DIETARY SUPPLEMENTATION OF TURMERIC (*Curcuma longa*) AND TULASI (*Ocimum sanctum*) IN LAYER QUAILS (*Coturnix coturnix*)

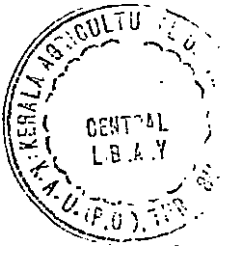
BHADRA. P. V.

Thesis submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2008



Department of Poultry Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

DECLARATION

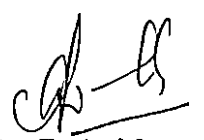
I hereby declare that the thesis entitled **"DIETARY SUPPLEMENTATION OF TURMERIC (*Curcuma longa*) AND TULASI (*Ocimum sanctum*) IN LAYER QUAILS (*Coturnix coturnix*)"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy,

BHADRA P.V.

CERTIFICATE

Certified that this thesis, entitled **"DIETARY SUPPLEMENTATION OF TURMERIC (*Curcuma longa*) AND TULASI (*Ocimum sanctum*) IN LAYER QUAILS (*Coturnix coturnix*)"** is a record of research work done independently by **Bhadra P.V.**, under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.



Dr. P. Anitha,
(Chairperson, Advisory Committee),
Associate Professor,
Department of Poultry Science,
College of Veterinary and
Animal Sciences, Mannuthy.

Mannuthy,
12.08.2008

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Bhadra P.V.**, a candidate for the degree of **Master of Veterinary Science in Poultry Science**, agree that the thesis entitled **"DIETARY SUPPLEMENTATION OF TURMERIC (*Curcuma longa*) AND TULASI (*Ocimum sanctum*) IN LAYER QUAILS (*Coturnix coturnix*)"** may be submitted by **Bhadra P.V.**, in partial fulfilment of the requirement for the degree.

12/08/08

Dr. P. Anitha,
(Chairperson, Advisory Committee)
Associate Professor,
Department of Poultry Science,
College of Veterinary and Animal Sciences, Mannuthy

12/08/08

Dr. A. Jalaludeen,
Director i/c and Head,
Centre for Advanced Studies in
Poultry Science,
College of Veterinary and
Animal Sciences, Mannuthy.
(Member)

12-8-08

Dr. P. A. Peethambaran,
Professor,
Centre for Advanced Studies in
Poultry Science,
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

12/8/08

Dr. P. Gangadevi,
Professor,
Department of Nutrition,
College of Veterinary and Animal sciences,
Mannuthy.
(Member)

7/11/08

External Examiner
(Dr H. N. NARASIMHA MURTHY)

ACKNOWLEDGEMENT

I express my sincere and heartfelt gratitude to the Chairperson of my Advisory Committee, ***Dr. P. Anitha****, Associate Professor, Department of Poultry Science, College of Veterinary & Animal Sciences, Mannuthy. Her meticulous guidance, unstinted support, tremendous patience and help rendered in all possible ways, which was the major factor that led me to accomplish this task. Her constant guidance and encouragement, even in her tight schedule of time were instrumental in the completion of this study.*

I am greatly indebted to ***Dr. A. Jalaludeen,*** *Director i/c and Head, Department of Poultry Science for his inspiring advices, professional guidance, personal attention, timely help, pleasant co-operation and affection rendered to me for the completion of my work.*

I owe my profound gratitude to ***Dr. P.A. Peethambaran,*** *Professor, Department of Poultry Science and wish to put on record my heartfelt thanks to him for the valuable suggestions, keen interest, supervision of the work from time to time rendered throughout my postgraduate study.*

I humbly place on record my respect and gratitude to ***Dr. P. Gangadevi,*** *Professor, Department of Nutrition as one of the Advisory committee members for her valuable suggestions during the tenure of work.*

No words or deeds are sufficient to express my gratitude to ***Dr. Amritha Viswanath,*** *Professor and* ***Dr. Deepa Menon,*** *Assistant Professor, Department of Poultry Science,* ***Dr. K. Narayanankutty,*** *Senior Scientist and* ***Dr.Richard Churchill,*** *Associate Professor, AICRP on Poultry for Eggs, and* ***Dr. K. Karthyayini,*** *Associate Professor, Department of Veterinary Physiology for their affectionate encouragement, incessant support and valuable advice throughout the course of this work.*

I extend my heart felt thanks to ***Dr. Leo Joseph,*** *Professor and Head, University Poultry Farm for his pleasant co-operation.*

I am cordially obliged to ***Dr.C.R. Lalithakunjamma,*** *Professor and Head, Department of Veterinary Pathology for her generous encouragement, inspiration, kindness and timely help extended to me.*

I am grateful to ***the Dean,*** *College of Veterinary and Animal Sciences, Mannuthy, Kerala for the generous provision of facilities for my research work.*

I am in short of words to acknowledge ***Smt.K.S. Sujatha,*** *Associate Professor & Head, Department of Statistics, for the help rendered in statistical analysis.*

I do express my sincere thanks to ***Dr.P.R. Chandrasekharan,*** *Instrumentation Engineer, for his eagerness to help at all times. The dedication shown by him in the upkeep of the instruments is indeed commendable.*

Special thanks to ***Dr. Binoj Chacko, Dr. Muneer and Dr. Kishore Kumar*** for the *wholehearted support rendered to me.*

With great fondness I acknowledge the sincere helping hand extended to me y colleagues, ***Drs. Girish, Chandini, Shamna and Balaji,*** *without whose tireless help, unconditional support and pleasant co-operation the successful completion of this research work would not have been possible.*

Let me thank whole heartedly my dear freinds ***Drs. Nimmy A.George, Deepa Mary and Savitha*** *for their support and friendship extended to me during the study.*

I cherish the spirit of understanding, invaluable help and pleasant co-operation rendered to me by beloved friends and classmates, ***Drs. Manjula, Midhun, , Rani, Jini, Princemon, Luveena, Rajeswari, Sandhya, Rekha*** *and* ***Raji*** *and other post graduate friends.*

I express my sincere gratitude to my seniors ***Drs. Preethymol Joseph, Simi, Preeta Raghavan, Lekshmy, Sheena*** *and* ***Raseena Karim*** *for their valuable suggestions and moral support.*

I warmly remember and acknowledge my Juniors ***Drs. Nimila Joseph, Suraj*** *and* ***Arunima*** *for their help rendered and cooperation during the course of study.*

I am thankful to the staff members of our department ***Mrs. Vilasini, Mr. Rafi, Mr.Rajesh, Mrs. Rema, Mrs. Ramany, Ms.Indhu*** *and* ***Ms. Deepthy*** *for their timely help.*

I would like to acknowledge the moral support and sustained encouragement extended by my ***in laws.***

With the limits of lexicon, I express my deep sense of gratitude to my beloved husband ***Prasanth*** *for his constant encouragement, understanding, support, love and prayers and bearing with me in all inconveniences.*

No phrase or words in any language can ever express my deep sense of love and gratitude to my beloved ***Father, Mother, Brother, Sister in law and Abhijith*** *for their moral support and encouragement during the study.*

Above all I bow before ***"God the Almighty"*** *for all the innumerable blessings showered upon me.....*

Bhadra P.V.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

1. INTRODUCTION

Poultry farming is a profitable venture and it provides huge employment opportunity to a large section of the society. It is one of the fastest growing segments of Indian agriculture. This sector has indeed become a potential tool to fight against poverty and malnutrition. India is the fifth largest producer of eggs in the world with a total production of 40 billion eggs per year. However, the per capita availability is only 40 eggs which is far below the level of 180 eggs recommended by the Nutritional Advisory Committee, Govt. of India (FAO, 2004-2005). In this context, boosting the egg production from other avian species like quails offers vast scope for bridging this wide gap between demand and supply.

At present, quails occupy the third largest position among poultry species next to chicken and duck, in India. Owing to small size, rapid growth, early onset of egg production, less capital outlay and quick returns, the commercial quail farming has become popular. The consumption of quail eggs and meat has also increased considerably. Japanese quail eggs and meat are renowned for being rich in vitamins, essential amino acids, unsaturated fatty acids and phospholipids, which are vital for human physical and mental development. Quail eggs and meat can be included in the diet of children, pregnant mothers and geriatric and convalescent patients. Egg is the best vehicle to incorporate several health promoting components in an acceptable form to mankind.

Supplementation of herbal products in poultry feed not only promote bird health but also the health of consumers. Herbs and spices are valuable in adding flavour to foods. In addition to its flavouring property, spices and condiments in poultry products will improve human health because of its antioxidant, antimicrobial and anti inflammatory properties

Turmeric *(Curcuma longa)* is extensively used as a spice, colouring material and food preservative in India and other Asian countries. The main bioactive component of turmeric, curcumin, is yellow in color and has wide spectrum of biological actions in the body. These include anti inflammatory, antioxidant, anticarcinogenic, antimicrobial, immunomodulatory, hypotensive and hypocholesterolemic activities. The hypolipidaemic and hypocholesterolemic properties of turmeric are advantageous in broilers (Simi, 2007). Tulasi *(Ocimum sanctum)*, an important sacred medicinal herb in India, possess remarkable biological activities like antimicrobial, immunomodulatory, anticancerous, antioxidant, anti inflammatory, hepatoprotective and cardioprotective (Gupta *et al.*, 2002). The leaves of *Ocimum sanctum* contain water soluble phenolic compounds and other constituents such as eugenol, methyl eugenol and caryophyllene that act as potential immunostimulant (Chopra *et al.*, 1956). The use of tulasi leaves for herbal enrichment of designer eggs has proved their cholesterol lowering effect in serum and egg yolk of laying hens (Narahari *et al.*, 2005).

Although several studies have been carried out for exploring the various biological activities of *Curcuma longa* and *Ocimum sanctum* in fowls, little studies have been conducted to evaluate their effect on production performance in quails. Therefore in the present study, an attempt was made to evaluate the effects of dietary supplementation of dried turmeric and tulasi on the production performance of layer Japanese quails and to assess the effect of these herbs on the physiological profile of the laying quails.

Review of Literature

2. REVIEW OF LITERATURE

2.1 BIOLOGICAL FUNCTIONS OF TURMERIC AND TULASI

Curcumin (diferuloylmethane), the main yellow bioactive component of turmeric and eugenol, methyl eugenol and caryophylline, the major constituents of tulasi possess a wide spectrum of biological actions. The antimicrobial, antioxidant, immunomodulatory, hypolipidaemic and hypocholesteremic activities of turmeric and tulasi are reviewed in this chapter. Safety evaluation studies indicate that both turmeric and tulasi are well tolerated at a very high level dose without any toxic effects. Studies on herbal supplementation of diets in quails appears to be scanty. Therefore literature available on various nutritional studies in quails are also reviewed below.

Negi *et al.* (1999) extracted the oil from *Curcuma longa* and tested the fractions of the hexane extract for antibacterial activity and found that fraction II was the most effective against *Bacillus cereus, B. coagulans, B. subtilis, Staphylococcus aureus, Eisherichia coli* and *Pseudomonas aeuruginosa.*

Kurkure *et al.* (2000) investigated the ameliorative effect of turmeric at the rate of 0.5 g/kg feed in induced aflatoxicosis in cockerels. It was observed that humoral immune status adjudged by HI titre against Newcastle disease virus and cell mediated immune response assessed by contact sensitivity test proved the potential of turmeric to moderately reduce immune toxicity due to dietary aflatoxin B_1 and concluded that population of lymphocytes in lymphoid organs were slightly restored by turmeric.

Logambal *et al.* (2000) studied the immunostimulatory effect of leaf extract of *Ocimum sanctum* in fish (*Oreochromis mossambicus*) against *Aeromonas hydrophila.* The results showed that the leaf extracts of *Ocimum sanctum* when administered intraperitoneally and orally enhanced the antibody response.

Rath *et al.* (2002) investigated the antimicrobial activities of six essential oils against certain gram positive and gram negative organisms and reported that turmeric was effective against *Escherichia coli, Salmonella typhimurium, Shigella boydic, Bacillus cereus* and *Pseudomonas aeuroginosa* .

Perumal *et al.* (2004) studied the antifungal activity of nine traditional medicinal plants against *Aspergillus flavus, A terreus* and *Mucor sp.* It was seen that *Curcuma longa* was the most effective against *Mucor sp* and exhibited significant activity against *Aspergillus flavus.*

Akinyemi *et al.* (2005) investigated the antibacterial activity of ethanol and water extracts of *Ocimum grattissimum* against Methicillin resistant *Staphylococcus aureus* (MRSA). They found greater antibacterial activity in the ethanol extract of the plant than the water extracts.

Narahari *et al.* (2005) conducted a study by feeding standard designer feed with 0.5 per cent Basil leaves, Garlic pearls, Fenugreek seeds, Bay leaves each and 0.1 per cent Spirulina in 30 weeks old layers to assess the antioxidant and immunomodulating properties of herbal enriched eggs for a period of twelve weeks. They concluded that Basil leaves had the antioxidant property next to Garlic and Bay leaves. They also reported the powerful immunomodulating effect of Basil leaves.

Abbas *et al.* (2007) evaluated comparative efficacy of turmeric crude powder and salinomycin sodium on the occurance of coccidiosis in broilers. They observed coccidiostatic effect in birds supplemented with turmeric at 3.0 per cent.

Emadi and Kermanshahi (2007) studied the effect of turmeric rhizome powder on performance of broiler chicken and observed the immunity response. They reported that inclusion of turmeric rhizome powder in the diet at the level of 0.25 and 0.50 per cent increased immunoglobulin M and G.

Mbata and Saikia (2007) extracted essential oil from *Ocimum grattissimum* and investigated antibacterial activity against *Listeria monocytogens* serotype 4a at a concentration of 20 to 250 microgram/ml.

2.2 METEOROLOGICAL OBSERVATIONS

Somanathan (1980) reported a maximum temperature ranging from 31.14 to 35.14°C, minimum temperature ranging from 21.15 to 25.80°C and average relative humidity (R.H.) ranging from 58.49 to 84.39 per cent during the period from January to June in the years 1974 to 1978 at the Meteorological observatory unit, Mannuthy. The measurements were taken at latitude of 10° 32" N, longitude of 76° 16" E and altitude of 22.25 m above MSL for 5 years and average values were reported.

Narayanankutty (1987) observed a maximum temperature of 32.2°C, minimum temperature of 28.9°C and R.H. of 56 to 68 per cent inside the experimental house at Mannuthy during January to February 1987, when an experiment was carried out in Japanese quails.

Padmakumar (1993) noticed maximum temperatures of 33.4, 36.18 and 32.74°C inside the experimental house during the periods of Dec-Jan, Apr-May and May-Jun, respectively at Mannuthy. The minimum temperatures were 20.90, 24.64 and 24.42 °C in the respective periods. The R.H. in the F.N. was 74.8, 81.2 and 87.8 per cent and in the A.N. was 35.6, 48.2 and 65.2 per cent in the respective periods, when an experiment was carried out in Japanese quails.

Sheena (2005) reported a maximum temperature of 34.2°C, minimum temperature of 23.3°C, R.H. of 78.1 per cent at 8 a.m. and 43.5 per cent at 2 p.m. inside the experimental house at Mannuthy during Dec 2004 to May 2005, when an experiment was carried out in Japanese quails.

Preethymol (2006) noted a maximum temperature of 37.07 °C, minimum temperature of 22.91 °C, R.H. of 91.43 per cent at 8 a.m. and 53.25 per cent at 2

p.m. inside the experimental house at Mannuthy during January to June 2006, when an experiment was carried out in Japanese quails.

2.3 BODY WEIGHT AND BODY WEIGHT GAIN

Sachdev and Ahuja (1986) reported that egg line Japanese quails having a body weight of 181 to 200 g at 6 weeks of age produced 206 eggs, while those with 161-181 g body weight produced only 172 eggs upto 50 weeks of age.

Shrivastav *et al.* (1993) reported a body weight gain of 18.8 g in female breeder Japanese quails in 100 days of production fed a ration having 22 per cent CP and 2750 kcal ME per kg.

Ozbey *et al.* (2004a) reported that broiler Japanese quails reared under a constant temperature of 35^0C had a body weight of 167.78 g at 6 weeks of age, while those reared under 18 to 24^0C had 177.61 g body weight.

Lekshmi (2005), while carrying out an experiment on the utilization of dried cuttle fish waste silage in Japanese quail layer ration reported that the mean body weight of layer quails at 6 weeks of age was ranging from 159.67 to160.05 g and at 26 weeks of age from 199.43 to 204.77 g with gain in body weight in the range of 38.85 to 44.73 g among the dietary groups.

Sheena (2005) carried out an experiment to study the effect of dietary supplementation of protease in Japanese quail layer ration containing 22 per cent CP and 2650 kcal per kg ME. The mean body weight recorded among the dietary groups was in range of 166.96 to 174.50 g at 6 weeks of age and 196.20 to 205.16 g at 26 weeks of age with weight gain varying from 27.73 to 36.06 g.

Preethymol (2006) evaluated the effect of dietary supplementation of lysine and methionine on the production performance of layer Japanese quails from 6 to 26 weeks of age and recorded a mean body weight of 180.0 g at 6 weeks of age and 225.83 g at 26 weeks of age with a body weight gain of 45.83 g in control group.

Raseena (2006) could not observe any significant difference in body weight gain of layer Japanese quails fed diet containing different levels of azolla from 6 to 26 weeks of age. The mean body weight recorded at 6 weeks of age among the dietary groups was ranging from 185.01 to186.56 g and that at 26 weeks of age was ranging from 220.52 to 223.31 g.

Gupta and Charan (2007) studied the growth promoting activity in two week old broiler chicken by supplementing *Ocimum sanctum* at the rate of 100, 200, 300, 400, 500 and 600 mg/bird respectively for a period of 15 days. They observed maximum body weight gain in birds fed with 200mg of dried *Ocimum sanctum* leaf powder.

In an experiment to evaluate the utilisation of dried fish waste and fermented fish waste silage in Japanese quail layer ration having 22 per cent CP and 2650 kcal per kg ME, Preeta (2007) found mean body weight gain of 23.78 g in control group and 25.53 g in group fed with dried fish waste from 6 to 26 weeks of age without any significant difference between groups.

2.4 AGE AT SEXUAL MATURITY (ASM)

Sachdev and Ahuja (1986) observed that egg line Japanese quails having a body weight of 161 to 180 g at 6 weeks of age reached sexual maturity at 78 days of age, while those with 181 to 200 g body weight reached sexual maturity at 66 days of age with an average age at sexual maturity of 73.18 days.

Padmakumar (1993) reported that the age at first egg was 55 days and age at 50 per cent production was 72 days for Japanese quails reared on 250 cm^2 floor space in cage and fed a ration with 22.9 per cent CP.

Sreenivasaiah (1998) stated that Japanese quails start egg production by the end of sixth week and reach peak production of 90 per cent by 15 weeks of age.

Lekshmi (2005) reported that the average age at first egg was 46.25 days and mean age at 50 per cent production was 71.75 days in layer quails fed with diet containing fish waste silage at the level of 17 per cent from 6 to 26 weeks of age.

Sheena (2005) conducted an experiment to evaluate the effect of dietary supplementation of protease on the production performance of layer Japanese quails and opined that the quails having mean body weight of 172.24 g attained sexual maturity at an average age of 47 days with 50 per cent production at 58 days of age.

Preethymol (2006) observed that layer Japanese quails reared on ration containing 27 per cent CP from 0 to 3 weeks and 24 per cent CP from 4 to 5 weeks with an average body weight of 180 g at 6 weeks of age attained sexual maturity at 42 days and 50 per cent production at 51 days of age.

Raseena (2006) concluded that in layer Japanese quails with a mean body weight of 185.23 g at 6 weeks of age, the average age at first egg, 10 per cent and 50 per cent egg production were 42, 43 and 47 days respectively while feeding with a ration having 22 per cent CP and 2650 kcal ME.

Preeta (2007) reported that the average age at first egg, 10 per cent and 50 per cent production in Japanese layer quails having a mean body weight of 189.37 g at 6 weeks of age were 42.50, 44.50, and 50.00 days, respectively when fed a ration with 22 per cent CP and 2650 kcal ME.

