treatment than T_0, T_2 and T_3. The FCR was at par with each other in treatment T_0, T_2 and T_3.

Table 4.5: Average weekly feed conversion ratio

Treatments	Weeks						Mean
	I	II	III	IV	V	VI	
T_0	1.67	1.19	1.26	1.96	1.72	3.06	1.81[b]
T_1	1.64	1.16	1.30	1.72	1.68	2.73	1.70[a]
T_2	1.65	1.24	1.25	1.87	1.95	3.01	1.82[b]
T_3	1.68	1.23	1.27	2.01	1.99	2.90	1.84[b]
S.E.±	0.04	0.03	0.02	0.02	0.03	0.04	0.03
C.D at 5%	0.12	0.08	0.05	0.07	0.08	0.13	0.09

Means having different superscript differed significantly.

Agreement results were reported by Jeberlin Prabina and Kumar (2010). Treatment T_3 (7.5 % azolla) resulted significantly lower FCR of 1.75 followed by 1.81 in T_2 (5 % azolla), whereas poorest feed conversion ratio of 2.00 was observed in T_4 (10 % azolla).

Results of the present investigation were in close agreement with the findings of Dhumal *et al.* (2009) as they replaced diet Standard Broiler Mash (SBM) with azolla meal and observed feed conversion ratio (FCR) as A- 1.95, B -1.93 and C- 1.91 for control, 2.5 per cent and 5 per cent azolla meal and concluded treated groups were better than control.

Though the values of FCR reported by Basak *et al.* (2002) were higher than present investigation, the results were in agreement with present investigation which indicated that with increase in azolla level more than 5 per cent the FCR lowered down. They reported 2.06 and 2.17 FCR for 5 per cent azolla and control group, respectively. But increase in azolla cause poorer FCR i.e. 2.38 for 10 per cent and 2.50 for 15 per cent azolla meal.

4.6. Morbidity and Mortality

There was no incidence of disease, all birds were healthy throughout the research and mean mortality of 2.5 per cent was observed for all treatments. The mortality was recorded as 3.3, 0.0, 3.3 and 3.3 per cent for the treatment groups T_0, T_1, T_2 and T_3, respectively. There was no any mortality in T_1 treatment. But there was death of one bird (i.e. 3.3 %) in each T_0, T_2 and T_3 treatments. The results indicated that supplementation with azolla meal did not affect mortality of broilers.

Similar finding observed by Basak *et al.* (2002) who reported that azolla meal had no any deleterious effects on broiler as well as Castillo *et al.* (1981) also found no toxic effect of dietary azolla on broiler.

4.7. Serum lipid profile

4.7.1. Serum total protein

The average serum total protein values (mg/dl) in different groups are presented in Table 4.6 and graphically presented in Fig.5.

From the data, it was revealed that the values for average serum total protein were 3.84, 3.98, 3.90 and 4.30 (mg/dl) for the treatment T_0, T_1, T_2 and T_3, respectively.

There was significant increase ($P<0.05$) in serum total protein value in treatment T_3 (4.30 mg/dl) than other treatments. Whereas, treatment T_0 (3.84 mg/dl), T_1 (3.98 mg/dl) and T_2 (3.90) recorded lower serum total protein values than T_3 (4.30 mg/dl) and were at par with each other.

Table 4.6: Average Serum protein (mg/dl)

Treatment	Serum Protein (mg/dl)
T_0	3.84^b
T_1	3.98^b
T_2	3.90^b
T_3	4.30^a
S.E.±	0.09
C.D. at 5%	0.27

Means having different superscript differed significantly.

Lanjewar *et al.* (2009) showed the effects of tulsi (*Ocimum tenuiflorum*) on performance of broilers and reported agreement results as the total serum protein was increased in 1.0 per cent tulsi (4.53 mg/dl) than control (4.16 mg/dl) and 0.5 per cent tulsi (4.22 mg/dl) group.

The results of Jaff (2011) showed similar increase in total serum protein due to the effect of coriander (*Coriandrum sativum*) in diet. He reported, total serum protein at 2 per cent (4.62±0.13) was higher than 1 per cent (4.42 ± 0.18), 3 per cent (4.44±0.31) of coriander (*Coriandrum sativum*) and control (4.31±0.18) mg/dl.

Elkhair *et al.* (2014) also observed increment in serum total protein with supplementation of tulsi (*Ocimum tenuiflorum*) @ 1 per cent (4.1 mg/dl) than 0.25 per cent (4.5 mg/dl), 0.50 per cent (5.1 mg/dl) and control (3.9 mg/dl) in broiler diet and Essa *et al.* (2011) and Singh *et al.* (2014) showed similar result of serum total protein when supplemented with coriander and tulsi, respectively.

