# PRODUCTION PERFORMANCE OF JAPANESE QUAILS REARED ON DIFFERENT PROTEIN LEVELS

**PADWAL N. P.**

**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**

**2010**

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

# DECLARATION

I hereby declare that this thesis, entitled **"Production performance of Japanese quails reared on different protein levels"** is a bonafide record of research work done by me during the course of research and that the 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

Date: **Padwal N. P.**

# CERTIFICATE

Certified that this thesis, entitled **"Production performance of Japanese quails reared on different protein levels"** is a record of research work done independently by **Dr. Padwal N. P.** under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

Mannuthy

Date:

**Dr. P. Anitha,**
(Chairperson, Advisory Committee)
Associate Professor,
Centre for Advanced Studies in
Poultry Science,
College of Veterinary and Animal
Sciences, Mannuthy, Thrissur

# CERTIFICATE

We, the undersigned members of the Advisory Committee of **Dr. Padwal N. P.** a candidate for the degree of Master of Veterinary Science in Poultry Science, agree that this thesis entitled **"Production performance of Japanese quails reared on different protein levels"** may be submitted by **Dr. Padwal N. P.** in partial fulfillment of the requirement for the degree.

**Dr. P. Anitha,**
(Chairperson, Advisory Committee)
Associate Professor,
Centre for Advanced Studies in Poultry Science,
College of Veterinary and Animal Sciences,
Mannuthy, Thrissur.

**Dr. A. Jalaludeen,**
Professor and Head,
Department of Poultry Science,
Farm,
College of Veterinary and
Animal Sciences, Pookot.
(Member)

**Dr. Leo Joseph,**
Professor and Head,
University Poultry and Duck

College of Veterinary and
Animal Sciences, Mannuthy.
(Member)

**Dr. K. Karthiayini,**
Associate Professor,
Department of Veterinary Physiology,
College of Veterinary and
Animal Sciences, Mannuthy.
(Member)

**External Examiner**

## ACKNOWLEDGEMENT

***I may be given credit for having blazed the trail but I took at the subsequent developments I feel the credit is due to others rather than me.***

***-Alexander Graham Bell.***

*Even though I sufficiently comprehend that this is not even a glint of light in the gigantic aura of science, so far this is the most significant scientific accomplishment in my life. Its materialization would be impossible without the people who supported and believed in me. More often words are incapable of expressing the heart's language. Within the limits of lexicon, I am humbly expressing the deepest sense of acknowledgment to all concerned.*

*With profound gratitude and respect, I would like to depict my deep sense of obligation and heartfelt indebtedness to the chairperson of my advisory committee,* ***Dr. P. Anitha,*** *Associate Professor, Department of Poultry Science, College of Veterinary & Animal Sciences, Mannuthy for her meticulous guidance, constant supervision, affectionate encouragement and timely advise during the entire study period, in spite of her hectic schedule. I consider it my blessed privilege and matter of pride to work under the potential guidance of a versatile academician.*

*I deem it my privilege in expressing my reverence and thankfulness to* ***Dr. A. Jalaludeen,*** *Professor and Head, Department of Poultry Science, College of Veterinary and Animal Sciences, Pookot, and member of my advisory committee for his sumptuous suggestions, kind co-operation, creative criticisms and inspiring comments during the entire course of the study. His sense of dedication to duty, personal discipline and innovative approach inspired me, as a scholar.*

*I am cordially indebted to* ***Dr. Leo Joseph,*** *Professor and Head, University Poultry Farm, College of Veterinary & Animal Sciences, Mannuthy, Member of the advisory committee, for his never ending support, constructive criticism, and pleasant co-*

*orporation given to me for the framing up and successful completion of this research work.*

*I gratefully acknowledge* ***Dr. K. Karthiayini,*** *Associate Professor****,*** *Department of Veterinary Physiology, College of Veterinary & Animal Sciences, Mannuthy, Member of advisory committee for her earnest help, whole hearted support, kind nature, valuable suggestions and constructive review of my manuscript.*

*I place my profound gratitude to* ***Dr. P.A. Peethambaran,*** *Professor and Head, Centre for Advanced Studies in Poultry Science, College of Veterinary and Animal Sciences, Mannuthy for his inspiring advices, pleasant co-operation and affection given to me for the completion of my work.*

*I extend my heartfelt thanks to* ***Dr. K. Narayanankutty,*** *Senior Scientist, AICRP on Poultry for eggs, for his personal attention, keen interest and affectionate encouragement throughout the tenure of the study.*

*As such, it is imperative to thank* ***R. Richard Churchil,*** *Assistant Professor, AICRP on poultry for eggs,* ***Dr. Binoj Chako, Dr. D. Anish*** *and* ***Dr. Deepa Menon*** *(Assistant Professors), Centre for Advanced Studies in Poultry Science, Kerala Agricultural University, for their meticulous concern and valuable suggestions.*

*I take great pleasure in thanking* ***Dr. E. Nanu,*** *Dean, faculty of veterinary and Animal Sciences for providing me the facilities for my research.*

*I am indebted to* ***Kerala Agricultural University*** *for the fellowship awarded to me for the postgraduate study.*

*I am expressing a bouquet of thanks to my seniors,* ***Drs. Girish, Balaji and Suraj*** *for their help and co-operation. Words posses no enough power to reflect my thankfulness to friends and departmental colleagues* ***Drs. B. Ajith Babu, Sabitha, Saritha, Sabna and Stella*** *for their incessant support, generous help and company rendered to me throughout the course of my work.*

*The purity and self less backing of* ***Drs. Ayub*** *(Assistant Director, Animal Husbandry Department)****, Bibu, Vidya, Jinu, Sakeer, Jeevan, Lijo, Ajith M., Anir, Muneer, Arun, Mahesh, Ashwin, Premanand, Harshad, Raghavan sir, Mohammed sir,***

***Murugesan sir, Vishnu, Senthil, Bimal, Riyas, Feroz, Firdous Anoop, Govind and Hari Samad*** *are far more valuable than they might ever regard. I pleasantly acknowledge that this thesis is also a memorabilia of my cherished friendship.*