2.5 EGG PRODUCTION

While assessing the protein requirement of female breeder Japanese quails using purified diet, Johri and Vohra (1977) reported that quails fed diet having 20.3 per cent CP and 2690 kcal ME had a quail day egg production of 62.6 per cent for a period of 44 days starting from 50 per cent production, which reduced

to 60 per cent when the CP and ME increased to 24 per cent and 2700 kcal per kg respectively.

Yamane *et al.* (1979) reported quail day egg production of 83.6 per cent on feeding a diet with 19.2 per cent CP for a period of 45 days (90 to 135 days of age) and a quail day production of 88.8 per cent when CP content of diet increased to 23.2 per cent.

Arscott and Goeger (1981) reported that the average egg production of Japanese quails fed with a ration having 21 per cent protein for a period of 40 weeks was 66.5 per cent, and those fed with a ration containing 15 per cent protein was 51.13 per cent.

Ross and Dominy (1990) conducted a study to assess dietary inclusion of spirulina at levels of 0, 1.5, 3.0, 6.0 and 12 per cent from 9 to 31 weeks of age in layer Japanese quails. The quail housed egg production ranged from 75.9 to 88.6 per cent among the experimental group without any significant difference.

Soares *et al.* (2003) reported that Japanese quail layers fed a diet having 22 per cent CP, 1.203 per cent lysine and 0.679 per cent methionine plus cystine from 7 to 14 weeks of age had 76.7 per cent egg production.

Lekshmi (2005) reported quail housed egg number of 90.32 and quail housed percentage of 64.4 from 6 to 26 weeks of age in control group fed with a ration containing 22 per cent CP and 2650 kcal ME while evaluating utilization of dried cuttle fish waste silage in layer Japanese quail. Increasing level of cuttle fish in the diet reduced egg production.

Sheena (2005) reported cumulative quail housed number per quail ranging from 60.38 to 80.80 with corresponding percentage ranging from 43.13 to 57.71 in dietary groups while assessing the effect of protease supplementation in layer quails for a period of 6 to 26 weeks of age.

Preethymol (2006) evaluated the effect of dietary supplementation of lysine and methionine in production performance of layer Japanese quails from 7 to 26 weeks of age and reported cumulative QHN and QDN of 110.36 and 112.70 with corresponding percentages of 78.83 and 80.50 in control group which were statistically similar with the treatment groups.

Raseena (2006) studied the effects of dietary inclusion of azolla at different levels in production performance of Japanese quails from 7 to 26 weeks of age and reported cumulative QHN varying from 112.18 to 120.00 among dietary groups.

In a study on the utilization of dried fish waste and fermented fish waste silage in layer Japanese quails from 7 to 26 weeks of age, Preeta (2007) reported maximum quail housed number and percentage as 91.74 and 65.53, respectively in quails fed with dried fish waste.

2.6 EGG WEIGHT

Johri and Vohra (1977) reported an average egg weight of 9.0 g in Japanese quail breeder hens fed with a diet containing 20.3 per cent CP and 2690 kcal ME for 44 days and egg weight of 8.9 g in those fed with a ration having 24 per cent CP and 2700 kcal per kg ME.

Egg weight of layer Japanese quails fed a ration with 21 per cent protein ranged from 9.6 to 9.8 g and a ration with 15 per cent protein produced eggs weighing 8.9 to 9.2 g, which were statistically comparable (Arscott and Goeger, 1981).

Ross and Dominy (1990) used nine week old Japanese quails to study the effects of 0, 1.5, 3.0, 6.0 and 12 per cent dietary inclusion of spirulina and reported mean egg weight of 10.89 and 10.96 g in 1.5 and 3.0 per cent spirulina inclusion groups respectively which were significantly ($p<0.05$) lower than 12.00 per cent inclusion..

Shrivastav *et al.* (1993) found that breeding Japanese quails had a mean egg weight of 10.28 g in 100 days of production when fed a diet having 22 per cent CP, 2750 kcal ME per kg, 1 per cent lysine and 0.7 per cent methionine plus cystine.

Shukla *et al.* (1993) examined the effect of dietary supplementation of zinc on egg production and egg quality characteristics of Japanese quail and found that the quails fed with a diet having 21 per cent CP and 2728 kcal per kg ME had the average egg weight of 11.56g from 7 to 19 weeks of age.

Sreenivasaiah (1998) stated that Japanese quails lay eggs weighing on an average of 10 g ranging from 6.4 to 13.8 g.

Japanese quail layers fed with a diet having 22 per cent CP, 1.203 per cent lysine and 0.679 per cent methionine plus cystine from 7 to 14 weeks of age had an average egg weight of 9.32 g (Soares *et al.,* 2003).

Lekshmi (2005) reported the average egg weight ranging from 10.73 to 10.81 g in dietary groups while assessing utilization of dried cuttle fish waste silage in Japanese quail layer ration and showed no significant difference in egg weight among the dietary groups.

In a study on the supplementation of protease on production performance of Japanese quail layers fed low protein diet from 6 to 26 weeks of age, Sheena (2005) reported mean egg weight varying from 10.40 to 11.14 g among dietary groups without significant difference.

Preethymol (2006) observed an average egg weight of 11.17g by feeding layer Japanese quails with a ration containing 22 per cent CP and 2650 kcal per kg ME.

In a study conducted by Raseena (2006) on the effect of dietary inclusion of azolla at different levels in layer Japanese quails, recorded an average egg

weight of 11.27g in the control group from 7 to 26 weeks of age which was significantly lower than the azolla fed groups.

Thiruvengadam *et al.* (2006) conducted a study in 68 weeks old laying hens to assess the production performance by feeding standard designer feed with 0.3 per cent tulasi, 0.1 per cent turmeric, 0.3 per cent keelanelli and a combination of 0.1 per cent tulasi and keelanelli each and 0.03 per cent turmeric. They observed that egg weight was not significantly affected by supplementing turmeric or tulasi.

Preeta (2007) reported an average egg weight of 11.91 g when layer quails were fed with a ration containing 22 per cent CP and 2650 kcal ME from 7 to 26 weeks of age.

Yalcin *et al.* (2007) conducted a study on the effects of dietary garlic powder on production performance in nine week old layer Japanese quails for a period of 21 weeks. They concluded that garlic powder at the rate of 0.5 and 1.0 per cent increased egg weight by 0.19 and 0.12 g respectively.

2.7 EGG MASS

In a study conducted by Shukla *et al.* (1993) on the effect of dietary supplementation of zinc on production characteristics in layer Japanese quails found that the total egg mass per quail was 782.8 g from 7 to 19 weeks of age in quails fed with a diet having 21 per cent CP and 2728 kcal ME per kg.

Preethymol (2006) reported that cumulative egg mass per quail from 7 to 26 weeks of age was 1259.1 g when fed with a ration having 22 per cent CP and 2650 kcal ME per kg and the egg mass increased to 1283.8 g when ration supplemented with 0.25 per cent methionine.

2.8 FEED CONSUMPTION

Maurice and Jensen (1978) observed that Japanese quails fed a diet having 23.2 per cent CP and 11.32 MJ ME per kg from 20 to 26 weeks of age had a daily feed consumption of 26.7 g per quail. When a ration with 12.17 MJ ME per kg was fed from 8 to 16 weeks of age, the feed consumption was 25.2 g.

Layer Japanese quails fed a casein-soyabean diet containing 16 per cent protein and 2969 kcal ME per kg showed feed consumption of about 22 g per quail per day (Allen and Young, 1980).

Arscott and Goeger (1981) reported that the average daily feed consumption varied from 21 to 22 g for Japanese quails fed a ration with 21 per cent CP and 19 to 21 g for those fed a ration with 15 per cent protein.

Ross and Dominy (1990) conducted experiment in nine weeks old Japanese quails to study the effects of dietary inclusion of spirulina from 9 to 31 weeks and reported that daily feed consumption per quail was varying from 23.3 to 24.9 g among the dietary groups.

Padmakumar (1993) reported an average daily feed consumption of 22.8 g in Japanese quails from 6 to 30 weeks of age when reared in cages.

Shukla *et al.* (1993) found that the feed consumption was 27.7 g per day in Japanese quails fed a diet having 21 per cent CP and 2728 kcal ME from 7 to 19 weeks of age.

Sreenivasaiah (1998) stated that Japanese quails consume 25 to 28 g feed per bird per day during production period.

Al-Sultan (2003) investigated the effect of turmeric in a basal diet supplemented with 0.25, 0.5 and 1.0 per cent levels in broiler chicken during a five weeks experimental period. Feed intake among the treatment groups

differed significantly and the highest feed intake was noticed in the group fed 1.0 per cent turmeric, followed by those fed 0.25 and 0.5 per cent levels.

The feed intake of Japanese quail layers was 23 g per bird per day when fed diet having 22 per cent CP from 42 to 98 days of age (Soares *et al.*, 2003).

Lekshmi (2005) reported that the average feed consumption was varied from 27.02 to 29 g per quail per day from 6 to 26 weeks of age in Japanese quail layers while assessing utilization of dried cuttle fish waste silage in the diet having 22 per cent CP and 2650 kcal per kg ME. Mean feed consumption was significantly higher in control group compared to other groups.

Sheena (2005) reported that the average feed consumption ranged from 28.48 to 29.41 g per quail per day from 6 to 26 weeks of age, in Japanese quail layers and could not observe any significant difference in feed consumption due to protease supplementation.

Durrani *et al.* (2006) investigated the effect of turmeric at 0.25, 0.5 and 1.0 per cent on overall performance of broiler chicken. They observed that in the starter phase and finisher phase the feed consumption in birds fed 0.5 per cent turmeric was significantly lower when compared to the other groups.

Preethymol (2006) observed an average feed consumption of 30.67 g per quail per day in control group from 7 to 26 weeks of age, while evaluating the effect of dietary supplementation of lysine and methionine on production performance in layer Japanese quails.

Raseena (2006) reported the mean feed consumption ranging from 28.35 to 30.05 g per quail per day from 7 to 26 weeks of age in layer Japanese quail and could not observe any significant difference in feed consumption due to dietary inclusion of azolla.

In an experiment to evaluate the utilisation of dried fish waste and fermented fish waste silage in Japanese quail layer ration, Preeta (2007) found an

average feed consumption of 30.89 g in control group from 7 to 26 weeks of age which was significantly lower compared to the other dietary groups.

Yalcin *et al.* (2007) conducted a study to assess the effect of dietary garlic powder on production performance in nine weeks old layer Japanese quails for a period of 21 weeks and reported an the average feed intake of 34.50 g per bird in control group. They could not observe any significant difference due to the addition of garlic powder to the experimental diet.

2.9 FEED CONVERSION RATIO (FCR)

Arscott and Goeger (1981) reported that Japanese quails fed a ration with 21 per cent protein required 373g of feed per dozen eggs while those fed a ration with 15 per cent protein required 448 g.

Ross and Dominy (1990) used nine weeks old Japanese quails to study the effects of 0, 1.5, 3.0, 6.0 and 12.0 per cent dietary inclusion of spirulina from 9 to 31 weeks of age. There was no significant difference in feed efficiency as determined by the amount of feed consumed per gram of egg produced (3.16, 2.95, 3.33, 2.77, 3.06 g/g, respectively).

Shrivastav *et al.* (1993) found that breeding Japanese quails had a feed efficiency of 4.272 kg per kg egg mass for 100 days of production when fed a diet with 22 per cent CP and 2750 kcal ME per kg.

Shukla *et al.* (1993) found that the FCR per kg egg mass was 2.98 in Japanese quails fed a diet with 21 per cent CP, 1.1 per cent lysine and 0.5 per cent methionine from 7 to 19 weeks of age.

Sreenivasaiah (1998) stated that layer Japanese quails have an average feed efficiency of 3.8 on egg mass basis and feed efficiency of 3.3 during maximum production period.

Japanese quail layers showed an average FCR of 0.44 per dozen eggs when fed a diet having 22 per cent CP and 2650 ME from 42 to 98 days of age (Soares *et al.*, 2003).

Lekshmi (2005), while carrying out an experiment on the utilization of dried cuttle fish waste silage in Japanese quail layer ration reported that the mean feed efficiency of layer quails from 6 to 26 weeks of age was ranging from 0.53 to 0.61 per dozen eggs among treatment groups.

While carrying out an experiment to study the effect of supplementation of protease in Japanese quail layer ration, Sheena (2005) recorded a mean feed efficiency of 0.57 per dozen eggs from 6 to 26 weeks of age in control group and could not observe any significant difference in FCR due to protease supplementation.

Preethymol (2006) reported an average feed efficiency of 0.48 per dozen eggs and 3.44 per kg egg mass from 7 to 26 weeks of age in layer Japanese quail while assessing the effect of dietary supplementation of lysine and methionine on production performance.

Raseena (2006) could not observe any significant difference in mean feed efficiency of layer Japanese quails fed diet containing different levels of azolla from 7 to 26 weeks of age. The mean feed efficiency recorded among the dietary groups was in the range of 0.41 to 0.45 per dozen eggs and 3.02 to 3.11 per kg eggs.

In an experiment to evaluate the utilisation of dried fish waste and fermented fish waste silage in Japanese quail layer ration having 22 per cent CP and 2650 kcal ME per kg, Preeta (2007) observed an average feed efficiency of 0.61 per dozen eggs from 7 to 26 weeks of age in control group without any significant difference between treatment groups.

2.10 HAEMATOLOGICAL PARAMETERS

Soni *et al.* (1992) investigated the effect of turmeric and curcumin in reversing the aflatoxin induced liver damage produced in ducklings for a period of 14 days. The results of the studies on haematological parameters indicated that the total leucocyte count and haemoglobin level did not differ significantly in the ducklings due to the dietary inclusion of turmeric or curcumin.

Narahari *et al.* (2005) conducted a study in 30 week old layers to assess the health promoting properties of herbal enriched eggs for a period of twelve weeks and reported that there was significant increase in total leucocyte count and haemoglobin by supplementing 0.5 per cent Basil leaves in the feed.

Gupta and Charan (2007) studied the growth promoting activity in two week old broiler chicken for a period of 15 days by supplementing *Ocimum sanctum* at the rate of 100, 200, 300, 400, 500 and 600 mg/bird. The results on haematological parameters indicated that the Hb, TEC and TLC did not differ significantly due to the supplementation of *Ocimum sanctum* at any level.

While conducting an experiment on the effect of dietary supplementation of turmeric at different levels on production performance in broilers for a period of 6 weeks, Simi (2007) observed that there was significant ($P<0.05$) increase in haemoglobin level and total leucocyte count in birds fed with 0.6 per cent turmeric.

2.11 SERUM PROTEIN AND CHOLESTEROL

Narayanankutty (1987) reported that the serum protein level in layer Japanese quail was 5.87 g/dl at 6 weeks of age when fed a ration having 24 per cent CP and 2700 kcal per kg ME .

Majumdar *et al.* (1996) found that the serum cholesterol level in cage reared meat line female broiler quails ranged from 351.16 to 387.12 mg per 100 ml.

Kurkure *et al.* (2001) studied the effect of dietary turmeric treatment to counteract aflatoxin induced haematological and biochemical alterations in broiler chicks. It was observed that value of serum total proteins was improved in aflatoxin plus turmeric (0.5 per cent) fed group, indicating restorative effect of turmeric during aflatoxicosis.

Ozbey *et al.* (2004b) reported that Japanese quails reared at a constant temperature of 35°C up to 14 weeks of age had a serum total protein level of 4.39 g/dl while it was significantly higher (5.06 g/dl) at temperature of 18 to 24°C. The total serum cholesterol at 18 to 24°C was 212.04 mg/dl and it increased significantly to 219.08 mg/dl at 35°C.

Sheena (2005) reported a serum protein level of 5.51 g per cent in layer Japanese quails at 26 weeks of age.

In a study on the effect of dietary supplementation of lysine and methionine in layer Japanese quails, Preethymol (2006) reported serum total protein and cholesterol levels of 6.83 g per cent and 190.33 mg per cent, respectively at 26 weeks of age.

Raseena (2006) reported 3.29 g per cent serum protein and 167.62 mg per cent serum cholesterol at 26 weeks of age in layer Japanese quails fed a ration with different levels of azolla and observed that serum cholesterol decreasing with increasing levels of azolla.

Simi (2007) studied the effect of dietary supplementation of different levels of turmeric on serum total cholesterol and total protein in six weeks old broilers and reported that the total cholesterol in the birds fed with 0.6 per cent turmeric was significantly lower compared to other groups and total protein did not differ significantly.

Yalcin *et al.* (2007) conducted a study on the effects of dietary garlic powder on serum cholesterol in nine week old layer Japanese quails for a period

of 21 weeks. They concluded that garlic powder at the rate of 0.5 and 1.0 per cent in layer quail ration decreased serum cholesterol from 32.67 to 27.74 mg/dl respectively.

2.12 EGG YOLK CHOLESTEROL

Vorlova *et al.* (2001) found that in laying hens the cholesterol content of eggs were lowest at the beginning of the lay period and showed peak values at 30th week. There after a mild decrease followed by no changes till the end of lay.

Narahari *et al.* (2005) assessed the cholesterol reducing property of herbal enriched eggs in laying hens. They concluded that 0.5 per cent Basil leaves found to be more effective in reducing yolk cholesterol levels.

Thiruvengadam *et al.* (2006) conducted a study by feeding standard designer feed with 0.3 per cent tulasi, 0.1 per cent turmeric, 0.3 per cent keelanelli and a combination of 0.1, 0.03 and 0.1 per cent tulasi, turmeric and keelanelli respectively in 68 weeks old laying hens to assess the cholesterol reducing property of herbal enriched eggs. They concluded that yolk cholesterol was reduced by all herbal enriched designer feeds, especially the combination of herbs.

Yalcin *et al.* (2007) studied the egg yolk cholesterol content in the eggs by dietary supplemention of garlic powder in nine weeks old layer Japanese quails for a period of 21 weeks. They found that garlic powder at the rate of 0.5 and 1.0 per cent in layer quail ration decreased egg cholesterol from 3.09 to 2.50 mg/g yolk respectively.

2.13 PROCESSING YEILDS AND LOSSES

Pandey *et al.* (1979) reported that 5-weeks old Japanese quails fasted for 12 hours had 87.17 per cent dressed weight, 65.97 per cent eviscerated weight, 5.66 per cent giblet, 2.51 per cent blood, 5.68 per cent feather and 19.66 per cent inedible portions.

Singh *et al.* (1980) noticed 93 per cent dressed yield, 65 per cent eviscerated yield and 6.1 per cent giblet yield for 8-week-old female Japanese quails.

Choudhary and Mahadevan (1983) observed that female Japanese quails lost 4.29 per cent blood and 10.5 per cent feather on slaughter at 8 weeks of age and had a dressing per cent of 86.36 and eviscerated yield of 58.0 per cent excluding giblet yield.

Narayanankutty (1987) reported that 6 weeks old Japanese quails fed a diet with 24 per cent CP and 2700 Kcal ME per kg had 4.65 per cent blood loss, 6.95 per cent feather, 88.4 per cent dressed yield, 70.74 per cent eviscerated yield, 7.3 per cent giblet and 78.04 per cent R-to-C yield.

Mandal *et al.* (1993) observed 3.6 per cent blood loss, 6.81 per cent giblet yield and 56.43 per cent eviscerated weight when 8-weeks old female Japanese quails were skin dressed.

Mishra *et al.* (1993) found an eviscerated yield of 70.1 per cent at 5 weeks of age in combined sex Japanese quails fed a starter diet with 24 per cent protein .The per cent eviscerated yield was 71.2 in those fed diet having 27 per cent CP.

Ozbey *et al.* (2004a) reported that broiler Japanese quails of 6 weeks of age had a carcass yield of 65.0 to 69.0 per cent.

Preethymol (2006) reported that six weeks old Japanese quails supplemented with lysine and methionine had 3.74 per cent blood loss, 85.78 per cent dressed yield, 5.55 per cent giblet and 60.34 per cent R-to-C yield.

Raseena (2006) reported that six weeks old Japanese quails included with various levels of azolla in the diet with 22 per cent CP and 2650 kcal ME per kg had 83.09 per cent dressed yield, 4.60 per cent giblet and 58.07 per cent R-to-C yield.