4.7.2. Serum Glucose

The average serum glucose values (mg/dl) in different groups are presented in Table 4.7 and graphically presented in Fig.6.

From the data, it was revealed that the average serum total glucose as 206.80, 222.40, 242.40 and 150.20 (mg/dl) for the treatments T_0, T_1, T_2 and T_3, respectively.

Table 4.7: Average Serum glucose (mg/dl)

Treatment	Serum Glucose (mg/dl)
T_0	206.80^b
T_1	222.40^b
T_2	242.40^a
T_3	150.20^c
S.E.±	5.93
C.D. at 5%	18.28

Means having different superscript differed significantly.

There was significant reduction ($P<0.05$) in serum glucose values in treatment T_3 (150.20 mg/dl) as compared to other treatments. Treatment T_2 (242.40 mg/dl) showed significantly higher glucose level as compared to other treatments. Treatment T_1 (222.40 mg/dl) and T_0 (206.80 mg/dl) were at par with each other.

There was increase in serum glucose with increase in azolla up to 10 per cent. But when the per cent of azolla meal increased up to 15 per cent the serum glucose level was decreased.

This result was in agreement with reports of Lanjewar *et al.* (2009) who reported a decrease in serum glucose with increase in tulsi (*Ocimum tenuiflorum*) up to 1.0 per cent than control and 0.5 per cent level (170.3mg/dl). Jaff (2011) also observed reduction in serum glucose at 2 per cent (175.00±0.32) than 1 per cent

(185.62±0.82), 3 per cent (178.50±0.21) of coriander and control (187.66±0.46) mg/dl. But Jung (2011) reported similar increment in the serum glucose with increase in supplementation of 0.75 per cent (170.95 mg/dl), 1 per cent (187.35 mg/dl), 1.5 per cent (188.26 mg/dl) and 2 per cent (188.74 mg/dl) of coriander seed in broiler diet while unsupplemented group the value was lower by 171.14 mg/dl.

4.7.3. Haemoglobin

The average haemoglobin values (mg/dl) in different groups are presented in Table 4.8 and graphically presented in Fig.7.

From the data, it was revealed that the haemoglobin was 9.40, 9.78, 10.72, and 10.68 (mg/dl) for the groups T_0, T_1, T_2 and T_3, treatments, respectively. Thus, there was significant increase in haemoglobin values observed in T_2 (10.72 mg/dl) and T_3 (10.68 mg/dl) as compared to control T_0 (9.40 mg/dl) and T_1 (9.78 mg/dl). Treatments T_2 and T_3 were at par with each as well as treatments T_0 and T_1 were at par with each other.

Table 4.8 : Average Haemoglobin (mg/dl)

Treatment	Haemoglobin (mg/dl)
T_0	9.40^b
T_1	9.78^b
T_2	10.72^a
T_3	10.68^a
S.E. ±	0.20
C.D. at 5%	0.63

Means having different superscript differed significantly.

From Table 4.8, it was evident that, the average haemoglobin value increased with increase in azolla in broilers feed

up to 10 per cent level. But it numerically lowered in 15 per cent azolla (T_3) then 10 per cent azolla (T_2).

Similar results were observed in some herbal feeds like ashwagandha (*Withania somnifera*) by Alka (1998) who reported haemoglobin as 10.66, 11.50 and 11.61 mg/dl for 0, 5 and 10 per cent ashwagandha respectively. Similarly Samarth *et al.* (2003) reported significant increase in haemoglobin concentration in group 1.0 per cent ashwagandha (9.71± 0.49 to 11.33 ± 0.35 g/dl) as compared to 0.5 per cent ashwagandha (9.33± 0.37 to 9.79 ± 0.73).

4.8. Dressing percentage

Dressing percentage is based on the relationship between the dressed carcass weight and the live animal weight after things like the hide and internal organs have been removed. Dressing percentage can be calculated by taking (weight of the carcass / weight of live bird) x 100.

The average dressing percent in different groups are presented in Table 4.9 and graphically presented in Fig. 8.

Table 4.9: Dressing percentage of experimental birds

Treatment	Dressing percentage
T_0	72.23^{ab}
T_1	72.47^{a}
T_2	71.89^{b}
T_3	71.93^{b}
S.E. ±	0.11
C.D. at 5%	0.35

Means having different superscript differed significantly.

It was revealed that the dressing percentages were 72.23, 72.47, 71.89 and 71.93 for the T_0, T_1, T_2 and T_3 treatments, respectively.

Significantly higher dressing percentage was observed for treatment T_1 (72.47) and T_0 (72.23) than T_2 (71.89) and T_3 (71.93). This may be due to the higher body weights recorded in T_1 and T_0 treatment than T_2 and T_3 treatments.