*It seems very difficult to express in words what I owe to my friends* ***Vijaysinh****,* ***Dinkar, Nitin, Girish, Rajendra, Albert, Dinesh, Kiran, Guruprasad, Prathamesh, Sunil, Gajanan, Vikas and all my classmates from AB series (2003 batch) at Nagpur Veterinary College*** *for their sprit buoyant with abiding courage and pleasure through their help and moral support during my golden days of research work at COVAS, Mannuthy, Thrissur.I am also thankful to the non-teaching staff of Revolving Fund Hatchery, Feed Mill, University Poultry Farm Hatchery and Centre for Advanced Studies in Poultry Science, especially,* ***Sri. Mohanan, Sri. Jayaraj, Sri. Sujeet, Sri. Jaideo, Sri. Sarad, Sri. Linto, Sri. Raffi, Sri. Ashraf, Smt. Indira, Smt. Ambily, Smt. Bindu, Smt. Rama, Smt. Vilasini, Smt. Lijy, Smt. Ramani, Miss Divya*** *and* ***Miss Deepthi*** *for the love and co-operation rendered to me during my study.*

*Words are incapable to express my feeling and gratitude in any language to my* ***Family and relatives*** *for their affection, encouragement, prayers and blessings which instilled in me the confidence to tackle many a hurdles during the study. I express my deep sense of gratitude to them for bearing with me in all inconveniences.*

*Finally and above every mortal, I thank the ever pervading essence of the Universe and the treasure house of all knowledge, which had kept me alive, flooded me with energy and hope and allowed me to complete this voyage.*

**Padwal N. P.**

*Dedicated To*

*My Beloved family*

*And*

*Respected Teachers*

# CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# *Introduction*

# 1. INTRODUCTION

Japanese quail (*Coturnix coturnix japonica*) has been introduced to the Indian sub-continent as an alternative avian species in the progressive poultry industry. Its unique characteristics like faster growth rate, early sexual maturity, high rate of production, short generation interval, hardy nature, simple rearing procedures and quicker returns on investment has opened a new area and an alternative for farmers interested in poultry production. There is immense potential for quails in providing gainful employment, supplementary source of income and as a valuable source of meat and egg. They can be essential part of the life of socially and economically weaker sections of the society. Many countries have recognized nutritional and economic value of Japanese quails and started rearing them commercially.

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. They can be included in the diets of children, pregnant mothers and geriatric and convalescent patients (Wahab, 2002).

Similar to other avian species, feed is the single major factor that determines the cost of production of the quail egg and meat. Considering the shortage of feedstuffs in India, effective manipulation of protein level in feed to reduce the cost of production is a need of the day. As the crude protein level in the feed increases above requirement, the excess amino acids will be catabolized and excreted resulting in excessive emission of nitrogen to environment. Moreover, feed with amino acid imbalance is an extra burden to bird's physiological system and cause inefficient use of metabolizable energy. Furthermore, highly valuable protein is wasted or underutilized whereas feeding with low protein causes undergrowth and decreased production (Karaalp *et al.,* 2009). Bureau of Indian Standards (1992) has not specified any nutrient

requirements for quail feeds. As quail feeds for growing period are not available in the local market, farmers feed quail chicks with broiler starter ration (23% crude protein) during this period. In field condition, the production performance of quail varies and this may be mainly due to difference in feeding strategy. Some of the earlier research works in layer quails conducted at Kerala Agricultural University showed variation in production performance when grown on diets containing different protein levels. The growth and production performance of quail lines have changed considerably by selection and breeding in recent years and therefore nutrient requirements are also likely to change. Protein content of ration is critical in determining the efficiency of quail production. If the feed containing lower protein (23% crude protein) during growing period can result in an equally good production as that of high protein diet, the expenditure on feed can be reduced which would result in higher return to entrepreneur. Considering these facts a study was planned with the following objectives.

1) To study the growth and production performance of Japanese quails reared on different protein levels.

2) To suggest optimum crude protein level in feed of growing Japanese quails to obtain maximum production performance.

# *Review of Literature*

# 2. REVIEW OF LITERATURE

## 2.1 PROTEIN REQUIREMENT FOR GROWTH

Vohra and Roudybush (1971) conducted an experiment to determine the effect of various levels of dietary protein viz., 20, 25, 30 and 35 per cent on the growth and subsequent egg production performance of quails. The fifth week body weights of quails fed 20 per cent dietary protein was not significantly different from those fed 25 per cent, but significantly lower than those fed 30 and 35 per cent protein. However the sixth week body weight was similar in all the groups. They recommended a dietary protein level of 25 per cent protein and energy level of 2880 kcal ME/kg diet during growing period.

Based on the research carried out on nutrient requirements of Japanese quail, Panda *et al.* (1977) summarized that the crude protein and metabolizable energy requirements were 25 per cent and 3000 kcal ME/kg respectively up to 3 weeks of age and 20 per cent and 2700 kcal ME/kg for 4 to 5 weeks of age.

Shrivastav *et al.* (1979b) conducted an experiment to determine the effect of protein and energy during growing period (0 to 6 weeks) on subsequent laying performance in Japanese quail with rations containing crude protein levels of 21, 24 and 27 per cent at two energy levels of 2600 and 2800 kcal ME/kg. They reported that there was significant increase in body weight of chicks with increase in dietary protein level from 21 to 24 per cent. However, no significant increase in body weight was noticed with increase in dietary protein level from 24 to 27 per cent.

Phogat and Chopra (1984) reported that quail require 27 per cent protein and 2800 kcal ME/kg during starter phase (0-3 weeks) and 24 per cent protein and same energy level during grower phase (4-5 weeks).

Sinha and Verma (1984) in their experiment with growing Japanese quails employing iso-caloric diets containing 24, 26 and 28 per cent crude proteins given to three groups for 6 weeks, starting at one week old, observed that despite a trend to more rapid growth on higher protein, differences between treatments in growth rate were not significant.

On reviewing the nutrition of Japanese quail, Shim (1984) suggested a dietary crude protein level of 24 per cent up to 3 weeks of age and 20 per cent from four to six weeks of age.

Babu *et al.* (1986) in his experiment with Japanese quails from zero to six weeks of age, employing protein levels of 24, 26 and 28 per cent in starter (0-3 weeks of age) and 21, 23 and 25 per cent (4-6 weeks of age) in grower diets at constant energy of 2700 kcal ME/kg, observed that for optimum body weight gain, the protein requirement was 26 per cent for starter and 23 per cent for grower diets.

Panda (1986) recommended a level of 27 per cent protein and 2800 kcal ME/kg for optimal growth of quail up to 3 weeks of age and 24 per cent protein with same energy level during 4 to 5 weeks of growing period.

Narayanankutty (1987) studied protein and energy requirement of Japanese quail for growth with rations containing per cent crude protein levels of 22, 24 and 26 and reported that there was no significant difference between treatment groups in weight gain at sixth week of age.

Marks (1993) conducted an experiment on Japanese quail to determine the influence of dietary protein levels on body weight gain during growing period and reported that at fourth week of age, quails receiving diets containing 24 and 27 per cent crude protein were significantly heavier than those receiving 18 and 21 per cent crude protein diet.