Simi (2007) studied the processing yields and losses in six weeks old broiler supplemented with various levels of turmeric and reported 84.24, 67.32, 5.31 & 11.73 per cent dressed yield , eviscerated yield, giblet yield and feather loss respectively.

2.14 LIVABILITY

Arscott and Goeger (1981) reported that the Japanese quails fed a ration with 21 per cent CP, the cumulative mortality varied from 26.7 to 43.3 per cent in 40-weeks period, while feeding a ration with 15 per cent CP, resulted in cumulative mortality varying from 30 to 40 per cent.

Padmakumar (1993) found that livability of Japanese quails ranged from 93.75 to 100 per cent for 28 day periods from 6 to 30 weeks of age when reared on 250 cm^2 floor space and fed a ration with 22.9 per cent CP.

Lekshmi (2005) reported a livability of 93.75 per cent from 6 to 26 weeks of age in Japanese quail layers while assessing utilization of dried cuttle fish waste silage in quail layer ration.

Sheena (2005) reported a livability of 90 per cent from 6 to 26 weeks of age in Japanese quail layers while conducting an experiment to study the effect of supplementation of protease in quail layer ration.

Simi (2007) studied the effect of dietary supplementation of turmeric on production performance of broiler chickens for a period of 6 weeks. The results of the study demonstrated that the livability was 100 per cent in the dietary groups.

Durrani *et al.* (2006) conducted a trial on the effect of turmeric on performance of broiler chicks for a period of five weeks by supplementing 0.25, 0.5 and 1.0 per cent turmeric in the diet. The results of the experiment demonstrated that the mortality at the end of fifth week was 1 per cent for the dietary group fed 1.0 per cent turmeric.

2.15 ECONOMICS

Padmakumar (1993) recorded a return of Rs. 11.66 per quail from 5 to 50 weeks of age on rearing Japanese quails provided with 250 cm^2 floor space when the sale price of egg was 40 Paise and feed cost was Rs. 6.5 per kg.

Lekshmi (2005) reported that on an average 44.92 g feed was required to produce one egg in Japanese quails from 6 to 26 weeks of age and obtained a profit of 29.08 Paise per egg when the cost of feed was Rs. 9.11 per kg and sale price was 70 Paise per egg.

Sheena (2005) observed that Japanese quails required on an average 47.68 g feed to produce one egg from 6 to 26 weeks of age and the feed cost per egg was Rs. 0.46 at the rate of Rs. 9.55 per kg feed.

Materials and Methods

3. MATERIALS AND METHODS

An experiment was carried out in the Department of Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, to study the effect of dietary supplementation of dried turmeric rhizome and tulasi leaves on production performance and biochemical profile in layer Japanese quails. The experiment was carried out during the period from 29th December 2007 to 16th May 2008.

3.1 EXPERIMENTAL MATERIALS

3.1.1 Birds

One hundred and sixty (160) Japanese quails at the age of five weeks procured from University Poultry Farm, Mannuthy were utilized for the study.

3.1.2 Rations

A control ration for layer quails was formulated with 22 per cent crude protein and 2650 kcal metabolizable energy per kg diet and was supplemented with dried turmeric rhizome and tulasi leaves as detailed below and that formed the experimental rations.

T_1 -- Control diet (quail layer diet) containing 22 per cent crude protein, 2650 kcal metabolizable energy per kg feed

T_2 -- Control diet supplemented with 0.3 per cent dried turmeric rhizome powder.

T_3 -- Control diet supplemented with 0.3 per cent dried tulasi leaves.

T4 -- Control diet supplemented with 0.3 per cent each of dried turmeric and tulasi leaves.

3.1.3 Chemical Analysis

The per cent ingredient composition of the experimental ration is given in Table 1 and the proximate composition of the ration estimated according to AOAC (1990) is presented in Table 2.

Table 1. Per cent ingredient composition of experimental rations

Ingredient	Layer diet
Maize	54.60
Soyabean meal	31.50
Unsalted dried fish	6.00
Dicalcium phosphate	1.05
Calcite	6.60
Salt	0.25
Total	100.00
Added per100 kg feed	
Merivite (g)[1]	10
Nicomix (g)[2]	10
DL-Methionine (g)[3]	25
UTPP (g)[4]	100
Choline chloride (g)[5]	100
E care Se (g)[6]	10
Tefroli (g)[7]	25
Trace Mineral Mix(Tm-6) (g)[8]	130

Note:

1. Merivite: A+B2+D3+K (Wockhardt Ltd, Mumbai) Composition per gram: Vitamin A: 82,500 IU, Vitamin B2: 52 mg, Vitamin D3: 12000 IU, Vitamin K: 10 mg, Calcium: 166 mg, Phosphate: 395 mg
2. Vitamin mixture: Nicomix BE-DS (Nicholas Primal India Ltd., Mumbai) Composition per gram: Vitamin B1: 8 mg, Vitamin B6: 16 mg, Vitamin B12: 80 mcg, Niacin: 120 mg, Calcium pantothenate: 80 mg, Vitamin E: 80 mg, Folic acid: 8 mg.
3. DL-Methionine: Methionine supplement contains 99 per cent Methionine
4. UTPP-5 Powder (Tetragon Chemic Pvt. Ltd., Bangalore) containing treated Aluminosilicates, Propionates, Formates and Acetates.
5. Bio choline Containing Choline chloride 50% (Indian Herbs Research and Supply Co. Ltd. U.P).
6. E care Se Super forte (Tetragon Chemic Pvt. Ltd., Bangalore): Each kg contains Vitamin E: 500 g, Selenium 1000 mg.
7. Tefroli powder herbal feed supplement (ttk health care).
8. Trace mineral mixture: Tm-6
   Composition per kg: Cobalt: 1g, Iodine: 2g, Copper: 2g, Iron: 20g, Zinc: 52 mg, Manganese: 55 g.

Table 2. Chemical composition of experimental ration on dry matter basis, per cent

Sl.No:	Parameters	Per cent
	Analysed values	
1	Dry matter	90.30
2	Crude protein	22.10
3	Ether extract	2.01
4	Crude fibre	3.28
5	Nitrogen free extract	61.61
6	Total ash	10.60
7	Acid insoluble ash	2.30
8	Calcium	3.20
9	Phosphorus	0.44
	Calculated values	
1	ME (kcal/kg)	2650.80
2	Lysine (%)	1.25
3	Methionine (%)	0.38

3.1.4 Preparation of Turmeric and Tulasi

Fresh turmeric rhizomes were procured, cleaned and washed in luke warm water. Water was drained out and it was dried under direct sunlight for proper drying. When rhizomes were fully dried, it was ground as fine powder.

Fresh tulasi leaves were collected and cleaned thoroughly. It was then dried under shade. When it was fully dried the leaves were finely powdered.

3.2 EXPERIMENTAL DESIGN

3.2.1 Housing of Quails

The quails in each replicate were housed in cages having a dimension of 60 x 60 x 25 cm. The cage house, cages, feeders and water troughs were thoroughly cleaned and disinfected one week prior to housing. The quails were housed in cages at five weeks of age for cage adaptation.

3.2.2 Experimental Layout

The experiment was conducted during the laying phase of Japanese quails from six to twenty six weeks of age. At six weeks of age, one hundred and sixty Japanese quail pullets were weighed individually and distributed randomly to four treatment groups of 40 each with four replicates of ten birds in each group. The observations were recorded for five periods of 28- days each, during the 20 weeks of experiment.

3.2.3 Management

The quails were provided with feed and water *ad libitum* throughout the experimental period. Standard managemental procedures were adopted identically to all treatment groups during the entire period of experiment.

3.2.4 Meteorological Parameters inside the Experimental House

The dry bulb and wet bulb readings were taken at 9 a.m. and 2 p.m. daily. The maximum and minimum temperatures were recorded daily during the experimental period. From these data period wise maximum and minimum temperature and per cent relative humidity were arrived.

3.2.5 Body Weight

Individual body weights of all birds were recorded at the end of sixth and twenty sixth week of age to study the pattern of body weight gain in different dietary groups.

3.2.6 Age at Sexual Maturity

The age at first egg, 10 and 50 per cent production (days) were recorded in each replicate and from this data mean age at first egg, age at 10 and 50 per cent production were arrived at.

3.2.7 Egg Production

Egg production was recorded daily from seven to twenty six weeks of age in each replicate and expressed as quail housed and quail day egg production.

3.2.8 Egg Weight

All the eggs laid by the quails among the treatment groups were collected for three consecutive days at the end of each 28-day laying period and weighed individually with 0.01g accuracy. Based on these data period wise mean egg weight was worked out in each replicate.

3.2.9 Egg Mass

Replicate wise egg mass was recorded daily and egg mass per quail was calculated for each 28-day period.

3.2.10 Feed Consumption

Feed intake of birds was recorded replicate wise for each 28-day period. From these data, the mean daily feed intake per bird for each period was calculated in all treatment groups.

3.2.11 Feed Conversion Ratio (FCR)

Feed consumed per dozen eggs and per kilogram of egg mass were calculated replicate wise during each period.

3.2.12 Blood parameters

At the end of experiment, two birds in each replicate were selected randomly and blood samples were collected at the time of slaughter by severing the jugular vein for the estimation of haematological and serum biochemical parameters. The Total Erythrocyte Count (TEC) and Total Leucocyte Count (TLC) were estimated by the method suggested by Natt and Herrick (1952). The concentration of Haemoglobin (Hb) was estimated by Ferrihaeme hydrochloride method described by Sastri (1998). The serum total protein was estimated by modified Biuret method and serum total cholesterol by CHOD-PAP method.

3.2.13 Egg yolk cholesterol

At twenty sixth week of age two eggs were randomly collected from each replicate. The yolk lipids were extracted by the method suggested by Washburn and Nix (1974). Yolk cholesterol concentration was estimated by utilizing the cholesterol estimation kit supplied by Agappe Diagnostic Pvt.Ltd. 'Agappe Hills', Ernakulam, Kerala, India - 683562.

3.2.14 Processing yields and losses

At the end of 26 weeks of age two quails from each replicate were selected randomly, fasted overnight giving drinking water *ad libitum* and slaughtered to study the processing yields and losses. The per cent loss due to bleeding and feather loss was worked out over the live weight. The per cent dressed yield, eviscerated yield, and the giblet and the ready to cook (R-to-C) yields were determined in each quail and the mean values in each treatment group was worked out.

3.3 LIVABILITY

The period wise per cent livability was recorded based on the number of birds alive in each period after recording the mortality of birds from different treatment groups. Post mortem examination was conducted in each case to find out cause of death.

3.4 ECONOMICS

Economics of egg production by incorporating dried turmeric rhizome and tulasi leaves in layer diet of Japanese quail was calculated taking into account of prevailing cost of the feed ingredients and quail eggs during the study period.

3.5 STATISTICAL ANALYSIS

Data collected on various parameters were statistically analysed by Completely Randomised Design (CRD) as described by Snedecor and Cochran (1994).

Results

4. RESULTS

The results of the experiment carried out to study the effect of dietary supplementation of dried turmeric rhizome and tulasi leaves on production performance in layer Japanese quails are presented in this chapter.

4.1 METEOROLOGICAL OBSERVATIONS

The mean maximum and minimum temperature (^{0}C) and the mean per cent relative humidity (R.H) in the F.N and A.N. inside the experimental house at 28 days interval from December 2007 to May 2008 are presented in Table 3. The maximum temperature averaged 30.50, 30.91, 33.48, 32.75 and 33.04°C in periods I, II, III, IV and V, respectively with an overall mean of 32.14°C. In the above periods, the minimum temperature averaged 24.91, 26.11, 26.89, 27.40 and 27.66°C with an overall mean of 26.59°C during the entire period of experiment.

During experimental period, the mean maximum temperature was the lowest in period I (30.50 ^{0}C) and the highest in period III (33.48^{0}C) and the difference between these values was 2.98°C. The mean minimum temperature was the lowest in period I (24.91°C) and reached the highest (27.66°C) in period V.

The relative humidity averaged 66.50, 76.21, 73.07, 83.50 and 90.64 in the forenoon and 50.93, 59.42, 51.11, 69.61 and 74.42 in the afternoon in periods I, II, III, IV and V, respectively. The overall mean relative humidity from 7 to 26 weeks of age was 77.98 per cent in the forenoon and 61.09 per cent in the afternoon.

4.2 BODY WEIGHT

Data on mean body weight of quails at 6 and 26 weeks of age among different dietary treatments viz., control quail layer ration (T1), quail layer ration supplemented with 0.3 per cent dried turmeric (T2), quail layer ration

Table 3. Mean maximum and minimum temperature (^{0}C) and per cent R.H. inside the experimental house during the period from December 2007 to May 2008

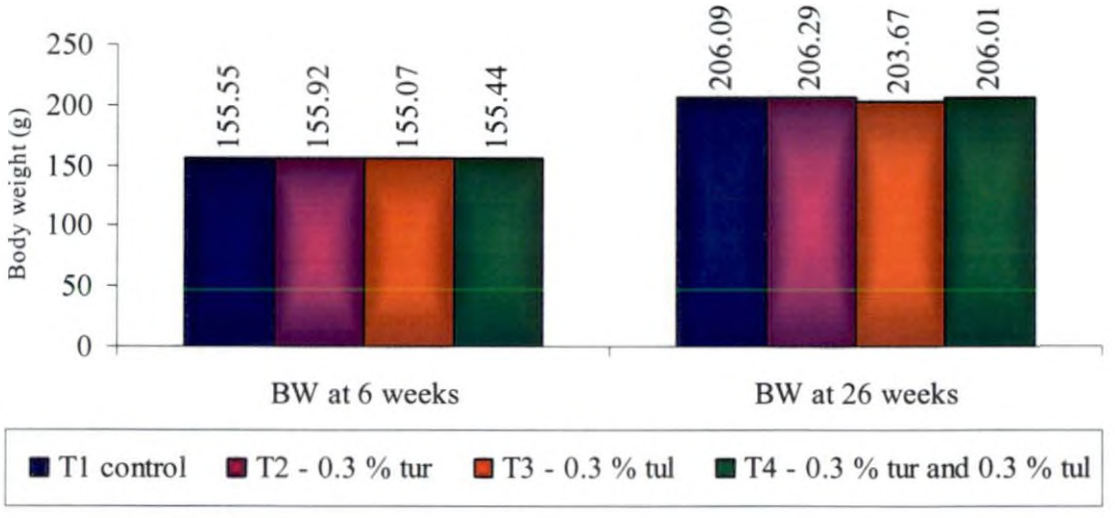
Periods	Age in weeks	Temperature (^{0}C)		Relative Humidity (%)	
		Maximum	Minimum	F.N.	A.N.
I : Dec 29 – Jan 25	7-10	30.50	24.91	66.50	50.93
II : Jan 26 – Feb 22	11-14	30.91	26.11	76.21	59.42
III : Feb 23 – Mar 21	15-18	33.48	26.89	73.07	51.11
IV: Mar 22 – Apr 18	19-22	32.75	27.40	83.50	69.61
V: Apr 19 – May 16	23-26	33.04	27.66	90.64	74.42
Overall mean	7-26	32.14	26.59	77.98	61.09

Table 4. Mean body weight and body weight gain as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 6 and 26 weeks of age

Age in weeks	Dietary supplementation of turmeric (Tur) and tulasi (Tul) levels (%)			
	T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
6	155.55 ± 4.40	155.92 ± 2.38	155.07 ± 4.08	155.44 ± 3.14
26	206.09 ± 2.05	206.29 ±3.67	203.67 ± 4.34	206.01 ± 3.96
Gain in BW (g)	50.55 ± 2.67	50.37 ± 1.66	50.30 ± 2.10	50.57 ± 2.17

Non significant

Fig.1 Body weights (g) at 6th and 26th week of layer quails affected by turmeric and tulasi supplementation in the diet



supplemented with 0.3 per cent dried tulasi (T3) and quail layer ration supplemented with combination of turmeric and tulasi each at 0.3 per cent levels are presented in Table 4 and graphically depicted in figure 1.

At sixth week of age, the body weight was almost uniform among the treatments T1, T2, T3 and T4 and the mean values were 155.55, 155.92, 155.07 and 155.44 g, respectively. The corresponding values at 26 weeks of age were 206.09, 206.29, 203.67 and 206.01 g. Statistical analysis of the data did not reveal significant difference between treatment groups at the beginning and at the end of the experiment.

The mean body weight gain during the experimental period among the different treatment groups T1, T2, T3 and T4 were 50.55, 50.37, 50.30 and 50.57 g respectively and the values were statistically comparable.

4.3 AGE AT FIRST EGG AND 10 AND 50 PER CENT PRODUCTION

The data on mean age at first egg, age at 10 and 50 per cent production as influenced by the dietary supplementation of dried turmeric and tulasi are presented in Table 5.

The age at first egg in the dietary groups T1, T2, T3 and T4 were 48, 50, 49 and 49, respectively. The mean age at first egg and 10 per cent production were same in the treatment groups and the values in T1, T2, T3 and T4 were 48.75, 51.00, 50.50 and 49.75 days, respectively. Whereas, the age at 50 per cent production was 55.50, 56.25, 55.75 and 56.00 days in the groups T1, T2, T3 and T4, respectively.

4.4 EGG PRODUCTION

4.4.1 Period-wise Egg Production

4.4.1.2 Period wise Quail Housed Number (QHN)

The data on mean quail housed number in each period from I to V calculated based on the number of quails housed at the beginning of that period

Table 5. Mean age at first egg (AFE), 10 and 50 per cent production (days) as influenced by dietary supplementation of dried turmeric and tulasi in experimental diets

Parameter	Treatments			
	T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
Age at first egg in the flock (days)	48	50	49	49
Mean age at first egg and 10 per cent production (days)	48.75 ±0.48	51.00 ± 0.41	50.50 ± 1.19	49.75 ± 0.48
Age at 50 per cent production (days)	55.50 ± 0.96	56.25 ± 0.48	55.75 ± 0.25	56.00 ± 0.41

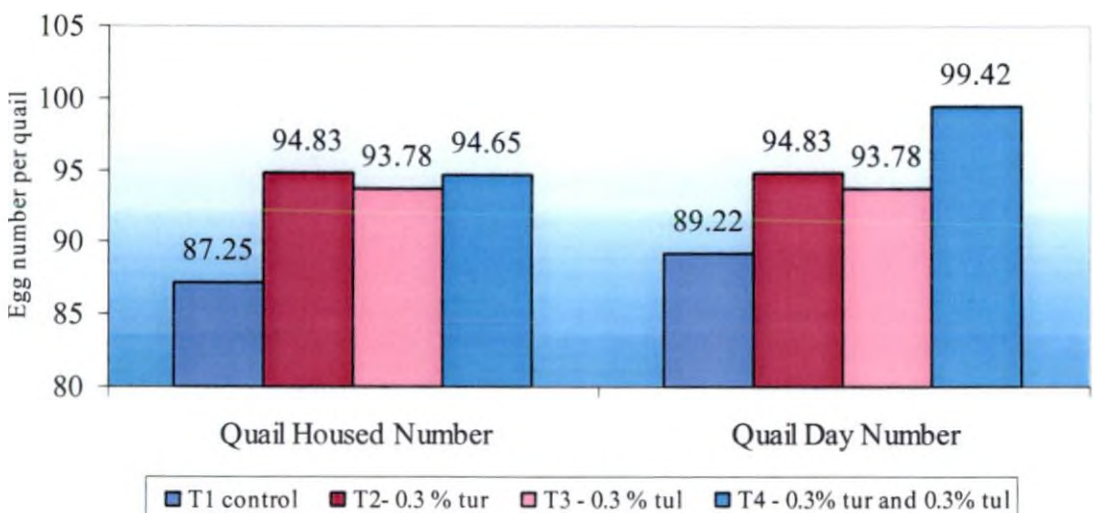
Non significant

Table 6. Period wise mean Quail Housed Number (QHN) of eggs as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Quails Housed Number (QHN)			
		T1 Control	**T2** Tur-0.3%	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
I	7-10	13.30 ± 0.93	12.68 ± 0.68	11.53 ± 0.78	12.65 ± 0.76
II	11-14	21.41 ± 0.56	22.55 ± 0.94	21.15 ± 0.96	23.84 ± 0.90
III	15-18	18.05 ± 0.61	19.63 ± 1.06	19.18 ± 0.78	20.89 ± 1.33
IV	19-22	18.54 ± 1.09	19.93 ± 1.50	20.85 ± 0.36	21.15 ± 1.51
V	23-26	17.68 ± 0.93	20.05 ± 1.49	21.08 ± 1.09	20.63 ± 0.87
Cumulative QHN	7-26	87.25 ± 3.62	94.83 ± 3.64	93.78 ± 1.59	94.65 ± 3.23

Non significant

Fig.2 Cumulative quail housed egg number and quail day egg number from 7 to 26 weeks of age influenced by turmeric (Tur) and tulasi (Tul) supplementation in quail layer diet



and the cumulative mean egg production during the entire period of the experiment from 7 to 26 weeks of age in various dietary groups are presented as quail housed egg number (QHN) in Table 6 and graphically depicted in figure 2.