The findings of present study were in accordance with results of Basak *et al.* (2002) who observed that treatment T_1 (control), T_2 (5% azolla), T_3 (10% azolla) and T_4 (15% azolla) resulted in 69.38, 72.16, 68.24 and 68.78 per cent dressing, respectively.

The result of Parthasarathy *et al.* (2002) were in accordance with present investigation who observed significantly higher dressing percentage (69.66 %) at 8 weeks of age for 5 per cent azolla meal.

4.9. Carcass weight of experimental birds

The average carcass weight in different groups are presented in Table 4.10 and graphically presented in Fig. 9.

Table 4.10: Carcass weight of broilers

Treatment	Carcass weight (g)
T_0	1891.00 ^{ab}
T_1	1932.20 ^{a}
T_2	1869.80^{b}
T_3	1885.60 ^{b}
S.E. ±	15.00
C.D. at 5%	46.21

Means having different superscript differed significantly

It was revealed that the carcass weight were 1891.00, 1932.20, 1869.80 and 1885.60 g for T_0, T_1, T_2 and T_3 treatments, respectively.

Significantly higher carcass weight was observed for treatment T_1 (1932.20) and T_0 (1891.00) than T_3 (1885.60) and T_2 (1869.80). This may be due to the higher body weights recorded in T_1 and T_0 treatment than T_2 and T_3 treatments.

Denli *et al.* (2003) were reported the similar carcass weight with the effect of feeding dietary antibiotic, probiotic or organic acid. The carcass yield of broiler in which carcass yield for various treatment were reported as in treatment group 1 (Basal diet + no additives (control) 1827±31 g, group 2 (Basal diet +0.1% protexin) 1824±3 g, group 3 (Basal diet +0.2% genex) 1872±31 g, group 4 (Basal diet +0.1% protexin +0.2% genex) 1802±25 g, group 5 (Basal diet + 0.15% flavomycin) 1882±25 g and group 6 (Basal diet + 0.15% flavomycin + 0.2% genex) 1964±51 g, respectively.

Parviz Farhoomand and Ali dadvend (2007) who reported that the carcass weight of broileRs. fed with graded levels of *Saccharomyces cervicia* supplemented diet in which carcass weight varies from treatment 1532±19, 1667.31±17, 1658.31±20 and 1603.44±21 g for treatment S_0, S_1, S_2 and S_3 respectively.

4.10. Cost of broiler production

The cost of production of broiler mainly dependent upon the cost of chicks, feed consumed by birds, medicines and miscellaneous inputs. The cost of broiler production is presented in Table 4.10.

Table 4.11: Cost of broiler production

Sr. No.	Particulars	Treatments			
	A. Variable cost	**T_0**	**T_1**	**T_2**	**T_3**
1	Price of day old chicks (`.)	20	20	20	20
2	Total feed consumption /bird (kg)	4.21	4.34	4.25	4.24
3	Cost of azolla (10 `./kg)	-	2.06	3.86	5.53
4	Average azolla meal consumption/bird (g)	-	206.69	386.4	553.05
5	Average basal feed consumption /bird (kg)	4.21	4.13	3.86	3.60
4	Cost of starter and finisher (30.3 `./kg)	127.56	125.13	116.96	109.08
	Total cost of feed (`.)	**127.56**	**127.19**	**120.82**	**114.61**
5	Misc. expenditure (Medicine, water & labour charges etc.) `.	9.0	9.0	9.0	9.0
	B. Fixed cost				
6	Depreciation on building and implements	1.25	1.25	1.25	1.25
7	Interest on fixed capital(10% of fixed investment)	1.50	1.50	1.50	1.50
	Total fixed cost (B)	**2.75**	**2.75**	**2.75**	**2.75**
	Total cost (A+B) (`.)	**159.31**	**158.94**	**152.57**	**146.36**
	Sales return				
8	Average body weight gain after 42 days (kg)	2.34	2.51	2.29	2.24
9	Average sale price / bird (`.85/kg live wt.)	198.9	213.35	194.65	190.4
10	Poultry manure (3 `./kg)	7.50	7.50	7.50	7.50
	Total return (`.)	**206.4**	**220.85**	**202.15**	**197.9**
	Net profit/bird (`.)	**47.09**	**61.91**	**49.58**	**51.54**
	Per kg profit (`.)	**20.12**	**24.66**	**21.65**	**23.00**

	Benefit: cost (B:C) ratio	**1.29**	**1.38**	**1.32**	**1.35**

The average live weight, average feed consumption, cost per kg feed, cost of chicks, total cost of rearing birds and expenditure on medicines and miscellaneous per bird were considered to find out the economics of broiler production after supplementation of different level of azolla meal.