Mishra *et al.* (1993) evaluated the performance of three genotypes of Japanese quail during 5 weeks of rearing period with respect to growth and slaughter related traits as affected by different protein levels in diets and found that diet containing 24 per cent crude protein supplemented with methionine and lysine (0.1 per cent each) was as efficient as the diet containing 27 per cent crude protein to maximize the growth performance traits.

Murakami *et al.* (1993) studied four dietary crude protein levels (20, 22, 24 and 26%) in Japanese quails and observed that 20 per cent crude protein resulted in better weight gain at 6 weeks of age.

Barque *et al.* (1994) conducted an experiment to determine the effect of varying protein and energy levels on the performance of Japanese quails with rations containing 4 levels of protein (20, 22, 24 and 26%) each with 3 levels of energy (2600, 2800 and 3000 kcal/kg ME) during 0-6 weeks period and reported that differences due to protein, energy and interaction between them in case of body weight gain were non- significant.

NRC (1994) recommended 24 per cent crude protein in both starter and grower quail rations and 20 per cent in breeder ration.

Baldini *et al.* (1995) studied the protein requirements of bobwhite quail reared up to eight weeks of age using 20, 25 and 28 per cent levels of crude protein and observed that 28 per cent crude protein level gave the best growth in quail chicks.

Hyankova *et al.* (1997) studied the responses in growth of Japanese quails by dietary crude protein levels of 26 and 21 per cent during 0 to 2 weeks of age and 23.8 and 19.5 per cent during 3 to 5 weeks of age, respectively and found that the body weight up to 5 weeks of age was not affected by dietary crude protein content.

Rajini and Narahari (1998), compared the performance of growing quails, fed diets containing 24, 26 and 28 per cent crude protein between 0 to 3 weeks and reported significantly higher weight gain with diets containing high protein (28% CP).

Reviewing the work undertaken to establish the nutrient requirements of quails, Shrivastav and Panda (1999) reported that for optimum growth, diet containing 24 per cent crude protein level during 0 to 3 weeks of age and 20 per cent crude protein during 4 to 5 weeks of age appeared adequate.

Minoguchi *et al.* (2000) found no significant effect on growth when quail chicks were fed with diets containing 20 and 24 per cent crude protein during the growing period (0-6 weeks).

Oliveira (2002) evaluated the performance of quails fed with diets containing 20, 22, 24 and 26 per cent crude protein levels and reported that there was no significant difference in weight gain at 3 weeks of age.

Soares *et al*. (2003) reported that there was no significant difference in weight gain from 0 to 35 days of age when quail chicks were fed with crude protein at 22, 24 and 26 per cent levels.

Djouvinov and Mihailov (2005) conducted two trials with ration containing crude protein levels of 23.4 and 18.2 per cent during starter (0-3

weeks) and grower phase (4-6 weeks) respectively for first trial and 22.1 and 16.7 per cent for second trial and could not find any significant difference in weight gain between groups at third (95.7 to 98.3 g) and sixth week of age (180.8 to 183.6 g).

Correa *et al.* (2005) studied the effect of protein and energy levels on 42$^{nd}$ day carcass yield of European quails (*Coturnix coturnix coturnix*) fed with two energy levels (2900 and 3100kcal ME/kg) and four protein levels (22, 24, 26 and 28%). They reported that crude protein and metabolizable energy at these levels had no significant effect on 42$^{nd}$ day body weight (246.50 to 256.33 g).

Fridrich *et al.* (2005) conducted experiment on Japanese quails with dietary crude protein levels of 18, 20, 22, 24 and 26 per cent and reported that crude protein at these levels had no significant effect on weight gain at 56 days of age.

Lekshmi (2005) reported that the mean body weight of layer quails at 6 weeks of age ranged from 159.67 to 160.05 g and that at 26 weeks of age from 199.43 to 204.77 g.

Sheena (2005) reported that the mean body weight of 6 week old layer Japanese quails ranged from 166.96 to 174.50 g and that of 26 weeks old birds ranged from 196.20 to 205.16 g.

Hashiguchi and Yamamoto (2006) fed Japanese quails with feed containing 24, 19 and 14 per cent crude protein during 0 to 8 weeks of age and found that the birds fed with 14 per cent crude protein had a significantly lower body weight than those fed with 19 and 24 per cent crude protein levels.

Freitas *et al.* (2006), working with quail fed protein levels of 20, 22, 24 and 26 per cent found that protein levels had no effect on weight gain during 0 to 6 weeks of age.

Binoj Chacko (2006) conducted an experiment in meat type Japanese quail fed with diets containing crude protein levels of 27, 25, 23 and 21 per cent during 0 to 2 weeks of age and 24, 22, 20 and 18 per cent during 3 to 5 weeks of age respectively and could not observe any significant difference in body weight gain due to different protein levels.

Preethymol (2006) reported mean body weight of 180.0 g at 6 weeks of age and 225.83 g at 26 weeks of age in layer Japanese quails.

Raseena (2006) reported that the mean body weight recorded at 6 weeks of age in quails ranged from 185.01 to186.56 g and that at 26 weeks of age ranged from 220.52 to 223.31 g.

Flauzino (2007) reported that there was no significant difference among the dietary treatment groups in body weight gain of seven week old Japanese quails when quail chicks fed with iso-caloric diets containing percent crude protein levels of 18, 20, 22 and 24.

Bhadra (2008) reported that the average body weight of the quails was 155.50 g at 6 weeks of age and 205.51 g at 26 weeks of age.

Correa *et al.* (2008) studied the effect of crude protein level for meat type quail during the growing period with crude protein levels of 23, 25, 27, 29, 31 and 33 per cent and reported significantly lower body weight (at 21 days of age) for 23 and 25 per cent protein levels.

Shamna (2008) while studying evaluation of dietary inclusion of azolla for growth in quail, reported that the overall mean body weight recorded in groups ranged from 79.06 to 91.49 g at 3 weeks of age and 156.57 to 169.63 g at 6 weeks of age when fed with diet containing 26 per cent crude protein level during 0 to 6 weeks of age.

Hyankova and Knizetova (2009) conducted a study on Japanese quail fed with rations containing per cent crude protein levels of 25.9 and 21.6 during 0 to 3 weeks of age and reported that males and females fed with low crude protein diet showed significantly lower body weight gain.

Karaalp *et al.* (2009) studied the effect of various per cent dietary crude proteins (24, 23, 22, 21 and 20) on growth of Japanese quails during the period from day old to 39 days and observed that there was no significant difference in weight gain between treatment groups.