The cumulative mean egg production per quail during the entire period from 7 to 26 weeks of age was 87.25, 94.83, 93.78, and 94.65 in groups T1, T2, T3 and T4, respectively. Highest QHN (94.83) was obtained in turmeric fed group (T2) and lowest (87.25) in control group T1.

In the control group T1, the egg production per quail in 28-day period from 7 to 10 weeks of age averaged 13.30 eggs and increased to 21.41 eggs in period II at 11 to 14 weeks of age registering peak production in this group (T1). The mean egg production was declined to 18.05 eggs in period III at 15 to 18 weeks of age. Then mean egg production was slightly increased to 18.54 eggs in period IV at 19 to 22 weeks of age and QHN declined to 17.68 eggs in period V at 23 to 26 weeks of age.

In the dietary group T2 supplemented with 0.3 per cent turmeric, the QHN averaged 12.68, 22.55, 19.63, 19.93 and 20.05 in periods I, II, III, IV and V, respectively showing highest mean yield in the period II at 11 to 14 weeks of age. In the dietary group T3 supplemented with 0.3 per cent tulasi, QHN averaged 11.53, 21.15, 19.18, 20.85, and 21.08 in periods I, II, III, IV and V, respectively showing the highest mean yield in period II. In the dietary group T4 supplemented with turmeric and tulasi each at 0.3 per cent level, the period wise QHN averaged 12.65, 23.84, 20.89, 21.15 and 20.63 in periods I, II, III, IV and V, respectively showing the highest egg production in period II. Statistical analysis of the period wise and the cumulative QHN revealed no significant difference due to dietary treatments.

4.4.1.3 Quail Housed Per cent (QHP) Egg Production

The data on period wise quail housed egg production based on the number of quails housed at beginning of each period from 7 to 26 weeks of age expressed

Table 7. Period wise mean Quail Housed Per cent (QHP) production as influenced by dietary supplementation of dried turmeric and tulasi in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Quail Housed Per cent (QHP)			
		T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
I	7-10	47.50 ± 3.32	45.20 ± 2.42	41.16 ± 2.79	45.18 ± 2.73
II	11-14	76.46 ± 1.99	80.54 ± 3.37	75.54 ± 3.41	85.16 ± 3.21
III	15-18	64.46 ± 2.18	70.09 ± 3.78	68.48 ± 2.77	74.63 ± 4.76
IV	19-22	66.20 ± 3.90	71.16 ± 5.37	74.47 ± 1.29	75.54 ± 5.38
V	23-26	63.13 ± 3.31	71.61 ± 5.33	75.28 ± 3.90	73.51 ± 2.96
Cumulative QHP	7-26	62.32 ± 2.58	67.73 ± 2.60	66.95 ± 1.15	67.61 ± 2.30

Non significant

as quail housed per cent (QHP) in various dietary treatments are presented in Table 7.

The mean quail housed per cent (QHP) production in control group T1 which was 47.50 per cent in period I increased to 76.46 per cent in period II and registered the peak yield in the control group. Thereafter, the QHP decreased to 64.46 per cent in period III and further increased to 66.20 per cent in period IV and declined to 63.13 per cent in period V.

In group T2 supplemented with 0.3 per cent turmeric, QHP was 45.20 per cent in period I, increased to 80.54 per cent showing the peak yield in period II, indicating a higher peak than that of control group. The egg production was declined to 70.09 per cent in the period III and showed slight increase to 71.16 per cent in period IV and 71.61 per cent in period V.

In the dietary group T3 supplemented with 0.3 per cent tulasi, the QHP averaged 41.16, 75.54, 68.48, 74.47 and 75.28 per cent in periods I, II, III, IV and V, respectively showing peak production in period II (75.54 per cent).

In the dietary groupT4 supplemented with the combination of turmeric and tulasi each at 0.3 percent level, QHP averaged 45.18, 85.16, 74.63, 75.54 and 73.51 per cent in periods I, II, III, IV and V, respectively showing peak production in period II (85.16 per cent) which was the highest period wise yield among all the groups.

The cumulative mean per cent quail housed egg production from 7 to 26 weeks of age was 62.32, 67.73, 66.95 and 67.61 for the treatment groups T1, T2, T3 and T4,respectively. Statistical analysis of the period wise and cumulative per cent production did not reveal significant difference between dietary groups.

4.4.2 Quail Day Egg Production

4.4.2.1 Quail Day Number (QDN)

The data on quail day egg number (QDN) and quail day percent (QDP) production are presented in Tables 8 and 9, respectively. The period wise QHN differed from QDN in the two groups T1 and T4 during the first period (7 to 10 weeks of age) as there was mortality in these two groups. During the period from II to V the QHN and QDN remained same in all groups since there was no mortality. The cumulative QDN from 7 to 26 weeks of age in the dietary groups T1, T2, T3 and T4 were 89.22, 94.83, 93.78 and 99.42 in that order with highest in the dietary group supplemented with combination of turmeric and tulasi (T4) and lowest in the control group (T1) with other groups T2 (turmeric) and T3 (tulasi) as intermediary. However Statistical analysis of the period wise and cumulative data on QDN revealed no significant difference due to dietary treatments.

4.4.2.2 Quail Day Per cent (QDP) Production

The mean cumulative per cent production on quail day basis from 7 to 26 weeks of age was 63.72, 67.73, 66.95 and 71.02 per cent in groups T1, T2, T3 and T4, respectively. In period I, during 7 to 10 weeks of age QDN varied from QHN in the treatment groups T1 and T4 due to mortality, whereas in other groups it was same as that of QHN. The difference in T1 and T4 groups did not show significant variations over the respective quail housed percentages during the period I.

4.4.3 Weekly Egg Production

4.4.3.1 Weekly Quail Housed Egg Number (QHN) and Per Cent (QHP) Production

The weekly mean egg production in various dietary groups calculated based on the number of quails housed in each group at the beginning of the experiment are set out in Table 10. The weekly fluctuations in egg production due

Table 8. Period wise mean Quail Day Number (QDN) of eggs as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Quail Day Number (QDN)			
		T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
I	7-10	13.54 ±0.97	12.68 ±0.68	11.53 ±0.78	12.95 ±0.63
II	11-14	21.41 ±0.56	22.55 ±1.89	21.15 ±0.96	23.84 ±0..90
III	15-18	18.05 ±0.61	19.63 ±1.06	19.18 ±0.78	20.89 ±1.33
IV	19-22	18.54 ±1.08	19.93 ±1.50	20.85 ±0.36	21.15 ±1.51
V	23-26	17.68 ±0.93	20.05 ±1.49	21.08 ±1.09	20.63 ±0.83
Cumulative QDN	7-26	89.22 ± 3.59	94.83 ± 3.64	93.78 ± 1.59	99.42 ± 3.26

Non significant

Table 9. Period wise mean Quail Day Per cent (QDP) production as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

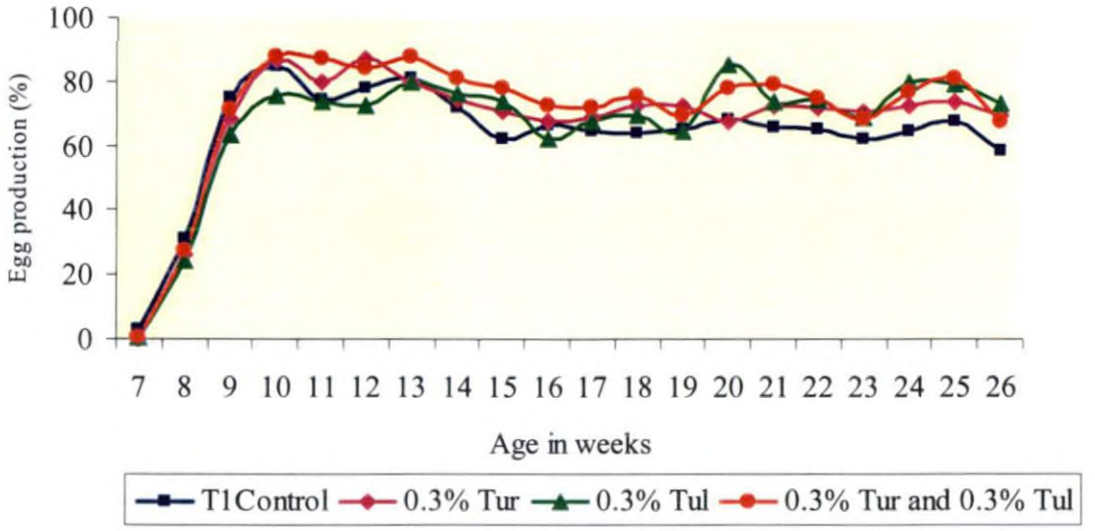
Period	Age in weeks	Quail Day Per cent (QDP)			
		T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
I	7-10	48.37 ± 3.46	45.20 ± 2.42	41.16 ± 2.79	46.27 ± 2.26
II	11-14	76.46 ± 1.99	80.54 ± 3.37	75.54 ± 3.41	85.16 ± 3.21
III	15-18	64.46 ± 2.18	70.09 ± 3.78	68.48 ± 2.77	74.63 ± 4.76
IV	19-22	66.20 ± 3.90	71.16 ± 5.37	74.47 ± 1.29	75.54 ± 5.38
V	23-26	63.13 ± 3.31	71.61 ± 5.33	75.28 ± 3.90	73.51 ± 2.96
Cumulative QDP	7-26	63.72 ± 2.58	67.73 ± 2.60	66.95 ± 1.14	71.02 ± 2.33

Non significant

Table 10. Weekly mean quail housed number (QHN) and quail housed per cent (QHP) production as influenced by turmeric (Tur) and tulasi (Tul) supplementation in experimental diets

Age in weeks	Mean QHN per week					Mean QH Percent per week			
	T1	T2	T3	T4		T1	T2	T3	T4
7	0.23	0.00	0.05	0.05		3.22	0.00	0.72	0.72
8	2.18	1.83	1.73	1.92		31.09	26.07	24.64	27.50
9	5.27	4.80	4.45	4.99		75.24	68.57	63.57	71.39
10	5.95	6.05	5.30	6.13		84.96	86.43	75.71	87.58
11	5.21	5.60	5.18	6.10		74.37	80.00	73.93	87.30
12	5.48	6.13	5.08	5.91		78.34	87.5	72.50	84.40
13	5.67	5.60	5.58	6.12		81.03	80.00	79.64	87.54
14	5.05	5.23	5.33	5.70		72.10	74.65	76.07	81.39
15	4.37	4.95	5.18	5.47		62.42	70.71	73.93	78.06
16	4.67	4.75	4.38	5.07		66.75	67.86	62.50	72.38
17	4.54	4.83	4.75	5.06		64.84	68.93	67.86	72.22
18	4.47	5.10	4.88	5.31		63.81	72.86	69.64	75.83
19	4.58	5.05	4.53	4.85		65.52	72.50	64.64	69.40
20	4.75	4.75	5.98	5.47		68.02	67.86	85.36	78.09
21	4.62	5.08	5.15	5.57		66.03	72.50	73.57	79.52
22	4.57	5.03	5.20	5.26		65.24	71.79	74.29	75.12
23	4.32	4.95	4.83	4.76		61.90	70.72	68.93	68.06
24	4.52	5.08	5.58	5.40		64.61	72.50	79.64	77.10
25	4.75	5.15	5.55	5.66		67.78	73.57	79.29	80.91
26	4.07	4.88	5.13	4.76		58.25	69.24	73.21	67.98
7-26	***87.25***	***94.83***	***93.78***	***94.65***		***62.32***	***67.73***	***66.95***	***67.61***

Fig.3 Weekly quail housed per cent production influenced by turmeric (Tur) and tulasi (Tul) supplementation in quail layer diet



to supplementation of turmeric and tulasi in quail layer rations are depicted in figure 3.

The weekly quail housed egg number and per cent production in control group T1 presented in Table 7 showed an increase in egg production from seven to ten weeks of age with the peak production of 5.95 eggs per quail (84.96 per cent) at 10^{th} week of age. The quails in this group showed egg production above 80 per cent at 10^{th} week (84.96 per cent) and 13^{th} week of age (81.03 per cent). Egg production above 70 per cent was noticed at 11, 12 and 14 weeks of age. Thereafter group showed fluctuations in egg production from 15 to 25 weeks of age and the production at 26^{th} week was 58.25 per cent.

The group of quails fed diet supplemented with 0.3 per cent turmeric (T2) showed increase in egg production from seven to ten weeks with a sudden decline at 11^{th} week (5.60 eggs per quail with 80.00 per cent) and registered the peak production of 6.13 eggs per quail with 87.50 per cent production at 12^{th} week of age. The production in 11 and 13 weeks of age were the same. From 14^{th} week onwards, this group maintained more than 70 per cent production except in 16, 17, 20 and 26 weeks of age where the egg production was 67.86, 68.93, 67.86 and 69.24 per cent respectively.

The group of quails fed diet supplemented with 0.3 per cent tulasi showed increase in production upto 10^{th} weeks of age (75.71 per cent) and then slight reduction to 73.93 per cent in 11^{th} and 72.50 per cent in 12^{th} week and thereafter from 13 to 19 weeks of age the production did not show a definite trend. The highest egg production noticed in this group was 5.98 eggs per quail (85.36 per cent) at 20 weeks of age. The egg production from 21 to 26 weeks of age was inconsistent.

The group of quails fed diet supplemented with the combination of 0.3 per cent turmeric and tulasi each (T4) showed consistent increase in weekly production and recorded the peak production 6.13 eggs per quail (87.58 per cent) at 10^{th} week of age. From 15 weeks of age till the end of experiment, the birds in

the group T4 maintained their egg production above 70 per cent except at 19, 23 and 26 weeks of age, wherein the egg production was 69.40, 68.06 and 67.98 per cent respectively.

4.4.3.2 Weekly Quail Day Number (QDN) and Per Cent (QDP) Production

The weekly mean egg production on quail day basis from 7 to 26 weeks of age in various dietary groups is set out in Table 11. The weekly quail day egg production (QDP) differed from quail housed production (QHP) at 8th week in T1 and T4 and 9th week in T4 groups as mortality occurred in these groups during the periods. The weekly quail day production was same as QHP during the remaining weeks and showed a similar trend as weekly quail housed production. .

4.5 MEAN EGG WEIGHT

The period wise mean egg weight was calculated based on the individual egg weight recorded for all eggs obtained during the last three consecutive days of each 28 day period. Thus the egg weight recorded in the last three days at 10, 14, 18, 22 and 26 weeks of age were utilized for arriving the overall mean egg weight during the period from 7 to 26 weeks of age in different dietary groups and the results are presented in Table 12. Statistical analysis of the mean data on egg weight revealed significant difference between dietary groups only in period III at 18 weeks of age.

During 10th week of age (Period I), the mean egg weight (EW) was 10.51, 10.70, 10.71 and 10.79 g in groups T1, T2, T3 and T4 respectively, the lowest being in the group T1 and the highest in group T4. The egg weights were almost similar in groups T2 and T3. At 14 weeks of age, the mean EW showed slight reduction in all groups except in control group T1.

In period III, at 18 weeks of age, the mean egg weight values were 11.11 and 11.06, 10.71 and 10.71 g in groups T1, T2, T3 and T4 respectively and the mean values in the control group (T1) and turmeric supplemented group (T2) were significantly higher than T3 and T4 ($P \leq 0.05$). The same egg weight value of

Table 11. Weekly mean quail day number (QDN) and quail day per cent (QDP) production as influenced by turmeric (Tur) and tulasi (Tul) supplementation in experimental diets

Age in weeks	Mean QDN per week					Mean QD Percent per week			
	T1	T2	T3	T4		T1	T2	T3	T4
7	0.23	0.00	0.05	0.05		3.22	0.00	0.72	0.72
8	2.21	1.83	1.73	1.93		31.57	26.07	24.64	27.58
9	5.27	4.80	4.45	5.08		75.24	68.57	61.79	72.49
10	5.95	6.05	5.30	6.13		84.96	86.43	75.71	87.58
11	5.21	5.60	5.18	6.10		74.37	80.00	73.93	87.30
12	5.48	6.13	5.08	5.91		78.34	87.50	72.50	84.40
13	5.67	5.60	5.58	6.12		81.03	80.00	79.64	87.54
14	5.05	5.23	5.33	5.70		72.10	74.64	76.07	81.39
15	4.37	4.95	5.18	5.47		62.42	70.71	73.93	78.06
16	4.67	4.75	4.38	5.07		66.75	67.86	62.50	72.38
17	4.54	4.83	4.75	5.06		64.84	66.79	67.86	72.22
18	4.47	5.10	4.88	5.31		63.81	72.86	69.64	75.83
19	4.58	5.05	4.53	4.85		65.52	72.50	64.64	69.40
20	4.75	4.75	5.98	5.47		68.02	67.86	85.36	78.09
21	4.62	5.08	5.15	5.57		66.03	72.5	73.57	79.52
22	4.57	5.03	5.20	5.26		65.24	71.79	74.29	75.12
23	4.32	4.95	4.83	4.76		61.90	70.71	68.93	68.06
24	4.52	5.08	5.58	5.40		64.60	72.50	79.64	77.10
25	4.75	5.15	5.55	5.66		67.78	73.57	79.29	80.91
26	4.07	4.88	5.13	4.76		58.25	69.24	73.21	67.98
7-26	***89.22***	***94.83***	***93.78***	***99.42***		***63.72***	***67.73***	***66.95***	***71.02***

Table 12. Period wise mean egg weight (g) as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Egg weight (g)			
		T1 Control	**T2** Tur-0.3%	**T3** Tul-0.3%	**T4** Tur-0.3% Tul-0.3%
I	10	10.51 ± 0.17	10.70 ± 0.07	10.71 ± 0.15	10.79 ± 0.09
II	14	10.69 ± 0.27	10.45 ± 0.08	10.50 ± 0.08	10.56 ± 0.10
III	18	11.11^{b} ± 0.07	11.06^{b} ± 0.10	10.71^{a} ± 0.10	10.71^{a} ± 0.14
IV	22	10.78 ± 0.20	10.48 ± 0.22	10.73 ± 0.21	10.57 ± 0.10
V	26	10.62 ± 0.20	10.86 ± 0.26	10.56 ± 0.03	10.46 ± 0.13
Cumulative mean EW (g)	7-26	10.74 ± 0.15	10.71 ± 0.10	10.64 ± 0.08	10.62 ± 0.07

Note: Mean values bearing the same superscript within the row did not differ significantly ($P \leq 0.05$)

10.71 g was recorded in groups T3 (Tulasi supplemented group) and T4 (Turmeric and Tulasi supplemented group).

During period IV and V the mean egg weight recorded among the dietary groups were 10.78, 10.48, 10.73 and 10.57 g at 22 weeks and 10.62, 10.86, 10.56 and 10.46 g at 26 weeks of age. The highest mean EW recorded in the study was 11.11 g in the control group followed by the turmeric supplemented group (11.06 g), at 18 weeks of age.

The cumulative mean egg weight during 7 to 26 weeks was the highest in the control group T1 followed by T2, T3 and T4 in that order (10.74, 10.71, 10.64 and 10.62 g). Statistical analysis of the data pertaining to cumulative mean egg weight did not show significant difference between dietary groups.