Table 4.10, it clearly describe the cost of production per bird as `.159.31, `.158.94, `.152.57 and `.146.36, for T_0, T_1, T_2 and T_3, respectively. The cost of production was higher in T_0 followed by T_1, T_2 and T_3 respectively. The benefit: cost ratio of each treatment per bird was 1.29, 1.38, 1.32 and 1.35 for T_0, T_1, T_2 and T_3 treatments, respectively. As the sale return obtained in T_1 treatment were higher due to more gain in body weight, the higher BC ratio obtained in T_1 (5 % azolla) treatment followed by T_3 (15 % azolla), T_2 (10 % azolla) and T_0 (Control).

The net profit per bird was denoted as 47.09, 61.91, 49.58 and 51.54 ` and per kg profit as 20.12, 24.66, 21.65 and 23.00 `. for T_0, T_1, T_2 and T_3, respectively. The total net profit was higher in treatment T_1 (5% azolla) as 61.91 ` than other treatments. Therefore, $T_1$ experimental birds exhibited 14.82 `/bird net profit than control. Net profit was decreased as increase in level of azolla which was due to lower body weight gain with increase cost of azolla meal.

CHAPTER V

SUMMARY AND CONCLUSION

An experiment entitled, “Effect of dietary levels of azolla (*Azolla pinnata*) in broilers” was conducted at the Poultry Unit, College of Agriculture, Dapoli. The objectives of the research trial were to study the chemical composition of experimental feed, growth performance of broiler birds, feed conversion ratio, Haemato-biochemical parameters and economics of the experimental feed.

The feeding treatments were as under,

T_0: Control (Basal feed)

T_1: Basal feed + 5 percent Azolla meal (50 g/ kg of feed)

T_2: Basal feed + 10 per cent Azolla meal (100 g/kg of feed)

T_3: Basal feed + 15 per cent Azolla meal (150 g/kg of feed)

The trial was conducted with 120 day old ‘Vencobb’ broiler chicks, obtained from M/S Venkateshwara Hatchery, Pune. The chicks were from same hatch and were reared under uniform management condition up to six weeks of age. On arrival, the chicks were randomly divided into four treatments each with five replications of thirty chicks in each treatment. All the birds were fed commercial broiler starter diet from 1 to 9 days. After 9 days chicks were fed commercial broiler starter diet + different level of azolla meal up to 21 days. After three weeks chicks were fed commercial broiler finisher diet + different level of azolla meal up to six weeks of age.

The observations were recorded on composition of feed, composition of azolla meal, feed consumption, live weight change, live weight gain, feed conversion ratio, morbidity and mortality, serum lipid profile, dressing percentage and cost of broiler production. The experiment was conducted in RBD (Randomized block design). The data obtained on various parameters were

analyzed and interpreted statistically. The results are summarized here under.

5.1 SUMMARY

5.1.1 Feed composition

The different treatment diets were prepared by mixing the azolla meal as per the treatment. The commercial feed purchased form market was used. The broiler starter and finisher contained 21.28 per cent and 19.34 per cent crude protein, 4.56 per cent and 4.73 per cent crude fat, 65.65 per cent 68.55 per cent NFE, 6.59 per cent and 5.63 per cent crude fibre and 1.92 per cent and 1.75 per cent total ash, respectively.

5.1.2 Azolla meal composition

The azolla meal contained 89.91 per cent dry matter, 21.56 per cent crude protein, 3.37 per cent crude fat, 43.69 per cent NFE, 15.05 per cent crude fibre and 16.33 per cent total ash.

5.2. Feed consumption

The average feed consumption of broiler chicken for a period of six weeks was 713.57 g in T_0, 723.96 g in T_1, 709.84 g in T_2 and 706.01 g in T_3. The feed consumption in treatment T_1 was the highest, Whereas, it was the lowest in treatment T_3.

5.3. Live weight changes

The broiler chicken reached to an average live weight of 2344.20 g in T_0, 2507.37 g in T_1, 2285.50 g in T_2 and 2244.03 g in T_3, at the end of sixth week experimental period. Significant difference was observed in T_1 treatment than other treatments.

5.4. Live weight gain

The average weight gain of broiler was 383.08, 410.74, 373.30 and 366.36 g/bird/week in treatment groups T_0, T_1, T_2 and T_3 respectively. Significant difference was observed in T_1 treatment than other treatments.

5.5. Feed conversion ratio

The average feed conversion ratio for the entire period for groups T_0, T_1, T_2, and T_3 were observed to be 1.81, 1.70, 1.82 and 1.84 respectively. Significant differences are observed among treatments.

5.6. Morbidity and Mortality

The mortality was recorded as 3.3, 0.0, 3.3 and 3.3 per cent for the treatment groups T_0, T_1, T_2, and T_3, respectively. There was no any mortality in T_1 treatment.