## 2.2 AGE AT SEXUAL MATURITY (ASM)

Sachdev and Ahuja (1986) observed that egg line Japanese quail 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.

Padmakumar (1993) reported that the age at first egg was 55 days and age at 50 per cent production was 72 days for caged Japanese quails reared on a floor space of 250 $cm^2$ per bird.

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 having mean body weight of 159.67 g at 6 weeks of age.

Sheena (2005) reported that Japanese 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 quails with 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) reported 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 was 42, 43 and 47 days, respectively.

Preeta (2007) reported that the average age at first egg, 10 per cent and 50 per cent production in layer Japanese quails having a mean body weight of 189.37 g at 6 weeks of age was 42.50, 44.50, and 50.00 days, respectively.

Bhadra (2008) reported that the age at first egg, 10 per cent and 50 per cent production in layer Japanese quails having a mean body weight of 155.55 g at 6 weeks of age was 48.00, 48.75 and 55.50 days, respectively.

Amrutkar (2009) reported that the age at first egg, 10 per cent and 50 per cent production in layer Japanese quails having a mean body weight of 187.51 g at 6 weeks of age was 41.00, 44.00 and 49.00 days, respectively.

## 2.3 EGG PRODUCTION

Shrivastav *et al.* (1979b) conducted an experiment in Japanese quail with rations containing per cent crude protein levels of 21, 24 and 27 with 2600 and 2900 kcal ME/kg during growing period (0-6 weeks) and 22 per cent crude protein with metabolizable energy of 2800 kcal/kg after growing period. They reported that egg production of quails fed 24 and 27 per cent protein were significantly higher than that of quails fed 21 percent crude protein during growing period.

Minoguchi *et al.* (2000) found that there was no significant effect on subsequent laying performance of quails when they were fed with diets containing 20 and 24 per cent crude protein during growing period.

Soares *et al.* (2003) reported that different levels of crude protein (18, 20, 22, 24 and 26%) in the rearing diet had no significant effect on egg production up to 63 days of age.

Djouvinov and Mihailov (2005) conducted two trials with ration containing crude protein levels of 23.4 and 18.2 per cent during starter and grower phase respectively for first trial and 22.1 and 16.7 per cent for second trial and could not find any significant difference in subsequent egg production between groups.

Lekshmi (2005) in the experiment on assessing the utilization of dried cuttle fish waste silage in layer Japanese quail, reported quail housed egg number of 90.32 and quail housed percentage of 64.4 from 6 to 26 weeks of age.

Sheena (2005) reported that cumulative egg number per quail was ranging from 60.38 to 80.80 in different groups while assessing the effect of protease supplementation in layer quails for a period of 6 to 26 weeks of age.

Preethymol (2006) reported that in layer Japanese quails from 7 to 26 weeks of age, the cumulative quail housed and quail day egg number was 103.84 and 110.36 with corresponding percentages of 78.83 and 80.50.

Raseena (2006) while studying the effects of dietary inclusion of azolla at different levels on production performance of Japanese quails from 7 to 26 weeks of age reported cumulative quail housed egg number varying from 112.18 to 120.00 among dietary groups.

Preeta (2007) reported maximum quail housed egg number and percentage as 91.74 and 65.53, respectively from 7 to 26 weeks of age.

Bhadra (2008) reported that the cumulative egg number per quail during the period from 7 to 26 weeks of age ranged from 87.25 to 94.83 and the corresponding percentage ranged from 62.32 to 67.73.

## 2.4 EGG MASS

Shrivastav *et al.* (1979b) reported that egg mass of quails fed 24 and 27 per cent crude proteins with either 2600 or 2900 kcal/kg ME during growing period were significantly higher than that of quails fed 21 percent crude protein during growing period.

Preethymol (2006) reported that cumulative egg mass per quail from 7 to 26 weeks of age was 1259.1 g on a diet containing 22 per cent protein and 2650 kcal/kg ME.

Bhadra (2008) in a study on laying Japanese quails fed with diet containing 22 per cent crude protein and 2650 kcal ME/kg from 7-26 weeks of age reported cumulative egg mass of 957.17 g.

## 2.5 EGG WEIGHT

Shrivastav *et al.* (1979b) conducted an experiment in Japanese quail with rations containing per cent crude protein levels of 21, 24 and 27 with 2600 and 2900 kcal ME/kg during growing period (0-6 weeks) and 22 per cent crude protein with 2800 kcal ME/kg after growing period. They reported that egg weight of quail fed 21, 24 or 27 per cent protein at either energy level during growing period was not significantly different.

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

Minoguchi *et al.* (2000) reported that feeding quails with 20 or 24 per cent crude protein during growing period does not significantly affect the egg weight.

Lekshmi (2005) reported an average egg weight of 10.73 to 10.81 g in Japanese quails from 6 to 26 weeks of age.

Sheena (2005) reported mean egg weight of Japanese quails as 10.40 g during 6 to 26 weeks of age.

Preethymol (2006) observed an average egg weight of 11.17 g by feeding layer Japanese quails with diet containing per cent crude protein levels of 27 during 0 to 3 weeks and 24 during 4 to 6 weeks of age.

Raseena (2006) recorded an average egg weight of 11.27g in layer Japanese quails from 7 to 26 weeks of age.

Preeta (2007) while studying the utilization of dried fish waste and fermented fish waste silage in layer Japanese quails from 7 to 26 weeks of age, reported an average egg weight of 11.91 g.

Bhadra (2008) in a study on layer Japanese quails from 7 to 26 weeks of age reported an average egg weight of 10.62 g.

## 2.6 FEED CONSUMPTION

Shrivastav *et al.* (1979a) reported that feed consumption was not affected when quail chicks were fed with diet containing per cent crude protein levels of 21, 24 and 27 during 0 to 6 weeks of age.

Babu *et al.* (1986) in an experiment in Japanese quails from zero to six weeks of age, employing protein levels of 24, 26 and 28 per cent in starter (0-3 weeks of age) and 21, 23 and 25 per cent (4-6 weeks of age) in grower diets at constant energy of 2700 kcal ME/kg, observed that the protein level had no significant effect on feed consumption.

Narayanankutty (1987) in a study to assess the protein and energy requirement of Japanese quails observed no significant difference in case of feed consumption of quails at sixth week of age when reared on rations with different crude protein levels (22, 24 and 26%).

Barque *et al.* (1994) could not observe any significant difference in feed consumption of quails fed on diets containing 20, 22, 24 and 26 per cent crude protein during 0-6 weeks of age.