4.6 EGG MASS

The mean egg mass per quail on quail day basis was arrived by weighing all eggs in each replicate. The period wise and cumulative mean egg mass in various dietary groups are presented in Table 13.

During the period I (7-10 weeks of age), the mean egg mass per quail recorded was 146.55, 136.88, 124.00 and 139.95 g for T1, T2, T3 and T4 groups, respectively with the highest egg mass in the control group and lowest in the group fed with tulasi powder. During the period II (11-14 weeks of age), increase in egg mass was recorded in all dietary groups with the highest egg mass per quail (253.64 g) in the group supplemented with turmeric and tulasi (T4) and the lowest (224.73 g) in the group fed diet containing tulasi (T3). The egg mass in the control group (T1) and turmeric supplemented group (T2) was 230.29 and 241.78 g respectively during period II.

During the period III (15-18 weeks of age) , the egg mass declined in all the dietary groups and the values recorded in groups T1, T2, T3 and T4 were 189.66, 204.68, 198.80 and 214.14 g respectively, the highest being in the group fed turmeric and tulasi combination. During the period IV (19-22 weeks of age),

Table 13. Period wise mean egg mass per quail (g) on quail day basis as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Mean egg mass per quail (g)			
		T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
I	7-10	146.55 ± 11.86	136.88 ± 8.71	124.00 ± 9.48	139.95 ± 8.50
II	11-14	230.29 ± 9.57	241.78 ± 10.76	224.73 ± 9.04	253.64 ± 11.81
III	15-18	189.66 ± 8.54	204.68 ± 12.16	198.80 ± 8.20	214.14 ± 15.70
IV	19-22	201.46 ± 14.93	214.45 ± 17.87	225.50 ± 6.81	222.84 ± 18.23
V	23-26	189.21 ± 12.43	212.75 ± 18.19	226.78 ± 13.97	217.11 ± 8.58
Cumulative mean	7-26	957.17 ± 49.26	1010.53 ± 45.14	999.80 ± 22.82	1047.68 ± 39.44

Non significant

increase in egg mass was recorded in all dietary groups with the highest egg mass (225.50 g) in tulasi supplemented group T3 followed by tulasi and turmeric

combination group T4 (222.84 g), turmeric group T2 (214.45 g) and control group T1 (201.46 g).

During the period V (23-26 weeks of age), slight decline in egg mass was observed in all the groups except tulasi supplemented group (T3), which showed the highest egg mass (226.78 g) during the period. The other three groups T1, T2, T4 recorded egg mass of 189.21, 212.75 and 217.11 g, respectively. Statistical analysis of data on egg mass per quail during different periods indicated that none of the period showed significant difference between the dietary groups.

The cumulative mean egg mass per quail during the entire period of experiment (7 to 26 weeks of age) was 1047.68 g in group fed with turmeric and tulasi (T4) followed by 1010.53 g in group fed with turmeric (T2), 999.80 g in group fed with tulasi (T3) and 957.17 g in control group (T1). However, the magnitude of variation between control and the treatment groups did not show significant difference statistically.

4.7 FEED CONSUMPTION

Statistical analysis of the data pertaining to the period wise mean daily feed consumption in each 28 day period and the overall period wise mean feed consumption did not show significant difference between the dietary groups.

The period wise mean daily feed consumption presented in Table 14 revealed that in the first period (7-10 weeks of age), the feed intake per quail in groups T1, T2, T3 and T4 was 28.62, 27.74, 27.20 and 27.52 g, respectively and were statistically comparable with each other.

During period II (11-14 weeks) the feed consumption declined in all dietary groups and the mean values were 25.23, 24.58, 24.95 and 25.62 g in groups T1, T2, T3 and T4, respectively. The difference was narrow between the dietary groups. In the corresponding groups, in period III (15-18 weeks) the feed intake were 25.10, 24.13, 24.56 and 25.80 g.

Table 14. Period wise mean feed consumption per quail (g) as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Mean daily feed consumption per quail(g)			
		T1 Control	**T2** Tur-0.3%	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
I	7-10	28.62 ± 0.56	27.74 ± 0.30	27.20 ± 0.20	27.52 ± 0.13
II	11-14	25.23 ± 0.65	24.58 ± 0.44	24.95 ± 0.10	25.62 ± 0.69
III	15-18	25.10 ± 0.40	24.13 ± 0.28	24.56 ± 0.49	25.80 ± 0.77
IV	19-22	25.49 ± 0.81	25.95 ± 0.60	25.87 ± 0.47	28.05 ± 1.02
V	23-26	27.08 ± 1.00	26.14 ± 0.41	26.31 ± 0.20	28.07 ± 0.95
Periodwise mean/ day	7-26	26.31 ± 0.64	25.71 ± 0.88	25.79 ± 0.02	27.03 ± 0.69
Cumulative mean/ quail (kg)		3.683	3.599	3.608	3.781

Non significant

During period IV (19-22 weeks), the mean daily feed consumption increased in the group T4 supplemented with turmeric and tulasi (28.05 g) while the other groups did not show much increase and the feed intake values in groups T1, T2 and T3 were 25.49, 25.95 and 25.87 g, respectively.

During period V slight increase in daily feed consumption was recorded in groups T1, T2 and T3 (27.08, 26.14 and 26.31 g) while in T4 group it was more or less same (28.07 g) as that in the previous period (28.05 g). The overall periodwise feed consumption per quail during the entire period of experiment was 26.31, 25.71, 25.79 and 27.03 g in groups T1 to T4 in that order.

4.8 FEED CONVERSION RATIO (FCR)

The feed conversion ratio (FCR) per dozen eggs is presented in Table 15 and FCR per kg egg mass is presented in Table 16 and graphically depicted in figure 4.

4.8.1 Feed Conversion Ratio (FCR) Per Dozen Eggs

Period wise feed conversion ratio per dozen eggs presented in Table 15 revealed that the ratios were very high during the period I (7-10 weeks of age) since the rate of egg production was very low during this period in all dietary groups.

During period I (7-10 weeks of age), the FCR values in all dietary groups were high with the poorest FCR (0.80) in group T3, followed by T2 (0.74), T1 (0.73) and T4 (0.72). In period II, FCR improved in all groups and the values were 0.40, 0.37, 0.40 and 0.36 in groups T1, T2, T3 and T4, respectively. In period III the FCR values in the dietary groups T1, T2, T3 and T4 were 0.47, 0.42, 0.43 and 0.42 respectively. In period IV, the FCR value in control group (T1) remained same (0.47) as that in the period III. FCR values in T2, T3 and T4 groups were 0.45, 0.42 and 0.46, respectively. In period V (23-26 weeks of age), the FCR in the control group increased to 0.51, while the values in T2, T3 and T4 remained same as that in previous period (0.45, 0.42 and 0.46, respectively).

Table 15. Period wise mean feed conversion ratio (kg feed/ dozen eggs) as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Mean Feed Conversion Ratio (kg feed/ dozen eggs)			
		T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3% Tul-0.3%
I	7-10	0.73 ± 0.05	0.74 ± 0.04	0.80 ± 0.05	0.72 ± 0.04
II	11-14	0.40 ± 0.01	0.37 ± 0.02	0.40 ± 0.02	0.36 ± 0..01
III	15-18	0.47 ± 0.02	0.42 ± 0.02	0.43 ± 0.02	0.42 ± 0.02
IV	19-22	0.47 ± 0.03	0.45 ± 0.04	0.42 ± 0.01	0.46 ± 0.03
V	23-26	0.51 ± 0.04	0.45 ± 0.04	0.42 ± 0.02	0.46 ± 0.03
Cumulative FCR	7-26	0.50 ± 0.03	0.46 ± 0.02	0.46 ± 0.01	0.48 ± 0.02

Non significant

Fig.4 Mean feed conversion ratio (kg feed per dozen egg) affected by supplementation of turmeric and tulasi in quail layer diet

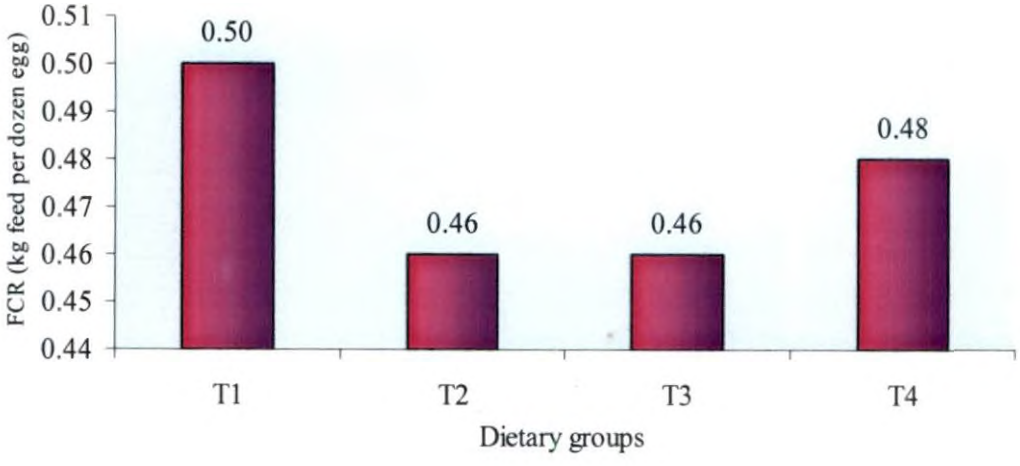
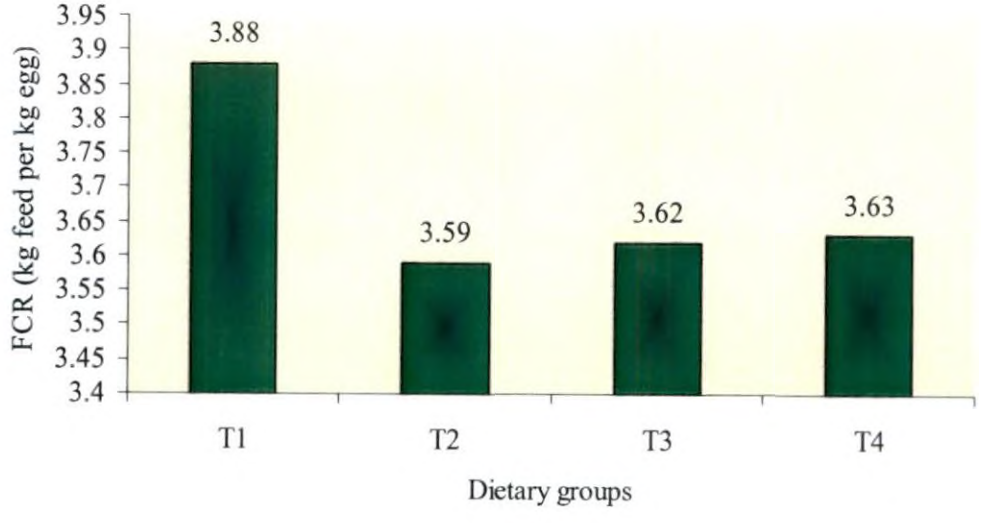


Fig.5 Mean feed conversion ratio (kg feed per kg egg) affected by supplementation of turmeric and tulasi in quail layer diet



The FCR values among dietary groups were statistically comparable during period I to V. The data on cumulative FCR for the entire period (7-26 weeks) among the dietary groups showed that the FCR was superior and same (0.46) in groups T2 and T3 followed by 0.48 in group T4 whereas the FCR in the control group T1 was 0.50. The magnitude of variation was non significant.

4.8.2 Feed Conversion Ratio (FCR) Per Kg Egg Mass

The Feed Conversion Ratio (FCR) per kg mass in various periods and the cumulative mean FCR from 7 to 26 weeks of age are presented in Table 16 and the cumulative means are depicted graphically in figure 5.

During period I, the FCR per kg egg mass was 5.65, 5.75, 6.26 and 5.56 for T1, T2, T3 and T4 groups respectively, with the poorest in group T3 (tulasi supplemented group). In the period II, FCR improved in all groups and the values were 3.09, 2.86, 3.13 and 2.85 in T1, T2, T3 and T4,respectively. The superior FCR of 2.85 in the experiment was recorded in the group supplemented with turmeric and tulasi combination (T4). In the period III, the ratios increased to 3.73, 3.34, 3.48 and 3.42 in T1, T2, T3 and T4,respectively. In the period IV, the FCR was 3.59, 3.46, 3.23 and 3.58 in T1, T2, T3 and T4,respectively. In period V, the ratios in dietary groups T1, T2, T3 and T4 increased to 4.03, 3.54, 3.29 and 3.66,respectively. However, the magnitude of variation between dietary groups was narrow to reveal significant difference in any of the periods.

The cumulative mean FCR per kg egg mass from 7 to 26 weeks of age in T1, T2, T3 and T4 were 3.88, 3.59, 3.62 and 3.63, respectively and were statistically comparable each other. The poorest FCR was observed in control group (T1) in terms of both per dozen eggs and per kg egg basis.

4.9 HAEMATOLOGICAL PARAMETERS

The hematological parameters of layer quails at the end of 26th week of age as influenced by the dietary supplementation of turmeric and tulasi are presented are in Table 17.

Table 16. Period wise mean feed conversion ratio (kg feed/kg egg mass) as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets from 7 to 26 weeks of age

Period	Age in weeks	Mean Feed Conversion Ratio (kg feed/ kg egg mass)			
		T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3% Tul-0.3%
I	7-10	5.65 ± 0.42	5.75 ± 0.35	6.26 ± 0..46	5.56 ± 0.33
II	11-14	3.09 ± 0.15	2.86 ± 0.12	3.13 ± 0.12	2.85 ± 0.10
III	15-18	3.73 ± 0.18	3.34 ± 0.18	3.48 ± 0.14	3.42 ± 0.17
IV	19-22	3.59 ± 0.27	3.46 ± 0.33	3.23 ± 0.09	3.58 ± 0.24
V	23-26	4.03 ± 0.37	3.54 ± 0.38	3.29 ± 0.22	3.66 ± 0.24
Cumulative FCR	7-26	3.88 ± 0.23	3.59 ± 0.18	3.62 ± 0.08	3.63 ± 0.12

Non significant

Table 17. Mean haematological parameter of layer quails as influenced by supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets

Blood parameters	Dietary supplementation of turmeric (Tur) and tulasi (Tul) levels (%)			
	T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
Haemoglobin (g/dl)	9.09^{a} ± 0.26	9.88^{ab} ± 0.24	9.72^{ab} ± 0.42	10.49^{b} ± 0.32
TEC (10^6/μ L)	2.55 ± 0.05	2.64 ± 0.04	2.69 ± 0.06	2.79 ± 0.01
TLC (10^3/μ L)	22.00^{a} ± 0.38	22.88^{ab} ± 0.55	23.38^{ab} ± 0.63	24.50^{b} ± 0.65

Note: Mean values bearing the same superscript within the row did not differ significantly ($P \leq 0.05$)

Fig.6 Mean haemoglobin (g/dl) affected by supplementation of turmeric and tulasi in quail layer diet

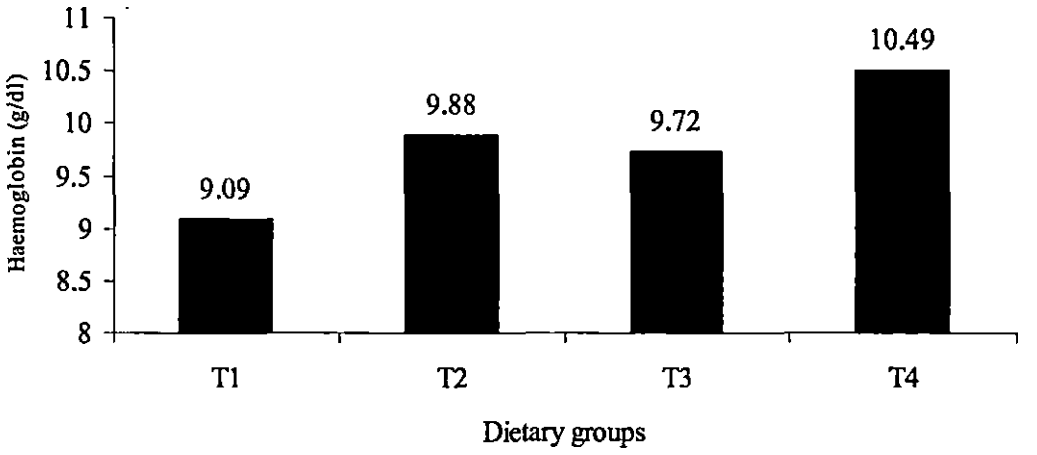
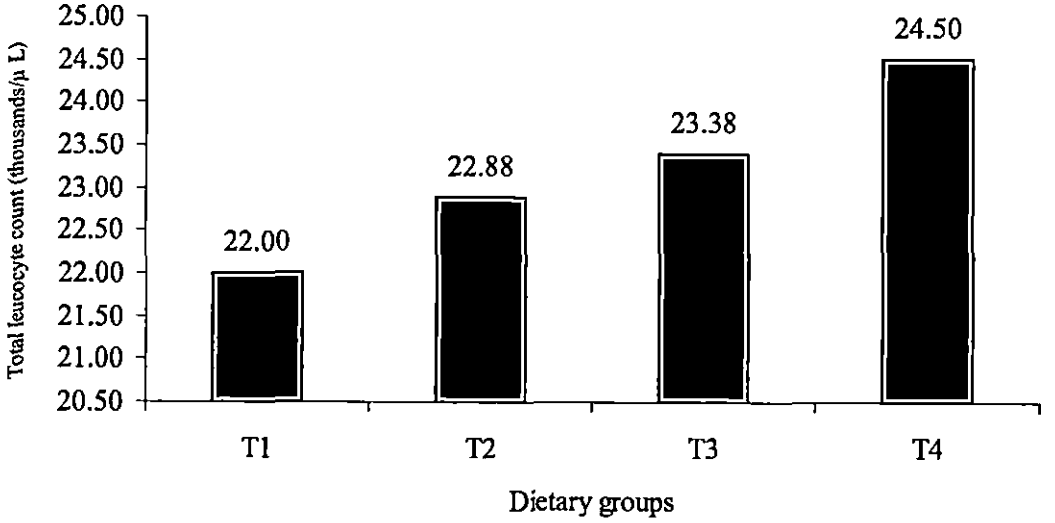


Fig.7 Mean total leucocyte count (thousands/μ L) affected by supplementation of turmeric and tulasi in quail layer diet



4.9.1 Heamoglobin (Hb)

The values of mean Heamoglobin (Hb) in quails belonging to the dietary groups T1, T2, T3 and T4 were 9.09, 9.88, 9.72 and 10.49 g per cent respectively (Table 17) and the variations are graphically depicted in figure 6. Statistical analysis of the data revealed significant difference between dietary groups. The quails fed combination of turmeric and tulasi (T4) showed the highest Hb value of 10.49 g per cent and was significantly higher than the lowest value of 9.09 g per cent recorded in the control group T1 ($P \leq 0.05$). The values in groups T2 and T3 were intermediary and comparable with those of T1 and T4.

4.9.2 Total Erythrocyte Count (TEC)

The mean total erythrocyte count observed in quails at 26th week of age is presented in the Table 17. The mean TEC observed for the dietary group T1, T2, T3 and T4 were 2.55, 2.64, 2.69 and 2.79 million per μ L. Statistical analysis of the data did not show any significant difference between the dietary groups.

4.9.3 Total Leucocyte Count (TLC)

The mean total leucocyte count observed at the end of 26th week of age as influenced by dietary supplementation of turmeric and tulasi are presented in Table 17 and graphically depicted in figure 7. The mean value of TLC observed for quails in dietary groups T1, T2, T3 and T4 were 22.00, 22.88, 23.38 and 24.50 thousands per μL respectively. The birds in the group fed with combination of 0.3 per cent turmeric and tulasi (T4) had significantly ($P \leq 0.05$) higher total leucocyte count than birds in control group (T1) while the values in groups T2 and T3 were intermediary and comparable with T1 and T4.