5.7. Serum lipid profile

5.7.1. Serum Protein

The average serum total protein was 3.84, 3.98, 3.90 and 4.30 (mg/dl) for the treatment T_0, T_1, T_2 and T_3, respectively. There was significant increase ($P<0.05$) in serum total protein value in treatment T_3 (4.30 mg/dl) than other treatments. Whereas, treatment T_0 (3.84 mg/dl), T_1 (3.98 mg/dl) and T_2 (3.90) were recorded lower serum total protein values than T_3 (4.30 mg/dl) and were at par with each other.

5.7.2. Serum Glucose

The average serum total glucose was 206.80, 222.40, 242.40 and 150.20 (mg/dl) for the treatments T_0, T_1, T_2 and T_3, respectively. There was significant reduction ($P<0.05$) in serum glucose values in treatment T_3 (150.20 mg/dl) as compared to other

treatments. Treatment T_2 (242.40 mg/dl) showed significantly higher glucose level as compared to other treatments. Treatment T_1 (222.40 mg/dl) and T_0 (206.80 mg/dl) were at par with each other.

5.7.3. Haemoglobin

The haemoglobin was 9.40, 9.78, 10.72, and 10.68 (mg/dl) for the groups T_0, T_1, T_2, T_3, treatments, respectively. Thus, there was increase in haemoglobin values observed in T_2 (10.72 mg/dl) and T_3 (10.68 mg/dl) as compared to control T_0 (9.40 mg/dl) and T_1 (9.78 mg/dl). Treatments T_2 and T_3 were at par with each as well as treatments T_0 and T_1 were at par with each other.

5.8. Dressing percentage

The average dressing percentages was 72.23, 72.47, 71.89 and 71.93 for the T_0, T_1, T_2 and T_3 treatments respectively. Significantly higher dressing percentage was observed for treatment for T_1 (72.47) and T_0 (72.23) than T_2 (71.89) and T_3 (71.93). This may be due to the higher body weights recorded in T_1 and T_0 treatment than T_2 and T_3 treatments.

5.9. Carcass weight

The carcass weight was 1891.00, 1932.20, 1869.80 and 1885.60 g for T_0, T_1, T_2 and T_3 treatments, respectively. Significantly higher carcass weight was observed for treatment T_1 (1932.20) and T_0 (1891.00) than T_3 (1885.60) and T_2 (1869.80). This may be due to the higher body weights recorded in T_1 and T_0 treatment than T_2 and T_3 treatments.

5.10. Cost of production

The cost of production per bird was `.159.31, 158.94, 152.57 and 146.56 for $T_0$, $T_1$, $T_2$ and $T_3$, respectively. The net profit per bird was `.47.09, 61.91, 49.58 and 51.54 and per kg profit as `. 20.12,

24.66, 21.65 and 23.00 for T_0, T_1, T_2 and T_3, respectively. The highest net profit was observed in T_1 group fed 5.0 per cent Azolla meal.

5.11. CONCLUSION

Azolla is a good source of protein and may be used up to 5% level in the broiler diet for better performance. Azolla meal is an unconventional feed ingredient at low price and may be used as poultry feed to reduce feed cost. It is observed that broiler bird gains 2.51 kg wt. in 42 days by 5 % using azolla feed. The net profit per bird was observed as `. 61.91 and per kg profit was `. 24.66 for 5 % azolla meal. The higher net profit was observed with 5 % azolla meal incorporation in broilers diet. Thus, results of study indicated that azolla (*Azolla pinnata)* meal at the rate 5 % in diet of broilers could be supplemented to improve growth performance.

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APPENDIX – I

WEEKLY METEOROLOGICAL DATA

Weeks	Temperature (°C)			Relative humidity %	Wind speed (km/hr)	Sunshine (hr)	Rainfall (mm)
	Max.	Min.	Mean temp.				
1st (8.1.15-14.1.15)	30.4	9.6	20	83	2.6	8.3	0
2nd (15.1.15-21.1.15)	30.5	11.7	21.1	87	2.5	7.9	0
3rd (22.1.15-28.1.15)	29.4	14.5	21.95	90	3.4	8.8	0
4th (29.1.15-4.2.15)	32.4	14.1	23.2	89	3.1	7.9	0
5th (5.2.15-11.2.15)	32	12.7	21.3	91	3.1	8.1	0
6th (12.2.15-18.2.15)	33	12	22.5	87	3.2	8.6	0
7th (19.2.15-25.2.15)	33.4	14	23.7	88	3.3	8.8	0