Hyankova *et al.* (1997) studied the responses in growth, feed intake and feed conversion efficiency to dietary crude protein levels of 26 and 21 per cent during 0 to 2 weeks of age and 23.8 and 19.5 per cent during 3 to 5 weeks of age and reported that feed intake was not affected by dietary crude protein content.

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

Soares *et al.* (2003) reported that there was no significant difference in feed consumption from 0 to 35 days of age when quail chicks were fed with diets containing per cent crude protein levels of 22, 24 and 26.

Djouvinov and Mihailov (2005) could not observe any significant difference in feed consumption with rations containing 23.4 and 22.1 per cent crude protein during starter phase and 18.2 and 16.7 per cent protein during grower phase.

Binoj Chacko (2006) in an experiment with meat type Japanese quails reported that there was no significant difference in feed consumption at 2 and 5 weeks of age when fed with diets containing crude protein levels of 27, 25, 23 and 21 per cent during 0 to 2 weeks of age and 24, 22, 20 and 18 per cent during 3 to 5 weeks of age.

Freitas *et al.* (2006), on working with quails fed with diets containing per cent protein levels of 20, 22, 24 and 26 found no effect of protein levels on feed intake during 0 to 6 weeks of age.

Preethymol (2006) recorded an average feed consumption of 30.67 g per quail per day in layer Japanese quails from 7 to 26 weeks of age.

Raseena (2006) reported that in 7 to 26 weeks old layer Japanese quails, the mean feed consumption ranged from 28.35 to 30.05 g per quail per day.

Preeta (2007) reported an average daily feed consumption of 30.89 g in layer Japanese quails from 7 to 26 weeks of age.

Flauzino (2007) reported no significant difference in feed consumption of quail chicks fed with iso-caloric diets containing percent crude protein levels of 18, 20, 22 and 24 at seven weeks of age.

Bhadra (2008) reported that the mean feed consumption was ranging from 25.10 to 28.62 g per quail per day from 7 to 26 weeks of age in layer Japanese quail reared on 23 per cent crude protein during growing period.

Correa *et al.* (2008) studied crude protein requirement for meat type quail during the growing period with crude protein levels of 23, 25, 27, 29, 31 and 33 per cent and reported significantly lower feed consumption for 23 and 25 per cent protein levels at third and sixth week of age.

Shamna (2008) reported that cumulative feed intake in Japanese quails ranged 202.79 to 221.91g during starter phase (0 to 3 weeks) and 523.32 to 548.17g during grower phase (4 to 6 weeks).

Karaalp *et al.* (2009) studied the effect of various dietary crude protein levels (24, 23, 22, 21 and 20 %) on growth and excreta nitrogen in Japanese quails during the period from day old to 39 days of age and observed that there was no significant difference in feed intake between groups.

## 2.7 FEED CONVERSION RATIO (FCR)

Shrivastav *et al.* (1979a) reported that feed efficiency was significantly affected when quail chicks were fed with diet containing per cent crude protein levels of 21, 24 and 27 during 0 to 6 weeks of age. The highest feed efficiency was obtained with a diet containing 24 per cent crude protein and 2800 kcal ME/kg.

Sinha and Verma (1984) in their experiment with growing Japanese quails fed with iso-caloric diets containing 24, 26 and 28 per cent crude proteins from one to six weeks of age observed that feed efficiency was not significantly affected by protein levels in rations.

Babu *et al.* (1986) in their experiment with Japanese quails from zero to six weeks of age, employing protein levels of 24, 26 and 28 per cent in starter (0-3

weeks of age) and 21, 23 and 25 per cent in grower diets (4-6 weeks of age) at constant energy of 2700 kcal ME/kg, observed that for optimum feed efficiency the protein requirement was 26 per cent for starter and 23 per cent for grower diets. But there was no significant difference for feed efficiency among dietary treatment groups.

Narayanankutty (1987) studied protein and energy requirement of Japanese quail for growth with rations containing per cent crude protein levels of 22, 24 and 26 and reported that there was no significant difference in feed efficiency at sixth week of age.

Hyankova *et al.* (1997) while studying the responses in growth, feed intake and feed efficiency to dietary crude protein levels of 26 and 21 per cent during 0 to 2 weeks of age and 23.8 and 19.5 per cent during 3 to 5 weeks of age in Japanese quails reported that the treatment effect on feed efficiency up to 5 weeks of age was not affected by dietary crude protein content.

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.

Rajini and Narahari (1998) compared the performance of growing quails fed diets containing 24, 26 and 28 per cent crude protein levels during the period from 0 to 3 weeks of age with metabolizable energy levels of 2,400, 2,600 and 2,800 kcal/kg and found significantly better feed efficiency with a diet containing 28 per cent crude protein, regardless of the level of energy.

Soares *et al.* (2003) reported that there was no significant difference in feed efficiency from 0 to 35 days of age when quail chicks were fed with diets containing per cent crude protein levels of 22, 24 and 26.

Fridrich *et al.* (2005) conducted an experiment in Japanese quails with dietary crude protein levels of 18, 20, 22, 24 and 26 per cent and reported that different protein levels had no significant effect on feed efficiency from 0 to 56 days of age.

Lekshmi (2005) reported that the mean feed efficiency of 6 to 26 weeks old layer Japanese quails ranged from 0.53 to 0.61 per dozen eggs.

Sheena (2005) recorded a mean feed efficiency of 0.57 per dozen eggs in layer Japanese quails from 6 to 26 weeks of age.

Freitas *et al.* (2006), working with quails fed per cent protein levels of 20, 22, 24 and 26 found that different protein levels had no effect on feed efficiency at six weeks of age.

Preethymol (2006) reported an average feed efficiency of 0.48 per dozen eggs and 3.44 per kg egg mass in layer Japanese quail for a period of 7 to 26 weeks of age.

Raseena (2006) recorded mean feed efficiency 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 from 7 to 26 weeks of age in layer Japanese quails.

Preeta (2007) observed an average feed efficiency of 0.61 per dozen eggs from 7 to 26 weeks of age in layer Japanese quails.

Flauzino (2007) observed no significant difference in feed efficiency of 7 weeks old quail chicks on iso-caloric diets with per cent crude protein levels of 18, 20, 22 and 24.

Bhadra (2008) reported an average feed efficiency of 0.50 per dozen eggs and 3.88 per kg egg mass from 7 to 26 weeks of age in layer Japanese quail.

Shamna (2008) reported an average feed efficiency ranged from 2.42 to 2.57 during starter phase (0 to 3 weeks), 6.24 to 7.07 during grower phase (4 to 6 weeks) and 4.39 to 4.80 during entire growing period (0 to 6 weeks) when fed with diet containing 26 per cent crude protein level during 0 to 6 weeks of age.