4.10 BIOCHEMICAL PARAMETERS

4.10.1 Serum Total Protein

The mean serum total protein levels in quails at 26 weeks of age in various dietary groups are set out in Table 18. The mean serum total protein for the

Table 18. Mean serum total protein (g/dl), total cholesterol (mg/dl) and egg yolk cholesterol (mg/g yolk) at 26 weeks of age in layer quails as influenced by dietary supplementation of dried turmeric (Tur) and tulasi (Tul) in experimental diets

Parameters	Treatments			
	T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3 % Tul-0.3 %
Serum total protein (g/dl)	3.25 ± 0.19	3.35 ± 0.19	3.38 ± 0.23	3.58 ± 0.16
Serum total cholesterol (mg/dl)	166.13^{a} ±2.36	149.00^{b} ±2.31	141.13^{c} ±2.13	125.75^{d} ±3.04
Egg yolk cholesterol (mg/g yolk)	18.67^{a} ±0.63	17.89^{ab} ±0.85	17.03^{b} ±0.35	16.56^{b} ±0.52

Mean values bearing the same superscript within the row did not differ significantly ($P \leq 0.05$)

Fig.8 Mean serum total cholesterol (mg/dl) affected by supplementation of turmeric and tulasi in quail layer diet

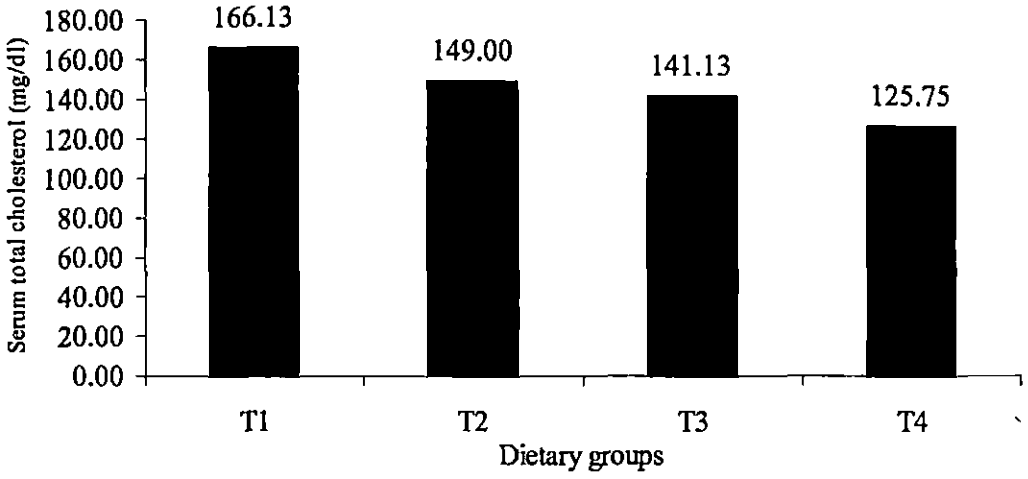
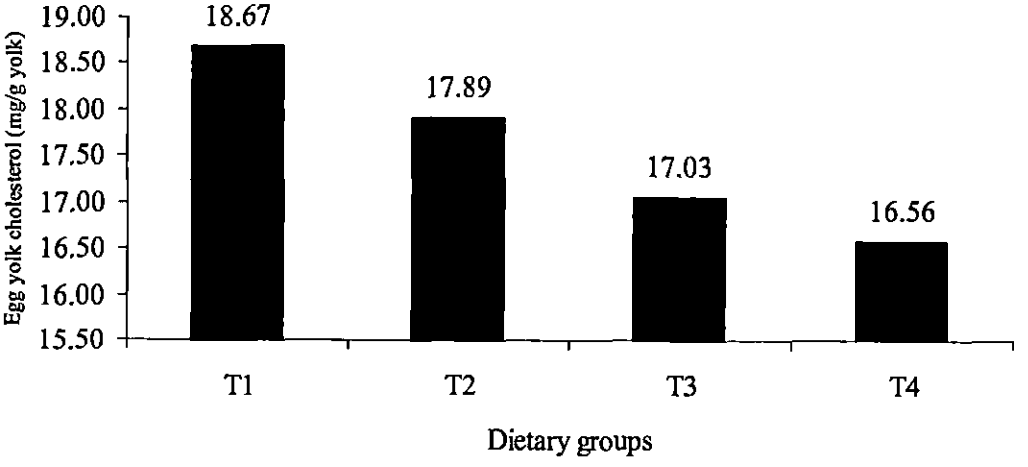


Fig.9 Mean egg yolk cholesterol (mg/g yolk) affected by turmeric and tulasi supplementation in quail layer diet



dietary groups T1, T2, T3 and T4 were 3.25, 3.35, 3.38 and 3.58 g per dl, respectively. Statistical analysis of the data on serum total proteins did not reveal significant difference between the dietary groups.

4.10.2 Serum Total Cholesterol

The mean serum total cholesterol estimated at the end of 26 weeks of age in various dietary treatments are set out in Table 18 and graphically depicted in figure 8. The serum total cholesterol levels for the dietary groups T1, T2, T3 and T4 were 166.13, 149.00, 141.13 and 125.75 mg per dl, respectively. Statistical analysis of the data revealed that the mean cholesterol values in all groups differed significantly each other ($P \leq 0.05$) with the highest value in control group T1 followed by T2 and T3 and the lowest value was recorded in group T4 supplemented with combination of turmeric and tulasi.

4.10.3 Egg Yolk Cholesterol

The mean egg yolk cholesterol values in quails estimated at 26 weeks of age in various dietary groups are represented in Table 18 and graphically depicted in figure 9. The mean egg yolk cholesterol values for the dietary groups T1, T2, T3 and T4 were 18.67, 17.89, 17.03 and 16.56 mg per g yolk, respectively. Statistical analysis of the data revealed that the mean egg yolk cholesterol content was lowered significantly in group fed tulasi (T3) and the group fed combination of turmeric and tulasi (T4) in comparison with that observed in the control group ($P \leq 0.05$). The mean value in turmeric group (T2) was intermediary and statistically comparable with both control group (T1) and T3 and T4 groups.

4.11 PROCESSING YIELDS AND LOSSES

The processing yields pertaining to dressed, eviscerated, giblet and ready to cook yield and per cent loss of blood and feather over the live weight at 26 weeks of age in layer quails as influenced by dietary supplementation of turmeric and tulasi are presented in Table 19. However, statistical analysis of the data on

Table 19. Mean Processing yields and losses in layer quails as influenced by supplementation of turmeric (Tur) and tulasi (Tul) powder in experimental diets

Processing yields and losses on live weight basis (per cent)	Dietary supplementation of turmeric and tulasi levels			
	T1 Control	**T2** Tur-0.3 %	**T3** Tul-0.3 %	**T4** Tur-0.3% Tul-0.3%
Dressed yield	90.01 ±0.74	90.65 ±0.42	91.11 ±0.53	91.96 ±0.37
Eviscerated yield	62.60 ±1.03	60.89 ±0.77	61.80 ±0.77	63.37 ±0.58
Giblet	5.06 ±0.13	4.92 ±0.18	5.15 ±0..34	4.94 ±0.16
Ready-to-Cook yield	67.66 ±1.00	65.81 ±0.67	66.95 ±0.69	68.31 ±0.54
Blood	4.79^{a} ±0.11	4.35^{ab} ±0.22	3.84^{b} ±0.32	3.93^{b} ±0.14
Feather	5.21 ±0.66	4.99 ±0.38	5.05 ±0.57	4.12 ±0.39

Mean values bearing the same superscript within the row did not differ significantly ($P \leq 0.05$)

yields and losses revealed significant difference between the dietary groups only in blood loss.

The per cent dressed yield was 90.01, 90.65, 91.11 and 91.96 in groups T1, T2, T3 and T4, respectively. The eviscerated yield of quails in the dietary groups T1, T2, T3 and T4 were 62.60, 60.89, 61.80 and 63.37 per cent respectively. The giblet yields were 5.06, 4.92, 5.15 and 4.94 in the respective groups. The ready to cook yield (R-to-C) were 67.66, 65.81, 66.95 and 68.31 per cent in T1, T2, T3 and T4, respectively. The R-to-C yield in the group T4 supplemented with each 0.3 per cent turmeric and tulasi was numerically higher than that of control group T1.

The results indicated that the mean values of per cent blood loss were 4.79, 4.35, 3.84 and 3.93 in group T1, T2, T3 and T4, respectively. The blood loss in the dietary group T2 was intermediary and comparable with all other dietary groups. The control group (T1) recorded significantly higher blood loss than those in T3 and T4 ($P \leq 0.05$). The feather losses in the above groups were 5.21, 4.99, 5.05 and 4.12 per cent respectively.

4.12 LIVABILITY

The mean livability per cent of Japanese quails from 7 to 26 weeks of age as influenced by supplementation of turmeric and tulasi are presented in Table 20. A total of three (3) quails were died during the experimental period from 7 to 26 weeks of age, one in group T1 and two in group T4. The overall livability was 100 per cent in groups T2 and T3 and that in groups T1 and T4 were 97.5 and 95.0 per cent, respectively.

4.13 ECONOMICS

The economics of egg production in Japanese quail as influenced by supplementation of turmeric and tulasi were worked out and presented in Table 21.

Table 20. Period wise mean livability per cent in layer quails as influenced by turmeric (Tur) and tulasi (Tul) supplementation in experimental diets

Periods	Age in weeks	Mean livability per cent			
		T1 Control	**T2** Tur- 0.3%	**T3** Tul- 0.3%	**T4** Tur- 0.3% Tul -0.3%
I	7-10	97.50	100.00	100.00	95.00
II	11-14	100.00	100.00	100.00	100.00
III	15-18	100.00	100.00	100.00	100.00
IV	19-22	100.00	100.00	100.00	100.00
V	23-26	100.00	100.00	100.00	100.00
Cumulative mean	7-26	97.50	100.00	100.00	95.00

Table 21. Economics of quail rearing in cages from 7 to 26 weeks of age influenced by turmeric (Tur) and tulasi (Tul) supplementation in experimental diets

Sl. No:	Particulars (7 to 26 weeks)	Dietary supplementation of turmeric and tulasi levels (%)			
		T1 control	**T2** Tur - 0.3 %	**T3** Tul – 0.3 %	**T4** Tur - 0.3 % Tul – 0.3 %
1	Quail housed egg number /quail	87.25	94.83	93.78	94.65
2	Feed cost per kg diet (Rs.)	11.13	11.28	11.13	11.28
3	Cumulative feed intake/quail (kg)	3.683	3.599	3.608	3.781
4	Total feed cost /quail (Rs.)	40.99	40.60	40.16	42.65
5	Total returns by sale of eggs (Rs.)*	78.53	85.35	84.40	85.19
6	Total feed cost + pullet quail cost (Rs.)	55.99	55.60	55.16	57.65
7	Margin of return over cost of feed and layer quail (Rs.)	22.54	29.75	29.24	27.54
8	Feed cost per egg (Rs.)	0.47	0.43	0.43	0.45
9	Margin of returns/quail housed/ period (Rs.)	4.51	5.95	5.85	5.51

*Sale price of egg – 90 Paise / egg

The quail housed egg number per quail for T1, T2, T3 and T4 were 87.25, 94.83, 93.78 and 94.65, respectively during 7 to 26 weeks of age. The cost of one kilogram feed for the dietary groups T1, T2, T3 and T4 were Rs.11.13, 11.28, 11.13 and 11.28, respectively. The cumulative feed intake per quail in the corresponding groups were 3.683, 3.599, 3.608 and 3.781 kg and the total feed cost per quail was 40.99, 40.60, 40.16 and 42.65 for the dietary groups T1, T2, T3 and T4, respectively. The total returns by the sale of eggs was higher in T2 (Rs.85.35), followed by T4 (Rs.85.19), T3 (84.40) and T1 (Rs.78.53). The total feed cost with pullet quail cost in T1, T2, T3 and T4 were Rs.55.99, 55.60, 55.16 and 57.65 respectively. Margin of return over cost of feed and layer quail was higher in T2 followed by T3, T4 and T1 (Rs.29.75, 29.24, 27.54, and 22.54). The cost of feed per egg was same in T2 and T3 (Rs.0.43) followed by T4 (0.45) and was lower than that of control group T1 (Rs.0.47). The margin of returns per quail per period was Rs.4.51, 5.95, 5.85 and 5.51 in T1, T2, T3 and T4 respectively.

Table 22. Summary of performance of Japanese quail layers (7 to 26 wk influenced by turmeric (Tur) and tulasi (Tul) supplementation in experimental diets

Sl. No:	Characteristic	Dietary supplementation of turmeric and tulasi levels (%)			
		T1 (control)	**T2** (0.3 % Tur)	**T3** (0.3% Tul)	**T4** (Tur+Tul)
1	Mean BW 6th wk (g)	155.55	155.92	155.07	155.44
2	Mean BW 26th wk (g)	206.09	206.29	203.67	206.01
3	Mean age at 50% production (days)	55.50	56.25	55.75	56.00
	Cumulative mean values from 7 to 26 wk				
4	QH egg number	87.25	94.83	93.78	94.65
5	QH per cent	62.32	67.73	66.95	67.61
6	QD egg number	89.22	94.83	93.78	99.42
7	QD per cent	63.72	67.73	66.95	71.02
8	Egg weight (g)	10.74	10.71	10.64	10.62
9	Egg mass (g)	957.17	1010.53	999.80	1047.68
10	Feed intake / day (g)	26.31	25.71	25.79	27.03
11	FCR / dozen eggs	0.50	0.46	0.46	0.48
12	FCR/ kg egg mass	3.88	3.59	3.62	3.63
13	Livability (%)	97.50	100.00	100.00	95.00
14	Margin of return over cost of feed and layer quail (Rs.)	22.54	29.75	29.24	27.54
15	Feed cost per egg (Rs.)	0.47	0.43	0.43	0.45
	At 26th week of age				
16	Haemoglobin (g/dl)*	9.09^{a}	9.88^{ab}	9.72^{ab}	10.49^{b}
17	Total erythrocyte count (10^6/µ L)	2.55	2.64	2.69	2.79
18	Total leucocyte count (10^3/ µ L)*	22.00^{a}	22.88^{ab}	23.38^{ab}	24.50^{b}
19	Serum total protein (g/dl)	3.25	3.35	3.38	3.58
20	Serum cholesterol (mg/dl)*	166.13^{a}	149.00^{b}	141.13^{c}	125.75^{d}
21	Egg yolk cholesterol (mg/g yolk)*	18.67^{a}	17.89^{ab}	17.03^{b}	16.56^{b}
22	Dressed yield %	90.01	90.65	91.11	91.96
23	Eviscerated yield %	62.60	60.89	61.80	63.37
24	R-to-C yield %	67.66	65.81	66.95	68.31

*Mean values bearing same superscripts did not differ significantly ($P \leq 0.05$)

Discussion

5. DISCUSSION

The effects of supplementation of dried turmeric and tulasi leaves in layer quail diets on the production performance are discussed in this chapter.

5.1 METEOROLOGICAL OBSERVATIONS

The data pertaining to microclimate inside the experimental house during the course of the experiment from December 2007 to May 2008 (Table 3) indicated that the periods III to V were synchronized with summer in this region. In the present study, the mean maximum temperature ranged from 30.50 to 33.48 in periods I to V with an overall mean of 32.14°C. The mean minimum temperature ranged from 24.91 to 27.66 with an average of 26.59°C. These values did not agree with the maximum temperature (31.14 to 35.14°C) and minimum temperature (21.15 to 25.80°C) reported by Somanathan *et al.* (1980) for the period from January to June in the years 1974 to 1978 at Mannuthy region.

The mean per cent relative humidity in the study ranged from 66.50 to 90.64 per cent in period I to V with an overall mean of 77.98 per cent in the forenoon. Whereas, in the afternoon, the relative humidity ranged from 50.93 to 74.42 per cent (periods I to V) with an overall mean of 61.09 per cent. The relative humidity (R.H.) range (58.49 to 84.39 per cent) reported by Somanathan *et al.* (1980) also did not agree with the present results.

5.2 BODY WEIGHT

The data presented in Table 4 indicated that, at sixth week of age, the body weight (BW) of quails was 155.55, 155.92, 155.07 and 155.44 g in groups T1, T2, T3 and T4, respectively and were similar in all groups at the beginning of the experiment. The BW recorded at this age can be considered as standard weight for female quails at point of lay. The sixth body weight of female quails

reported by Sheena (2005), Preethymol (2006), Raseena (2006) and Preeta (2007) were in the range of 166.96 to 186.56g. The variations in sixth week BW might be due to differences in the nutrient levels in the starter and grower rations and also due to the changes in the systems of rearing during growing period.

All experimental diets were isocaloric and isonitrogenous containing 22 per cent crude protein and 2650 kcal ME per kg diet and were fed *adlibitum* from sixth week onwards. The group T1 was fed with the control diet without the supplementation of turmeric and tulasi powder. The groups T2, T3 and T4 were fed diets supplemented with turmeric, tulasi and its combination each at 0.3 per cent level, respectively.

In the present study, the body weights of quails at 26 weeks of age were 206.09, 206.29, 203.67 and 206.01 g in groups T1, T2, T3 and T4, respectively. The mean values in groups T1, T2 and T4 were almost same and the BW in group T3 was slightly lower, but statistical analysis of the data did not reveal significant difference between groups. The mean body weight recorded in the present study is in full agreement with the body weight of 196.20 to 205.16 g in layer quails reported by Lekshmy (2005) and Sheena (2005) at 26 weeks of age. The BW recorded in the present study was lower than that reported by Preethymol (2006) and Raseena (2006).

The mean body weight gain during the period from 6 to 26 weeks of age among the different treatment groups were similar (50.55, 50.37, 50.30 and 50.57 g) and were higher than the weight gain for the same period reported by Lekshmy (2005), Sheena (2005), Preethymol (2006) and Preeta (2007). The sixth and 26^{th} week body weight recorded in this study were lower than the corresponding body weights reported by the above authors. This finding indicated that the laying quails did not attain much weight even after 20 weeks of laying period from 6 to 26 weeks of age.

5.3 AGE AT FIRST EGG AND 10 AND 50 PER CENT PRODUCTION

The data presented in Table 5 indicated that the absolute age at first egg (AFE) in groups T1, T2, T3 and T4 were 48, 50, 49 and 49 days, respectively. The mean age at first egg and the age at 10 per cent production coincided and the mean values in these groups were 48.75, 51.00, 50.50 and 49.75 days, respectively. The AFE recorded in this study can be considered as late sexual maturity in layer quails. Raseena (2006) reported AFE of 42 days. The mean age at first egg recorded in all groups in the study was higher than that reported by Lekshmy (2005), Preethymol (2006) and Preeta (2007), but more or less similar to that reported by Sheena (2005).

The age at 50 per cent production as influenced by the dietary supplementation of dried turmeric and tulasi averaged 55.50, 56.25, and 55.75 and 56.00 days in the groups T1, T2, T3 and T4, respectively which did not show significant difference between groups. The above values were 2 to15 days lower than that reported by Lekshmy (2005) and Sheena (2005) and slightly higher than that of Preethymol (2006) Raseena (2006) and Preeta (2007).

5.4 EGG PRODUCTION

5.4.1 Period-wise Egg Production

5.4.1.1 Period wise Quail Housed Number (QHN) and Per cent Production (QHP)

The results presented in Table 6 and 7 revealed that the cumulative mean Quail Housed Number (QHN) of eggs during the period from 7 to 26 weeks of age was 87.25, 94.83, 93.78 and 94.65 eggs per quail with corresponding per cent production of 62.32, 67.73, 66.95 and 67.61 in groups T1, T2, T3 and T4, respectively. Statistical analysis revealed no significant difference among dietary groups. However, QHN and QHP in all the groups fed turmeric and tulasi were numerically higher than the control group.