APPENDEX – II
ABBREVIATIONS USED

AOAC	:	Association of Official Analytical chemists
e.g.	:	For example
Temp	:	Temperature
Kg	:	Kilogram
RBD	:	Randomized Block Design
%	:	Per cent
/	:	Per
<	:	Less than
>	:	Greater than
^{0}C	:	Degree Celsius
@	:	At the rate of
C.D.	:	Critical difference
etc.	:	Etcetera (and other things)
Fig.	:	Figure
G	:	Gram
Hr	:	Hour(s)
i.e.	:	Id est (that is)
D. M.	:	Dry matter
CoA	:	oenzyme A
CP	:	Crude Protein
Dl	:	Decilitre
mm	:	Milimeter
HDL	:	High density lipoprotein
HDLC	:	High density lipoprotein cholesterol
LDL	:	Low density lipoprotein
LDLC	:	Low density lipoprotein cholesterol
FCR	:	Feed Conversion Ratio
PRS	:	Poultry Research Station
NFE	:	Nitrogen free extract
nm	:	Nanometer
NS	:	Non-significant
ppm	:	Parts per million
rpm	:	Revolution per minute
mg	:	Miligram
km	:	Kilometer
M	:	Molar
KOH	:	Potassium hydroxide
`	:	Rupees

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Dr. J. S. Dhekale
Title of thesis : Effect of dietary levels of Azolla (*Azolla pinnata*) in broilers.

ABSTRACT

The trial was conducted with 120 day old 'Vencobb' broiler chicks. The birds were from the same hatch and were reared under uniform management condition up to six weeks of age. On arrival, the chicks were weighed individually and randomly divided into four groups of thirty each with five replications. All the birds were fed commercial broiler starter diet from 1 to 9 days. After 9 days chicks were fed commercial broiler starter diet + different level of Azolla meal up to 21 days. After three weeks chicks were fed commercial broiler finisher diet + different level of azolla meal up to six weeks of age treatment groups T_0, T_1, T_2 and T_3 were fed standard broiler starter and finisher diet with Azolla meal the at rate of 0%, 5%, 10% and 15%, respectively.

Results of experiment showed that chicks fed with 5% (T_1) azolla meal had higher ($P<0.05$) feed consumption, live body weight, body weight gain and better ($P<0.05$) feed conversion ratio. There was significant increase ($P<0.05$) in serum total protein value in treatment T_3 (4.30 mg/dl) than other treatments. There was significant reduction ($P<0.05$) in serum glucose values in treatment T_3 (150.20 mg/dl) as compared to other treatments. Thus, there was increase in haemoglobin values observed in T_2 (10.72 mg/dl) and T_3 (10.68 mg/dl) as compared to control T_0 (9.40 mg/dl) and T_1 (9.78 mg/dl). Significantly higher dressing percentage was observed for treatment for T_1 (72.47) and T_0 (72.23) than T_2 (71.89) and T_3 (71.93). Significantly higher carcass weight was observed for treatment T_1 (1932.20 g) and T_0 (1891.00 g) than T_2 (1869.80 g) and T_3 (1885.60). The net profit per bird was `. 47.09, 61.91, 49.58 and 51.54 and per kg profit was `. 20.12, 24.66, 21.65 and 23.00 for T_0, T_1, T_2 and T_3, respectively. The highest net profit was obtained in T_1 group fed 5 per cent Azolla meal.