Correa *et al.* (2008) studied crude protein requirement for meat type quail during the growing period with crude protein levels of 23, 25, 27, 29, 31 and 33 per cent and reported significantly poor feed efficiency for 23 and 25 per cent protein levels at third and sixth week of age.

Karaalp *et al.* (2009) studied the effect of various per cent dietary crude proteins (24, 23, 22, 21 and 20) on growth and excreta nitrogen in Japanese quails during the period from day old to 39 days of age and observed no significant difference in feed efficiency between different treatment groups.

## 2.8 COST EFFECTIVENESS

Shrivastav and Panda (1991) studied the effect of reducing dietary protein in broiler quails from day old to 5 weeks of age and observed significant low return over feed cost in the group fed diet with 23 per cent crude protein for 21 days than those fed 25 per cent crude protein for the same period.

Karaalp *et al.* (2009) studied the effect of various per cent dietary crude proteins (24, 23, 22, 21 and 20) on growth and excreta nitrogen in Japanese quails during the period from day old to 39 days and observed that the amount of dietary crude protein has not significantly influenced the cost of feed and quail production parameters.

## 2.9 LIVABILITY

Mishra *et al.* (1993) evaluated the response of growth and carcass quality trait to different protein concentrations (24, 24 + 0.1 per cent lysine + 0.1 per cent methionine and 27 per cent) in Japanese quail from 1 to 5 weeks of age and reported that mortality was significantly higher when quails were raised on high protein than low protein diets.

Baldini *et al.* (1995) studied the protein requirements of bobwhite quail reared in confinement to eight weeks of age with three levels of dietary crude protein viz; 20, 25 and 28 per cent and observed that 28 per cent crude protein level gave the best livability in quail chicks.

Shamna *et al.* (2008) reported the mean livability per cent ranging from 97.90 to 100.00 from 0 to 6 weeks of age in Japanese quails.

Bhadra *et al.* (2008) reported mean livability per cent ranging from 95.00 to 100.00 from 7 to 26 weeks of age in Japanese quails.

## 2.10 METEOROLOGICAL OBSERVATIONS

Padmakumar (1993) noticed maximum temperatures of 33.4, 36.18 and 32.74$^{o}$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 $^{o}$ C in the respective periods. The relative humidity (R.H.) in the forenoon (F.N.) was 74.8, 81.2 and 87.8 per cent and in the afternoon (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$^{o}$C, minimum temperature of 23.3$^{o}$C and relative humidity 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 37.07ºC, minimum temperature of 22.91ºC and 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.

Bhadra (2008) reported that a maximum temperature of 32.14ºC, minimum temperature of 26.59º C and relative humidity of 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 at Mannuthy.

Amrutkar (2009) reported that a maximum temperature of 31.18ºC, minimum temperature of 23.16ºC and relative humidity of 80.85 per cent in the F.N. and 61.20 per cent in the A.N. inside the experimental house from August 2008 to December 2008 at Mannuthy.

# *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 growth and production performance of Japanese quails reared on different protein levels. The experiment was conducted from August 2009 to February 2010.

## 3.1 EXPERIMENTAL MATERIALS

### 3.1.1 Birds

Six hundred, day-old Japanese quail chicks belonging to a single hatch, received from University Poultry Farm, Mannuthy were utilized for study.

### 3.1.2 Experimental diets

Three types of isocaloric (2800 Kcal/kg) diets containing different levels of protein were formulated and fed to three treatment groups ($T_1$, $T_2$ and $T_3$) of quails during starter phase (0-3 weeks of age). The dietary protein levels in group $T_2$ and $T_3$ was reduced during grower phase (4-6 weeks of age) with same level of energy while the nutrient levels kept same in group $T_1$. During layer phase (7-26 weeks of age) all groups were fed with isonitrogenous isocaloric diet. The details of experimental diets with varying levels of dietary crude protein (CP), on dry matter basis are given below.

| Group | Starter diet (0-3 weeks) | Grower diet (4-6 weeks) | Layer diet (7-26 weeks) |
|---|---|---|---|
| | CP (%) | CP (%) | CP (%) |
| $T_1$ | 23 | 23 | 22 |
| $T_2$ | 25 | 23 | 22 |
| $T_3$ | 27 | 24 | 22 |

### 3.2 EXPERIMENTAL LAYOUT

The experiment was conducted in Japanese quails from 0 to 26 weeks of age including starter, grower and layer phases. Six hundred (600), day-old Japanese quail chicks belonging to single hatch were allotted randomly to three treatment groups with four replicates of fifty quails each. At the end of sixth week, sixteen female quails were selected from each replicate and housed in layer cages to assess the production performance of one hundred and ninety two (192) layer quails in three treatment groups of four replicates for the period of twenty weeks. Quails were weighed individually at day-old and at third, sixth and twenty sixth week of age. The number of males and females allotted to each replicate and treatment was as follows:-

| Group | Growing period ( 0 to 6 weeks) | | | | Layer phase (7 to 26 weeks) | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of quails (Males + Females) | | | | Number of quails (Females) | | | |
| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_1$ | $R_2$ | $R_3$ | $R_4$ |
| $T_1$ (S-23% CP, G-23% CP) | 50 | 50 | 50 | 50 | 16 | 16 | 16 | 16 |
| $T_2$ ( S-25% CP, G-23% CP) | 50 | 50 | 50 | 50 | 16 | 16 | 16 | 16 |
| $T_3$ (S-27% CP, G-24% CP) | 50 | 50 | 50 | 50 | 16 | 16 | 16 | 16 |
| Grand Total | 600 | | | | 192 | | | |

### 3.3 HOUSING AND MANAGEMENT OF QUAILS

The quails in each replicate were housed in cages with floor space per quail 54, 96 and 233 $cm^2$ during starter, grower and layer phases, respectively.

The equipments connected with experimental work were thoroughly cleaned and disinfected prior to actual experimental period. Experimental feeds with different crude protein levels were formulated and compounded for the experiment. The per cent ingredient composition of the experimental rations are given in Table 1 whereas proximate compositions which are presented in Table 2.

Standard managemental conditions were maintained uniformly. The quails were fed experimental diets *ad libitum* and clean drinking water was provided throughout the experimental period.

## 3.4 OBSERVATIONS RECORDED

### 3.4.1 Body Weight

Individual body weights of all birds were recorded at day-old, at the end of third, sixth and twenty-sixth weeks of age and the mean values were calculated to study the pattern of body weight gain in different dietary groups.