In the control group, the period wise QHN was 13.30, 21.41, 18.05, 18.54 and 17.68 eggs in periods I to V, respectively, showed low production after peak without fluctuations. The period wise egg production in quails fed diet (T2) supplemented with 0.3 per cent turmeric averaged 12.68, 22.55, 19.63, 19.93 and 20.05 eggs per quail showed higher egg production from 2nd period onwards, in comparison with the control group. The cumulative QHN in quails fed diet supplemented with turmeric produced 7.58 eggs more than that of control group, but this difference was statistically non significant. The period wise egg production in quails fed diet (T3) supplemented with 0.3 per cent tulasi (11.53, 21.15, 19.18, 20.85 and 21.08) followed similar trend same as that observed in the group T2. Thus, the cumulative mean egg production in quails fed diet supplemented tulasi was lower by 1.05 eggs than those fed turmeric.

The period wise egg production in quails fed diet (T4) supplemented with the combination of turmeric and tulasi each at 0.3 per cent level revealed higher egg production in periods II, III and IV (12.65, **23.84**, **20.89**, **21.15** and 20.63 eggs per quail) in comparison with all other groups (Figure 3) and the total production from 7 to 26 weeks of age (94.65 eggs) was 7.40 eggs higher than that of control group (87.25 eggs). Statistical analysis of the cumulative quail housed egg number and per cent production did not reveal significant difference between dietary groups. The cumulative quail housed number (QHN) per quail obtained in the control group in the present study is close to the QHN reported by Lekshmy (2005) but lesser by 20 to 22 eggs than that reported by Preethymol (2006) and Raseena(2006) who have recorded early sexual maturity and higher feed intake in quail in comparison to the results obtained in this study.

5.4.1.2 Period wise Quail Day Egg Number (QDN) and Per cent Production (QDP)

Period wise quail day number and per cent production shown in Table 8 and 9 revealed that the period wise quail day number and per cent differed from quail housed number and its per cent (Table 6 and 7) during period I (7 – 10

weeks of age) only. When cumulative QDN and QDP were considered from 7 to 26 weeks of age the highest QDN of 99.42 with corresponding QDP of 71.02 was observed in group fed with combination of turmeric and tulasi (T4) and lowest QDN of 89.22 and QDP of 63.72 in control group (T1). As the mortality of one bird in T1 group and two birds in T4 group occurred during the first week of experiment it might not be due to any dietary effect. The magnitude of increase in cumulative quail day egg number from 7 to 26 weeks of age noticed in turmeric group (T2), tulasi group (T3) and combination group (T4) were 5.61, 4.56 and 10.22, respectively. The highest increase of 10.22 eggs per quail in T4 group indicates the synergetic effect of turmeric and tulasi on egg production in layer quails.

5.4.2 Weekly Egg Production (%)

The weekly quail housed per cent (QHP) production in control group were above 70 per cent from 9 to 14 weeks of age and it was below 70 per cent from 15 to 26 weeks and recorded 58.25 per cent production at 26 weeks of age. High egg production of 84.96 per cent at 10^{th} week and 81.03 per cent at 13^{th} week of age recorded in this group also indicated that the level of peak production was maintained for short duration.

The QHP in quails fed diet containing turmeric (T2) maintained higher egg production rate for longer duration, from 10^{th} week onwards. It was above 70 per cent during 10 to 26 weeks of age, except 16, 17, 20 and 26 weeks of age and the level of production was 69.24 per cent at 26 weeks of age. Moreover, the QHP were above 80 per cent at 10, 11, 12 and 13 weeks of age indicated higher peak production for longer duration than that obtained in the control group. The cumulative egg production from 7 to 26 weeks of age was 94.83 eggs per quail and it was 7.58 eggs more than that obtained in the control group, inspite of the higher unit cost of feed.

The rate of egg production from 10 to 26 weeks of age in quails fed tulasi was more or less similar to that observed in the quails fed turmeric. From 10th week onwards, it was above 70 per cent in all weeks except 16 to 19 and at 23 weeks of age. In quails fed diet containing tulasi (T3), the highest production was 85.36 per cent which remained only for one week that too at 20 weeks of age. The cumulative egg production from 7 to 26 weeks of age was 93.78 eggs per quail and it was 6.53 eggs more than that obtained in the control group and 1.05 eggs less than that in the turmeric fed group T2.

The quails fed diet containing both turmeric and tulasi (T4) exhibited synergetic effect. The weekly egg production in group T4 was higher than that recorded in groups T2 and T3 and combination effect was reflected from 10th week onwards. The QHP in quails fed diet (T4) were plus 70 per cent in all weeks except 19, 23 and 26 weeks of age. The level of peak production was high and it was maintained above 80 per cent for longer duration for a period of six weeks. The mean values of quail housed egg production were 87.58, 87.30, 84.4, 87.54 and 81.39 per cent from 10 to 14 weeks of age, in that order. Thereafter, the weekly egg production was maintained fairly high at 78.06, 75.83, 78.09, 79.52, 75.12, 77.10 and 80.91 per cent at 15, 18, 20, 21, 22, 24 and 25 weeks of age respectively.

5.5 MEAN EGG WEIGHT

The mean egg weight (EW) worked out on the basis of all eggs weighed individually during three consecutive days towards the end of each 28-day period (at 10, 14, 18, 22 and 26 weeks) in different groups are presented in Table 12. At 10th week of age, the mean egg weight ranged from 10.51 to 10.79 g did not differ significantly between dietary groups. Mean egg weight was lowest in group T1 and the highest in group T4 and intermediary in groups T2 and T3 (10.70 and 10.71 g respectively). At 14 weeks of age, compared to 10th week EW, a slight decline in egg weight was noticed in all groups except in the control group, but did not make significant difference between groups.

At 18 weeks of age, the mean egg weight of 11.11 g recorded in control group was statistically comparable with that in the turmeric fed group (11.06 g) and both these weights were significantly ($P<0.05$) higher than that in the groups T3 and T4 fed tulasi alone and in combination with turmeric (10.71 g). The high egg weight recorded in the control group at 18 weeks of age can be attributed to the low egg number at this age. The group (T2) fed turmeric also showed significantly higher ($P\leq0.05$) egg weight even with high egg number indicated positive influence of turmeric on egg weight. The egg weights in groups T3 and T4 were same and were significantly lower than groups T1 and T2. This finding is in agreement with Thiruvengadam *et al.* (2006) who could not observe any significant effect on egg weight by supplementation of tulasi in standard designer feeds in laying hens. In the combination group T4, the positive effect of turmeric on egg weight as such was not reflected because of the higher egg production in this group. This positive effect of turmeric was not consistent in subsequent periods wherein a general decline in egg weight was observed at 22^{nd} and 26^{th} week of age.

While considering the pooled egg weight at 10, 14, 18, 22 and 26 weeks of age, the overall egg weight for 15 days among treatment groups was almost uniform (10.74, 10.71, 10.64 and 10.62 g). The mean egg weight during this period is in agreement with the optimum egg weight of 10.0 g in quails reported by Sreenivasiah (1998). The mean egg weight during this experimental period falls in the range of average egg weight of 10.73 to 10.81 g reported by Lekshmy (2005) and 10.40 to 11.14 g reported by Sheena (2005). On the other hand mean egg weight from 7 to 26 weeks of age obtained in this study was lesser by 0.4 to 1.0 g than that reported by Preethymol (2006), Raseena (2006) and Preeta (2007). The above variations could be attributed to the differences in daily feed consumption and mean body weight at 6 and 26 weeks of age in quails. However, the three days mean egg weight at the above ages did not represent the actual mean egg weight records based on the total egg mass for the corresponding periods.

5.6 EGG MASS

The total egg mass per quail worked out on quail day basis from 7 to 26 weeks of age (Table 13) was the highest (1047.68 g) in the group fed 0.3 per cent turmeric and tulasi combination (T4) and was 90.51 g more than that in control group (T1), was due to the increase of 10.20 eggs on quail day basis in this group. The magnitude of difference recorded in egg mass in turmeric fed group (T2) was 53.36 g due to higher production of 5.61 eggs per quail in comparison with the control group. In the tulasi fed group, the difference of 4.56 eggs per quail in comparison with the control group leading to a difference of 42.63 g in total egg mass.

5.7 FEED CONSUMPTION

The mean daily feed intake of quails in different treatments showed no significant difference between dietary groups in the entire experimental period from I to V (Table 14). The cumulative mean feed intake from 7 to 26 weeks per quail per day was 26.31, 25.71, 25.79 and 27.03 g for dietary groups T1, T2, T3 and T4, respectively.

The period wise feed intake per quail per day revealed comparatively higher feed intake in all treatment groups during period I and V which could not be attributed to any specific reason as this increase in feed consumption was narrow and the groups were statistically comparable. No adverse effects could be observed on feed intake in laying quails due to supplementation of turmeric or tulasi in any of the periods studied. The mean feed consumption can be considered optimum from 7 to 26 weeks of age in relation with the body weight in experimental quails. Sreenivasaiah (1998) stated that Japanese quails consume 25 to 28 g feed per bird per day during production period.

The comparatively lower feed consumption recorded in this study might be due to the lower body weight of quails at 6 and 26 weeks of age. The mean daily feed consumption per quail obtained in the present study is lower than that

reported by Lekshmy (2005) and Sheena (2005) who reported a mean feed consumption of 28 to 29 g in quails and Preethymol (2006), Raseena (2006) and Preeta (2007) who reported higher body weight and higher feed intake in layer quails.

5.8 FEED CONVERSION RATIO (FCR) PER DOZEN EGGS AND PER KG EGG MASS

Feed conversion ratio per dozen eggs as well as per kg egg mass did not show any significant difference either in the cumulative FCR or in period wise values due to the supplementation of turmeric, tulasi or both. Eventhough the FCR values were higher in all treatment groups during 7-10 weeks of age, FCR improved in subsequent periods due to increase in egg production. The cumulative FCR calculated in different treatment groups based on cumulative quail housed egg number were 0.50 (T1), 0.48 (T4) and 0.46 (T2 and T3). The numerically lower egg number with comparatively higher feed intake per quail resulted poorest FCR in control group (0.50 per dozen eggs) compared to turmeric (T2) and tulasi groups (T3).

The FCR values based on the egg mass was also highest (3.88) in control group, lowest (3.59) in turmeric group (T2) and intermediary (3.62 and 3.63) in tulasi group (T3) and combination group (T4), respectively. Poorest FCR in control group was due to lowest egg mass, while the comparatively lower feed consumption and better egg mass in the turmeric group (T2) resulted in superior FCR. Eventhough the egg mass per quail was highest in combination group (T4), the highest feed intake of quails in this group resulted the similar FCR value as in tulasi group (T3) which had lower egg mass.

However, the present findings on FCR per dozen eggs and kg egg mass in quails support the findings of Preethymol (2006) and Raseena (2006) who reported similar FCR values in layer quails during same period.

5.9 HAEMATOLOGICAL PARAMETERS

The mean values of haematological parameters observed at the end of 26th week of age as influenced by the dietary supplementation of turmeric and tulasi in layer Japanese quails are presented in Table 17. The supplementation of turmeric and tulasi significantly increased the haematological parameters as haemoglobin and total leucocyte count ($P \leq 0.05$) in comparison with the control group. While the total erythrocyte count did not reveal significant difference among the dietary groups.

5.9.1 Haemoglobin

The values of mean Heamoglobin (Hb) in quails belonging to the dietary groups T1, T2, T3 and T4 were 9.09, 9.88, 9.72 and 10.49 g per cent, respectively. The quails fed combination of turmeric and tulasi (T4) showed the highest Hb value of 10.49 g per cent and was significantly higher than the lowest value of 9.09 g per cent observed in the control group T1 ($P \leq 0.05$). The values in groups T2 and T3 were intermediary and comparable with those of T1 and T4.The salient features of these findings are in close agreement with Narahari *et al.* (2005), who reported a significant increase in haemoglobin by supplementation of 0.5 per cent Basil leaves in layer feed and Simi (2007) reported increase in haemoglobin level in broilers fed 0.6 per cent turmeric.

5.9.2 Total Erythrocyte Count

The mean total erythrocyte count observed in quails at 26th week of age observed for the dietary groups T1, T2, T3 and T4 were 2.55, 2.64, 2.69 and 2.79 million per µ L which were statistically comparable. This result supports the findings of Gupta and Charan (2007), who could not observe any significant difference in TEC of broilers supplemented with *Ocimum sanctum* at different levels in feed.

5.9.3 Total Leucocyte Count

The mean total leucocyte count observed at the end of 26th week of age as influenced by dietary supplementation of turmeric and tulasi in dietary groups T1, T2, T3 and T4 were 22.00, 22.88, 23.38 and 24.50 thousands per μ L, respectively. The birds in the group fed with combination of 0.3 per cent turmeric and tulasi (T4) had significantly higher total leucocyte count than birds in control group (T1), while the values in groups T2 and T3 were intermediary and comparable with T1 and T4. This finding is in agreement with that of Narahari *et al.* (2005), who reported a significant increase in total leucocyte count in layer hens by dietary supplemention of 0.5 per cent Basil leaves and Simi (2007), who observed significant increase in TLC of broilers by dietary supplementation of 0.6 per cent turmeric. The present finding supports the immunomodulatory actions of turmeric and tulasi in poultry, reported by the above authors.

5.10 BIOCHEMICAL PARAMETERS

5.10.1 Serum Total Protein

The mean serum total protein levels in layer Japanese quails at 26 weeks of age presented in Table 18 for the dietary groups T1, T2, T3 and T4 were 3.25, 3.35, 3.38 and 3.58 g per dl, respectively . Statistical analysis of the data on serum protein did not reveal significant difference. The serum protein values of layer quails in this study were lower than that reported by Sheena (2005) and Preethymol (2006), but Raseena (2006) reported the serum protein value as 3.29 g per cent at 26 weeks of age.

5.10.2 Serum Total Cholesterol

The total cholesterol estimated in serum of quails at the end of 26 weeks of age in various dietary treatments are set out in Table 18. The serum total cholesterol levels for the dietary groups T1, T2, T3 and T4 were 166.13, 149.00, 141.13 and 125.75 mg per dl, respectively. Statistical analysis of the data revealed

that the mean cholesterol values in all groups differed significantly each other ($P \leq 0.05$) with the highest value in control group T1 followed by T2 and T3 and the lowest value was recorded in group T4 supplemented with combination of turmeric and tulasi. This finding indicated the hypocholesterolemic effect of turmeric and tulasi separately and in combination at a level of 0.3 per cent each in the diet of caged Japanese quail layers. A similar trend of reduction in serum cholesterol levels in layer quails by dietary inclusion of azolla was observed by Raseena (2006).

5.10.3 Egg Yolk Cholesterol

The cholesterol values estimated in egg yolk of quails at 26 weeks of age (Table 18) averaged 18.67, 17.89, 17.03 and 16.56 mg per g yolk in dietary groups T1, T2, T3 and T4, respectively. Statistical analysis revealed significant ($P \leq 0.05$) reduction in egg yolk cholesterol by supplementation of tulasi alone and in combination with turmeric. The yolk cholesterol value of eggs in turmeric group was intermediary and was statistically comparable with other three groups. A similar trend in reduction of egg yolk cholesterol was observed in laying hens by supplementation of tulasi by Narahari *et al* (2005). The significant ($P \leq 0.05$) reduction in yolk cholesterol in group supplemented with turmeric and tulasi combination in the present study agrees with the findings of Thiruvengadam *et al.* (2006) who observed significant reduction in egg yolk cholesterol in laying hens by supplementation of the designer diet with combination of turmeric, tulasi and keelanelli. The yolk cholesterol values observed in quails in various dietary groups in this study are close to the values reported by Yalcin *et al.* (2007).

5.11 PROCESSING YIELDS AND LOSSES

The processing yields pertaining to dressed, eviscerated, giblet and ready-to-cook yield over the live weight at 26 weeks of age in layer quails as influenced by dietary supplementation of turmeric and tulasi are presented in Table 19.

Statistical analysis of the data on yields revealed that none of the above traits were significant between the dietary groups.

The mean dressed yield in dietary groups T1, T2, T3 and T4 were 90.01, 90.65, 91.11 and 91.96 per cent and the mean per cent eviscerated yields were 62.60, 60.89, 61.80 and 63.37 per cent, respectively. The magnitude of difference in per cent dressed yield and eviscerated yield between treatments were narrow. The present results showed that the dressed yields obtained is almost similar to the findings of Singh *et al.* (1980).

The mean per cent R- to-C yield was 67.66, 65.81, 66.95 and 68.31 for T1, T2, T3, and T4 and the mean giblet yield was 5.06, 4.92, 5.15 and 4.94 respectively. The R-to-C yield was the highest for the group supplemented with combination of 0.3 per cent turmeric and tulasi (T4) and the giblet yield was the highest for the group supplemented with tulasi (T3).

The data on feather loss did not differ significantly among the dietary groups. This agrees with the findings of Pandey *et al.* (1979). The data on blood loss noticed in the group T1 was significantly higher than that of T3 and T4 ($P<0.05$), but was comparable with the group supplemented with turmeric (Table 19). The results obtained in the present study is in agreement with the findings of Narayanankutty (1987).

5.12 LIVABILITY

The mean livability per cent of Japanese quails from 7 to 26 weeks of age as influenced by supplementation of turmeric and tulasi (Table 20) revealed that three (3) quails were died during the experimental period, one in group T1 at 8^{th} week and in group T4 one each at 8^{th} and 9^{th} week of age. The overall livability was 100 per cent in groups T2 and T3 and that in groups T1 and T4 were 97.5 and 95.0 per cent, respectively. However, autopsy of the dead birds revealed no specific reasons that can be attributed to the effect of dietary supplementation of turmeric and tulasi combination and also in control group. This is in agreement

with the results of Padmakumar (1993) who reported that livability ranged from 93.75 to 100 per cent in laying Japanese quails. Simi (2007) observed 100 per cent livability in broilers supplemented with turmeric.

5.13 ECONOMICS

The economics of rearing Japanese layer quails on ration supplemented with 0.3 per cent turmeric, 0.3 per cent tulasi and their combination (Table 21) indicated that the cost of one kilogram feed for the dietary groups T1, T2, T3 and T4 were Rs.11.13, 11.28, 11.13 and 11.28, respectively. The higher feed cost in turmeric supplemented groups was due to the high cost of turmeric (Rs.50 per kg of dried rhizome). Margin of return over cost of feed and layer quail was higher in T2 followed by T3, T4 and T1 (Rs 29.75, 29.24, 27.54 and 22.54) due to the higher egg number in T2. The feed cost per egg was lowest and same in T2 and T3 (Rs 0.43) followed by T4 (Rs 0.45) and was lower than that of control group (Rs 0.47). The margin of returns per quail per period was Rs 4.51, 5.95, 5.85 and 5.51 in T1, T2, T3 and T4, respectively.

Based on the above findings, it was concluded that the supplementation of 0.3 per cent turmeric and tulasi combination in quail layer diets resulted in significant reduction in serum and egg yolk cholesterol levels with out adversely affecting the production performance in respect of egg number, egg weight, feed intake and feed conversion ratio. The numerical increase in egg production with turmeric and tulasi supplementation in quail layer diets leads to economical advantages.

Summary

6. SUMMARY

An experiment was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, to study the effect of dietary supplementation of dried turmeric rhizome and tulasi leaves on production performance and physiological profile in layer Japanese quails.

The experiment was carried out during the period from 29th December 2007 to 16th May 2008. One hundred and sixty (160) layer Japanese quails were weighed individually at six weeks of age and allocated randomly to four dietary groups viz., T1, T2, T3 and T4 with four replicates consisting of ten quails each. Each replicate was housed in separate cages and standard managemental practices were followed uniformly. Quail layer diet containing 22 per cent crude protein and 2650 kcal metabolizable energy per kg feed formed the control diet (T1). The control diet supplemented with 0.3 per cent dried turmeric rhizome powder formed the diet T2 and diet T3 was formed by supplementing the control diet with 0.3 per cent dried tulasi leaves. Supplementation of the control diet with the combination of dried turmeric and tulasi leaves each at 0.3 per cent level formed the diet T4.

The data were collected for five periods of 28 days each, from 7 to 26 weeks of age. The maximum and minimum temperature (^{0}C) and per cent relative humidity in the F.N and A.N. inside the experimental house were recorded daily. Egg production was recorded daily and expressed as quail housed and quail day egg number and per cent production week wise and period wise. The period wise mean egg weight was worked out from three consecutive days at the end of each 28-day laying period and egg mass per quail was computed from replicate wise egg mass measured daily. Feed consumption was recorded period

was 26.59 C and relative humidity was 77.96 per cent in the F.N and 61.09

wise and the feed conversion ratio per dozen eggs and per kg egg mass were calculated period wise.