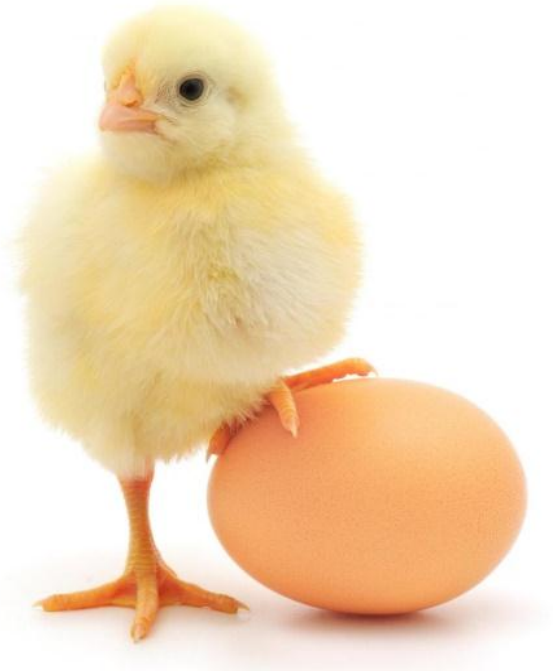
REVIEW OF LITERATURE

MATERIAL AND METHODS

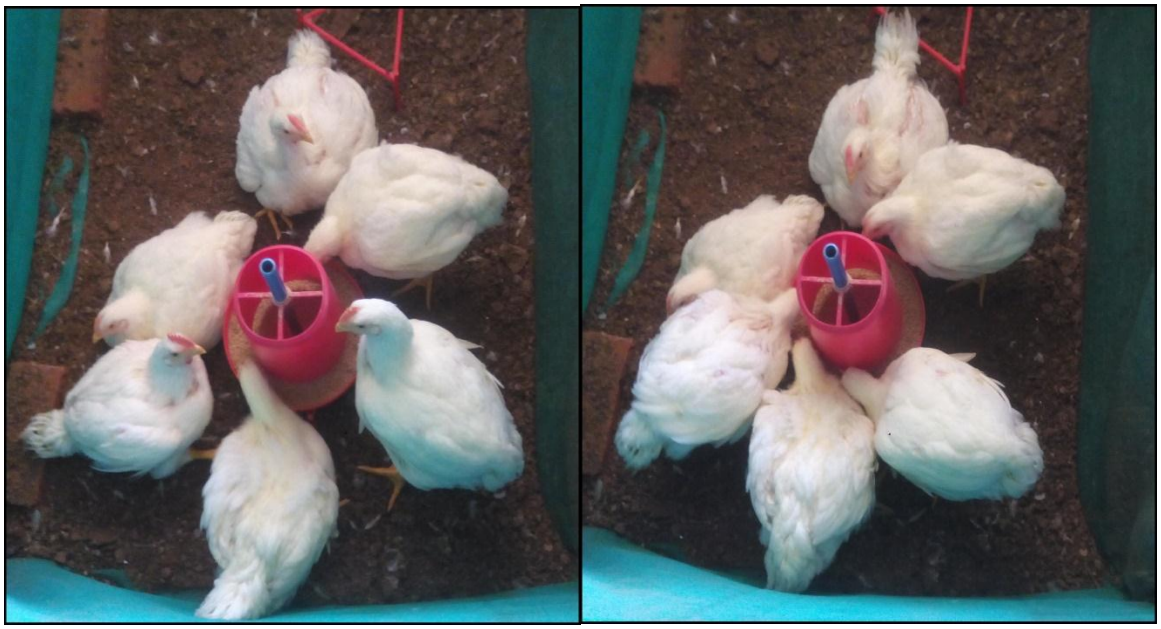
LITERATURE CITED

SUMMARY AND CONCLUSION

RESULTS AND DISCUSSION

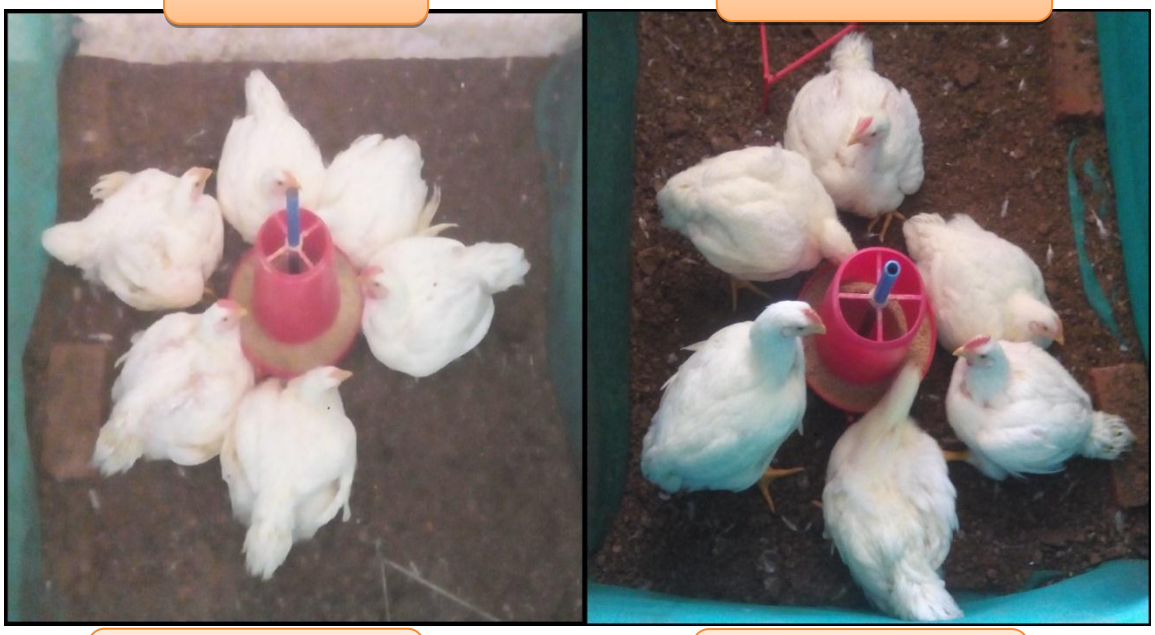


APPENDICES



T_o- Control

T_1- 5 % Azolla



T_2- 10 % Azolla

T_3- 15 % Azolla

Plate 1. Feeding trial of broiler birds

Plate. II Green azolla (*Azolla pinnata*)