### 3.4.2 Age at Sexual Maturity

The age at first egg and at 10 and 50 per cent production (days) were recorded in each replicate.

### 3.4.3 Egg Production

The 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. The data on mean quail housed egg production in each 28-day period and cumulative mean quail housed egg production from 7 to 26 weeks of age in various dietary groups calculated based on the number of quails housed at the beginning of layer phase.

**Table 1. Per cent ingredient composition of rations.**

| Sl. No. | Ingredient | Starter diet | | | Grower diet | | Layer diet |
|---|---|---|---|---|---|---|---|
| | | $T_1$ (23%CP) | $T_2$ (25%CP) | $T_3$ (27%CP) | $T_1$ & $T_2$ (23%CP) | $T_3$ (24%CP) | $T_1$, $T_2$ &$T_3$ (22%CP) |
| 1 | Maize | 49.02 | 46.16 | 42.44 | 49.02 | 50.6 | 45.24 |
| 2 | Soyabean meal | 29.10 | 35.14 | 41.50 | 29.10 | 34.50 | 26.40 |
| 3 | Unsalted dried fish | 8.00 | 8.00 | 8.00 | 8.00 | 8.00 | 9.00 |
| 4 | De-oiled Rice Bran | 10.48 | 7.36 | 4.76 | 10.48 | 0.00 | 12.00 |
| 5 | Wheat bran | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.95 |
| 6 | Di-calcium phosphate | 1.21 | 1.18 | 1.16 | 1.21 | 1.70 | 1.10 |
| 7 | [1]Calcite powder | 1.91 | 1.88 | 1.86 | 1.91 | 4.92 | 4.20 |
| 8 | Salt | 0.28 | 0.28 | 0.28 | 0.28 | 0.28 | 0.11 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 9 | [2]Methionine(g) | 20.00 | 0.00 | 20.00 | 20.00 | 0.00 | 20.00 |
| 10 | [3]Lysine(g) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | [4]Trace minerals mix(g) | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 12 | [5]Biocholine(g) | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 513 | [6]UTPP (g) | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 14 | [7]Supplevite(g) | 26.67 | 26.67 | 26.67 | 26.67 | 26.67 | 26.67 |
| 15 | [8]Salinomix(g) | 50.00 | 50.00 | 50.00 | 50.00 | 50.00 | 50.00 |
| | Total | 396.67 | 376.67 | 696.67 | 396.67 | 376.67 | 396.67 |

**Note:**

1. Calcite powder: Limestone powder containing 38 per cent Calcium.
2. DL- Methionine: Contains 99 per cent methionine.
3. Trace mineral mixture : TM-6. Composition per Kg: Cobalt: 1 g, Copper: 2 g, Iodine: 2 g, Iron: 20 g, Zink: 52 mg, Manganese: 55 g.
4. Bio-choline: with choline chloride activity (Indian Herbs Research and supply Co., Ltd., U.P.)
5. UTPP-5: Powder (Tetragon Chemic Pvt. Ltd., Bangalore) contains treated Aluminosilicates, Propionates, Formates and acetates.
6. Supplevite premix: Vitamin supplement- Composition:- 259 g contains Vit. A 10000000, Vit. B1 1800 mg, Vit. B2 5000 mg, Vit. B6- 1600 mg, Vit. B12- 20500 mcg, niacin- 1200 mg, Calcium-d-Pantothenate- 8000 mg, Vit. K3- 1000 mg, Vit. E- 8000 mg and folic acid- 800 mg (Sarabhai Zydus Animal Health Ltd.)
7. Salinomix- Salinomix containing salinomycin sodium 12.5% ( Venkey's Pvt. Ltd., Tamil Nadu.)

**Table 2. Per cent chemical composition of rations.**

| Sl. No. | Nutrients | Starter diet | | | Grower diet | | Layer diet |
|---|---|---|---|---|---|---|---|
| | | $T_1$ | $T_2$ | $T_3$ | $T_1$ & $T_2$ | $T_3$ | $T_1$, $T_2$ &$T_3$ |
| Analyzed Values | | | | | | | |
| 1 | Dry matter (%) | 90.50 | 90.00 | 89.10 | 90.40 | 90.20 | 89.90 |
| 2 | Crude protein (%) | 23.35 | 25.24 | 27.03 | 23.18 | 24.16 | 22.25 |
| 3 | Ether extract (%) | 3.10 | 3.09 | 3.01 | 3.10 | 3.04 | 2.83 |
| 4 | Crude fiber (%) | 4.20 | 4.00 | 3.90 | 4.10 | 3.80 | 3.18 |
| 5 | Total Ash (%) | 7.50 | 7.35 | 7.40 | 8.10 | 7.21 | 8.63 |
| 6 | Acid insoluble ash (%) | 2.40 | 2.25 | 2.24 | 2.41 | 2.31 | 3.06 |
| 7 | Calcium (%) | 0.98 | 0.94 | 0.93 | 1.03 | 1.01 | 3.40 |
| Calculated Values | | | | | | | |
| 1 | ME (kcal/kg) | 2800 | 2800 | 2800 | 2800 | 2800 | 2650 |
| 2 | Phosphorus (%) | 0.42 | 0.40 | 0.39 | 0.45 | 0.40 | 0.45 |
| 3 | Lysine (%) | 1.39 | 1.56 | 1.64 | 1.31 | 1.34 | 1.40 |
| 4 | Methionine (%) | 0.46 | 0.48 | 0.34 | 0.45 | 0.51 | 0.46 |
| 5 | Threonine (%) | 1.03 | 1.05 | 1.04 | 1.10 | 1.08 | 1.05 |

### 3.4.4 Egg Mass and Egg Weight

All the eggs laid by the quails in each replicate group were collected and weighed in mass daily. Based on the replicate wise egg mass recorded, egg mass per quail and mean egg weight were calculated during each 28-day period and entire period of experiment from 7 to 26 weeks of age.

### 3.4.5 Feed Consumption

The total feed consumed in each replicate was recorded separately during starter phase (0-3 weeks), grower phase (4-6 weeks) and each twenty-eight day interval during laying period. From these data, the mean daily feed intake per bird for each period was calculated in all treatment groups.

### 3.4.6 Feed Conversion Ratio (FCR)

Feed consumed per kilogram weight gain during starter phase (0-3 weeks) and grower phase (4-6 weeks) were calculated. During layer phase (7-26 weeks), replicate wise FCR was calculated as feed consumed per dozen eggs and per kilogram of eggs for each 28-day period.