At the end of 26 weeks of age, body weight of the quails was recorded individually and two quails at random from each replicate were slaughtered to study the processing yields and losses. Per cent yields of dressed, eviscerated, giblet and R-to-C weight were recorded separately in each quail slaughtered. The per cent losses of blood and feather were determined.

Blood collected at the time of slaughter was used to estimate the haemoglobin, total erythrocyte count, total leucocyte count, serum protein and cholesterol levels. At 26^{th} week of age two eggs were randomly collected from each replicate for assessing the egg yolk cholesterol. The economics of turmeric and tulasi supplementation in the diet was worked out based on the cost of feed ingredients and sale price of quail eggs prevailed during the period of study.

The salient findings in the study are presented below.

1. The overall mean maximum temperature was 32.14^0C, minimum temperature was 26.59^0C and relative humidity was 77.98 per cent in the F.N and 61.09 per cent in the A.N., inside the experimental house from December 2007 to May 2008.

2. The average body weights of the quails were 155.55, 155.92, 155.07 and 155.44 g at 6 weeks of age and 206.09, 206.29, 203.67 and 206.01g at 26 weeks of age in groups T1, T2, T3 and T4, respectively. The body weight at both these ages did not show significant difference between groups.

3. The absolute age at first egg was 48, 50, 49 and 49 days and the mean age at first egg and 50 per cent production were 55.50, 56.25, 55.75 and 56.00 days in dietary groups T1, T2, T3 and T4, respectively.

4. Period wise and cumulative mean values of QHN and per cent, QDN and per cent, egg mass, daily feed consumption, FCR per dozen eggs and per kg egg mass did not differ significantly between groups.

5. The quail housed cumulative egg number during the period from 7 to 26 weeks of age was 87.25, 94.83, 93.78 and 94.65 in groups T1, T2, T3 and T4, respectively and the corresponding percentages were 62.32, 67.73, 66.95 and 67.61.

6. The mean cumulative egg number on quail day basis was 89.22, 94.83, 93.78 and 99.42 in the groups T1, T2, T3 and T4, respectively and corresponding percentages were 63.72, 67.73, 66.95 and 71.02.

7. The overall mean egg weight for three consecutive days towards the end of 10, 14, 18, 22 and 26 weeks of age was 10.74, 10.71, 10.64 and 10.62 g in the groups T1, T2, T3 and T4, respectively and the differences between mean values were non significant.

8. The cumulative mean egg mass per quail on quail day basis in T1, T2, T3 and T4 were 957.17, 1010.53, 999.80 and 1047.68 g, respectively.

9. The period wise mean daily feed consumption per quail during the entire period of experiment averaged 26.31, 25.71, 25.79 and 27.03 g in the groups T1, T2, T3 and T4, respectively.

10. The cumulative FCR per dozen eggs in the dietary groups T2 and T3 was same (0.46) and that in T1 and T4 were 0.50 and 0.48, respectively. The cumulative FCR per kg egg mass in T1, T2, T3 and T4 were 3.88, 3.59, 3.62 and 3.63, respectively.

11. The mean values of Hb were 9.09, 9.88, 9.72 and 10.49 g/dl for T1, T2, T3 and T4, respectively and the group T4 showed significantly higher value than that of T1 ($P \leq 0.05$). The total leucocyte count was lowest in the control group ($22 \times 10^3/\mu$ L) and highest in the group T4 ($24.50 \times 10^3/\mu$ L) showing

significant increase with the supplementation of 0.3 per cent turmeric and tulasi combination in quail layer diets. The mean values of total erythrocyte count revealed no significant difference between dietary groups.

12. The mean values of total cholesterol in serum were 166.13, 149.00, 141.13 and 125.75 mg/dl for T1, T2, T3 and T4, respectively and differed significantly among each other ($P \leq 0.05$). The mean value of egg yolk cholesterol were 18.67, 17.89, 17.03 and 16.56 mg/g yolk for T1, T2, T3 and T4, respectively and the groups T3 and T4 showed significantly lower value in comparison with T1 ($P \leq 0.05$). Serum protein level in various dietary groups did not differ significantly among each other.

13. The per cent yields of dressed, eviscerated, giblet and R-to-C yield did not differ significantly among the dietary groups. The loss of blood in dietary groups were 4.79, 4.35, 3.84, and 3.93 in T1, T2, T3 and T4, respectively and were significantly higher in T1 in comparison with T3 and T4 ($P \leq 0.05$). There was no significant difference in per cent loss of feather.

14. The cumulative mean livability among dietary groups T1, T2, T3 and T4 were 97.50, 100.00, 100.00 and 95.00 per cent, respectively.

15. The feed cost in the groups T1, T2, T3 and T4 were Rs. 11.13, 11.28, 11.13 and 11.28 per kg diet, respectively. The cost of feed per egg was lower in T2 and T3 (Rs. 0.43) followed by T4 (Rs. 0.45) and T1 (Rs.0.47). The margin of returns over feed cost and layer quails was higher in T2 and T3 (Rs. 29.75 and 29.24) compared to the low returns in T4 and T1 (Rs. 27.54 and 22.54 respectively) for the period from 7 to 26 weeks of age.

The results of this study revealed that supplementation of turmeric and tulasi in quail layer diet at 0.3 per cent levels did not adversely affect body weight, feed intake, feed conversion ratio and quail housed egg production and per cent, and egg weight. Supplementation of 0.3 per cent turmeric and tulasi separately and in combination in quail layer diet resulted in significant decrease

in serum cholesterol and the supplementation of tulasi alone and in combination with turmeric reduced egg yolk cholesterol significantly ($P \leq 0.05$). Significant increase in haemoglobin and total leucocyte count with turmeric and tulasi combination was also observed. The overall evaluation of the study indicated that supplementation of dried turmeric and tulasi leaves at 0.3 per cent level in quail layer diets separately and in combination resulted numerical increase in egg production with improvement in physiological status of birds leading to economical advantages.

References

REFERENCES

Abbas, R.Z., Iqbal, Z. and Khan, M.N. 2007. Anticoccidial activity of *Curcuma longa L.* in broilers. www.ecam.oxfordjournals.org.

Akinyemi, O.K., Oladapo, O., Okwara, E.C., Ibe, C.C. and Fasure, K.A. 2005. Screening of crude extracts of six medicinal plants used in South west Nigerian unorthodox medicine for antimethicillin resistant *Staphylococcus aureus* activity. *BMC complimentary and Alternative Medicine.* 5: 6

Allen, N.K. and Young, R.J. 1980. Studies on the amino acid and protein requirement of laying Japanese quail (*Coturnix coturnix japonica*). *Poult. Sci.* 59: 2029-2037

Al-Sultan, S.I. 2003. The effect of *Curcuma longa* (Turmeric) on overall performance of broiler chickens. *Int. J. Poult. Sci.* 2: 351-353

AOAC. 1990. *Official Methods of Analysis.* Fifteenth edition. Association of Official Analytical Chemists, Washington, D.C, 587 p.

Arscott, G.H. and Goeger, M.P. 1981. Protein needs for laying Japanese quail as influenced by protein level and amino acid supplementation. *Nutr. Rep. Int.* 24: 1287-1295

Chopra, R.N., Nayar, S.L. and Chopra, I.C. 1956. *Glossary of Indian Medicinal plants.* Publication and Information Directorate, CSIR, New Delhi, India

Choudhary, M.K. and Mahadevan, T.D. 1983. Studies on the effect of age and sex on slaughter characteristics of quails (*Coturnix coturnix japonica*). *Indian J. Poult. Sci.* 18: 33-36

Durrani, F.R., Ismail, M., Sultan, A., Suhail, S.M., Chand, N. and Durrani, Z. 2006. Effect of different levels of feed added turmeric (*Curcuma longa*) on the performance of broiler chicks. *J. Agric. Biol. Sci.* 1: 9-11

Emadi, M. and Kermanshahi, H. 2007. Effect of turmeric rhizome powder on the activity of some blood enzymes in broiler chickens. *Int. J.Poult. Sci.* 6:48-51

FAO. 2004-2005. www.faostat.fao.org.

Gupta, G. and Charan, S. 2007. Exploring the potentials of Ocimum sanctum (Shyama tulsi) as feed supplement for its growth promoter activity in broiler chickens. Indian J. Poult. Sci. 42: 140-143

*Gupta, S.K., Prakash, J. and Shrivastva, S. 2002. Validation of traditional claim of tulasi, *Ocimum sanctum* Linn. as a medicinal plant. *Indian J. Exp. Biol.* 40: 765-773

Johri, T.S. and Vohra, P. 1977. Protein requirements of Coturnix coturnix japonica for reproduction using purified diets. *Poult. Sci.* 56: 350-353

Kurkure, N.V., Pawar, S.P., Kognole, S.M., Bhandarkar, A.G., Gamorkar, A.G. and Kalorey, D.R. 2000. Ameliorative effect of turmeric (*Curcuma longa*) in induced aflatoxicosis in cockerels. *Indian J. Vet. Path.* 24: 26-28

Kurkure, N.V., Pawar, S.P., Kognole, S.M., Gaonorkar, A.G., Bhandarkar, A.G. and Kalorey, D.R. 2001. Prevention of aflatoxin induced toxicity by

turmeric in cockerels haematology and biochemical study. *Indian J. Vet. Res.* 10: 35-40

Lekshmi, M.A. 2005. Utilisation of dried cuttle fish (*Sepia officialis*) waste silage in Japanese quail (*Coturnix coturnix japonica*) layer ration. MVSc thesis, Kerala Agricultural University, Thrissur, 95 p

Logambal, S.M., Venketalakshmi, S. and Michael, D.R. 2000. Immunostimulatory effect of leaf extract of *Ocimum sanctum Linn.* In *Oreochromis mossambicus* (Peters). *Hydrobiologia* 430: 113-120

Majumdar, S., Narayan, R., Agarwal, S.K. and Khan, T.H. 1996. Influence of housing systems and casein feeding on serum cholesterol and protein levels of broiler quails. Souvenir and abstracts of eighteenth annual poultry science symposium, 11-13 January 1996. College of Veterinary and Animal Sciences, Thrissur. *Abstract* : PM.02

Mandal, K.G., Das, P.K., Datta, G.C. and Das, K. 1993. Influence of age and sex on slaughter characteristics of Japanese quail. *Indian J. Poult. Sci.* 28: 262-264

Maurice, D.V. and Jensen, L.S. 1978. Effect of dietary cereal on liver and plasma lipids in laying Japanese quail. *Br. Poult. Sci.* 19: 199-205

Mbata, T. I., and Saikia, A. 2007. Anti bacterial activity of essential oil from *Ocimum gratissimum* on *Listeria monocytogenes* . *J. Food Safety.* 5:15-19

Mishra, S.K., Panda, B., Mohapatra, S.C., Shrivastav, A.K. and Singh, R.P. 1993. Response of genotypes to dietary protein levels for growth and carcass quality traits in Japanese quail. *Indian J. Poult. Sci.* 28: 106-115

Narahari, D., Michaelraj, P., Kirubakaran, A. and Sujatha, T. 2005. XI[th] European symposium on the quality of eggs and egg products, Doorwerth, The Netherlands

Narayanankutty, K. 1987. Dietary protein and energy requirements of meat type Japanese quail (*Coturnix coturnix japonica*) for growth. Ph.D. thesis, Kerala Agricultural University, Thrissur. 114p

Natt, M.P. and Herrick, C. A. 1952. A new blood diluent for counting the erythrocytes and leucocytes in chicken. *Poult. Sci.* 31: 735-738

Negi, P.S., Jayaprakasha, G.K., Jagan Mohan, Rao, L. and Sakariah, K.K. 1999. Antibacterial activity of turmeric oil: a byproduct from curcumin manufacture. *J. Agric. Fd. Chem.* 47: 4297-4300

Ozbey, O., Erisir, Z., Aysondu, M.H. and Ozmen, O. 2004a. The effect of high temperatures on breeding and survival of Japanese quails that are bred under different temperatures. *Int. J. Poult. Sci.* 3: 463-467

Ozbey, O., Yildiz, N., Aysondu, M.H. and Ozmen, O. 2004b. The effects of high temperature on blood serum parameters and the egg productivity characteristics of Japanese quails (*Coturnix coturnix japonica*). *Int. J. Poult. Sci.* 3: 485-489

Padmakumar, B. 1993. Effect of floor density on production performance in Japanese quails reared in cages and deep litter. MVSc thesis, Kerala Agricultural University, Thrissur, 121 p.

Pandey, N.K., Mahapatra, C.M. and Verma, S.S. 1979. Effect of pre-slaughter fasting on slaughter characteristics and cut-up parts of Japanese quail (*Coturnix coturnix japonica*). *Indian Poult. Gaz.* 63:11-113

Perumal, G., Subramanyam, C., Natarajan, D., Srinivasan, K., Mohanasundari, C. and Prabhakar, K. 2004. Antifungal activities of traditional medicinal plant extracts – a preliminary survey. *J. Phytol. Res.* 17: 81-83

Preeta, R. 2007. Utilisation of dried fish waste and fermented fish waste silage in Japanese quail (*Coturnix coturnix japonica*) layer ration. MVSc thesis, Kerala Agricultural University, Thrissur, 72 p

Preethymol, J. 2006. Effects of dietary supplementation of lysine and methionine on production performance of Japanese quail (*Coturnix coturnix japonica)* M.V.Sc. thesis, Kerala Agricultural University. Thrissur. 114p

Raseena, K.2006. Effect of dietary supplementation of Azolla (*Azolla pinnata*) on production performance of Japanese quail (coturnix coturnix japonica) M.V.Sc. thesis. Kerala Agricultural University, Thrissur. 117p

Rath, C.C., Dash, S.K. and Mishra, R.K. 2002. Antibacterial efficacy of six Indian essential oils individually and in combination. J. *Essent. Oil Bearing Plants* 5: 99-107

Ross, E. and Dominy, V. 1990. The nutritional value of dehydrated, blue green algae (*Spirulina platensis*) for poultry. *Poult. Sci.* 69: 794-800

Sachdev, A.K. and Ahuja, S.D. 1986. Studies on the influence of body weight at sexual maturity on production traits in Japanese quail. *Indian J. Poult. Sci.* 21: 66-68

Sastri, G.A. 1998. *Veterinary Clinical Pathology*. Third edition. CBS Publishers and Distributers. Pvt.Ltd., New Delhi, 207 p

Sheena, G.K. 2005. Supplementation of protease on the production performance of Japanese quails(*Coturnix coturnix japonica)* fed low protein diet. M.V.Sc. thesis, Kerala Agricultural University, Thrissur. 92p

Shrivastav, A.K., Raju, M.V.L.N. and Johri, T.S. 1993. Effects of varied dietary protein on certain production and reproduction traits in breeding Japanese quail. *Indian J. Poult. Sci.* 28: 20-25

Shukla, P.K., Shrivastav, A.K., Singh, R.P. and Bedi, S.P.S. 1993. Effect of dietary supplementation of zinc on egg production and egg quality characteristics of Japanese quail. *Indian J. Poult. Sci.* 28:190-194

Simi, G. 2007. Effect of dietary supplementation of Turmeric (*Curcuma longa)* on production performance of broiler chicken. M.V.Sc. thesis, Kerala Agricultural University. Thrissur. 81p

Singh, R.P., Shrivastav, A.K. and Panda, B. 1980. Studies on slaughter characteristics of Japanese quail (*Coturnix coturnix japonica*) at different stages of growth. *Indian Poult. Gaz.* 64: 12-17

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods*. Eighth edition. Afiliated East-West Press.

Soares, R.T.R.N., Fonseca, J.B., Santos, A.S.O. and Mercandante, M.B. 2003. Protein requirement of Japanese quail (*Coturnix coturnix japonica*) during rearing and laying periods. *Rev. Bras. Cienc. Avic.* 5: 153-156

Somanathan, V.L. 1980.Bio-climatological studies on dry matter intake and water consumption of growing livestock. M.V.Sc thesis, Kerala Agricultural University, Thrissur, India. 92 p

Soni, K.B., Rajan, A. and Kuttan, R. 1992. Reversal of aflatoxin induced liver damage by turmeric and curcumin. *Cancer Lett.* 66: 115-121

Sreenivasaiah, P.V. 1998. *Scientific Poultry Production.* Second edition. IBH Prakashana, Bangalore, 803 p

Thiruvengadam, R., Ahmed, M., Prabhakaran, R., Narahari, D. and Sundararasu, V. 2006. Herbal enrichment of eggs to improve their health promoting properties. *Tamilnadu J. Vaterinary and Animal Sciences.* 2: 212-219

Vorlova, L., Sieglova, E., Karapiskova, R. and Kopriva, V. 2001. Cholesterol content in eggs during the laying period. *Acta Vet. Brno.* 70: 387-390

Washburn, K.W. and Nix, D.F. 1974. A rapid technique for extraction of yolk cholesterol. *Poult. Sci.* 53:1118-1122

Yalcin, S., Onbasilar, I., Sehe, A. and Yalcin, S. 2007. The effects of dietary garlic powder on the performance, egg traits and blood serum cholesterol of laying quails. *Asian- Aust. J. Anim. Sci.* 20: 944-947

Yamane, T., Ono, K. and Tanaka, T. 1979. Protein requirement of laying Japanese quail. *Br. Poult. Sci.* 20: 379-383

* Originals not consulted

DIETARY SUPPLEMENTATION OF TURMERIC (*Curcuma longa*) AND TULASI (*Ocimum sanctum*) IN LAYER QUAILS (*Coturnix coturnix*)

BHADRA. P. V.

Abstract of the thesis submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2008

Department of Poultry Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR-680651
KERALA, INDIA

ABSTRACT

An experiment was carried out to study the effect of dietary supplementation of turmeric and tulasi on production performance of Japanese quail layers. One hundred and sixty Japanese quails at 6 weeks of age were allocated randomly to four dietary groups with four replicates of ten quails each. Quail layer ration containing 22 per cent crude protein and 2650 kcal ME per kg feed formed the control diet T1. The control diet supplemented with dried turmeric rhizome powder, dried tulasi leaves and a combination of both each at 0.3 per cent level formed the diets T2, T3 and T4, respectively. The experiment was carried out for five periods of 28 days each from 7 to 26 weeks of age.

The body weight at 6 and 26 weeks of age and the body weight gain during experimental period did not differ significantly between dietary treatments. Even though the age at first egg in the flock in dietary groups T1, T2, T3 and T4 was 48, 50, 49 and 49 days respectively, the mean age at 50 per cent production were almost similar in all dietary groups. The results obtained in the study revealed that period wise and cumulative mean values of quail housed and quail day egg number and per cent production, egg mass, daily feed consumption, FCR per dozen eggs and per kg egg mass did not differ significantly between dietary groups. The overall mean egg weight for three consecutive days towards the end of 10,14, 18, 22 and 26 weeks of age were non significant. Statistical analysis of the data pertaining to dressed, eviscerated, giblet and ready-to-cook yields revealed no significant difference between dietary groups. The loss of blood in dietary groups were significantly ($P \leq 0.05$) higher in group in T1 in comparison with group T4. While the mean values of feather loss showed no significant difference.

The dietary supplementation of turmeric and tulasi combination (T4) significantly improved the haemoglobin and total leucocyte count in comparison with the control group whereas total erythrocyte count revealed no significant

difference. The mean values of total cholesterol in serum differed significantly among each other ($P \leq 0.05$). Egg yolk cholesterol in group T3 and T4 showed significantly lower values in comparison with T1 ($P \leq 0.05$). Serum protein level in various dietary groups did not differ significantly among each other. The overall livability per cent was not adversely affected in turmeric and tulasi fed quails. The cost of feed per egg was lower in T2 and T3 (Rs. 0.43) compared to T1 (Rs. 0.47) and was intermediary in T4 (Rs. 0.45).

The critical evaluation of the results revealed that the supplementation of dried turmeric and tulasi leaves separately and in combination, each at 0.3 per cent level in quail layer diets resulted in numerical increase in egg production leading to economical advantages.