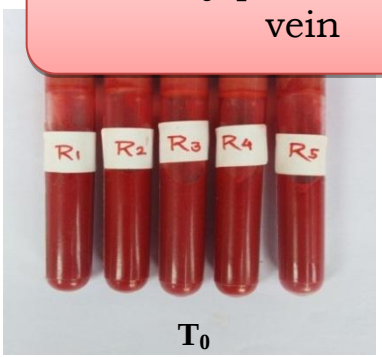
Plate. III Azolla meal (*Azolla pinnata*)

Plate. IV Broiler starter and Broiler finisher

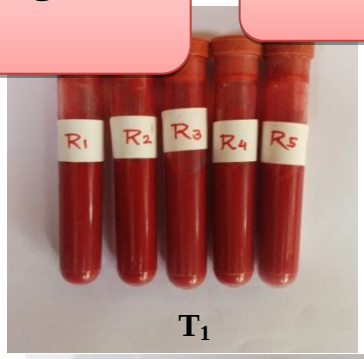
Plate V. Blood collection

Withdrawal of blood from bird by puncturing the vein

Clotting of blood



T_0



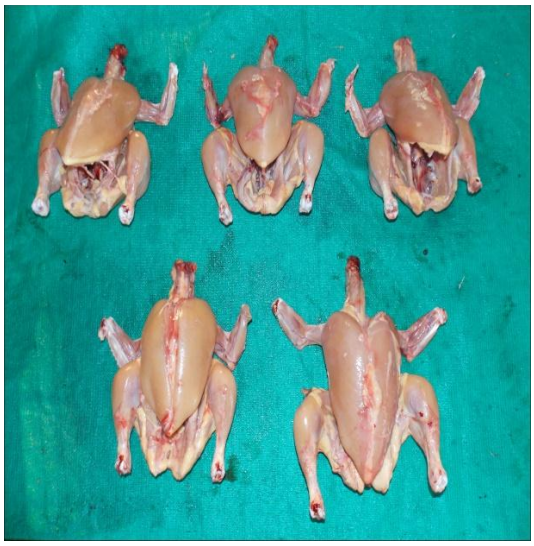
T_1

T_2

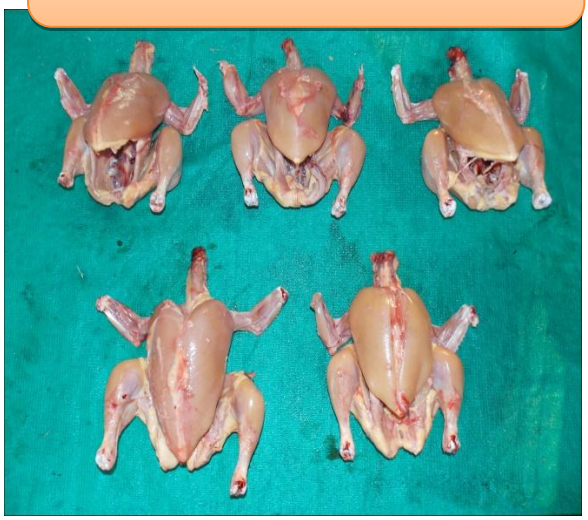
T_3

Blood samples from different treatments

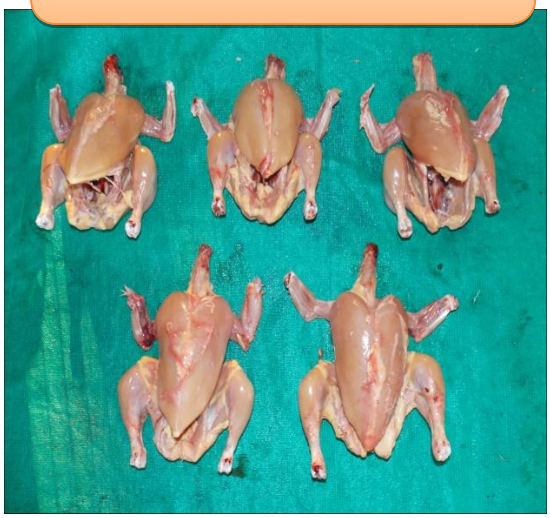
T_0- Control



T_1- 5 % Azolla meal



T_2- 10 % Azolla meal



T_3- 15 % Azolla meal

Plate . VI Carcass quality of broiler birds from different treatment