### 3.4.7 Cost and return

The actual cost and return during the experimental period for twenty-six weeks of age was recorded. The cost of day-old chicks prevailing in University Poultry Farm, Mannuthy and cost of feed utilized during the period were used in the calculations. Current sale prices for table eggs and for female quails at 6 and 26 weeks in the farm were considered.

### 3.4.8 Livability

Per cent livability was recorded based on the number of birds alive during starter and grower phase and in each 28-day period during layer phase after recording the mortality of birds from different treatment groups. Post mortem examination was conducted in each case to find out cause of death.

### 3.4.9 Meteorological parameters

The dry bulb and wet bulb readings were taken at 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.

## 3.5 STATISTICAL ANALYSIS

Data collected on various parameters were statistically analyzed as described by Snedecor and Cochran (1994).

# *Results*

# 4. RESULTS

The results of the experiment carried out to study the production performance of Japanese quail reared on different protein levels are presented in this chapter.

## 4.1 BODY WEIGHT

Data on mean body weight of quails at day-old, 3, 6 and 26 weeks of age among different dietary treatments viz., 23 per cent crude protein (CP) during starter and grower phase ($T_1$), 25 per cent CP during starter and 23 per cent CP during grower phase ($T_2$) and 27 per cent CP during starter and 24 per cent CP during grower phase ($T_3$) are presented in Table 3 and graphically depicted in figure 1.

The day-old mean body weight of quail chicks in groups $T_1$, $T_2$ and $T_3$ were 7.36, 7.38 and 7.38 g, respectively. At the end of third week, the mean body weight of quails in groups $T_1$, $T_2$ and $T_3$ fed with iso-caloric diets containing 23, 25 and 27 per cent crude protein levels were 83.55, 83.35 and 83.67 g, respectively which did not differ significantly.

At the end of sixth week, the mean body weights of males were 169.05, 171.11 and 169.38 g and those of females were 185.62, 187.30 and 186.48 g in groups $T_1$, $T_2$ and $T_3$, respectively. There was no significant difference in body weight of quails in different treatment groups at the end of third and sixth week.

At the end of twenty-sixth week, the mean body weight of layer quails in the groups $T_1$, $T_2$ and $T_3$ were 229.95, 229.98 and 229.26 g, respectively and the values were statistically comparable.

**Table 3. Body weight (g) of Japanese quails as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ±S. E.**

| Age | | Mean body weight (g) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| Day-old | | 7.36 ± 0.01 | 7.38 ± 0.01 | 7.38 ± 0.01 |
| 3 weeks | | 83.55 ± 0.78 | 83.35 ± 0.66 | 83.67 ± 0.78 |
| 6 weeks | Male | 169.05 ± 0.96 | 171.11 ± 1.12 | 169.38 ± 0.89 |
| | Female | 185.62 ± 1.23 | 187.30 ± 0.68 | 186.48 ± 1.52 |
| 26 weeks ( Female) | | 229.95 ± 1.25 | 229.98 ± 1.17 | 229.26 ± 0.14 |

Non significant

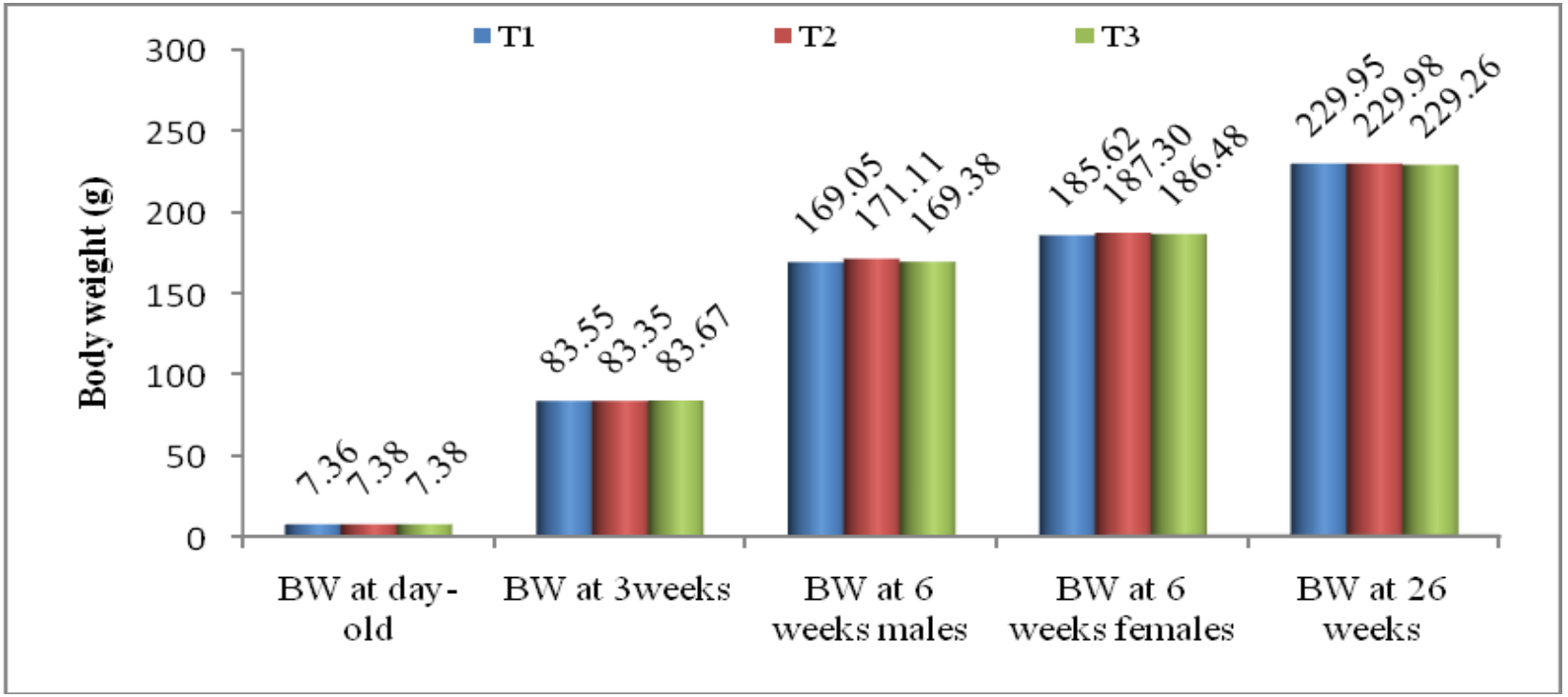


**Fig.1. Body weight of Japanese quails at day-old, 3rd, 6th and 26th week of age as influenced by dietary crude protein levels during growing period**

## 4.2 AGE AT FIRST EGG, 10 AND 50 PER CENT PRODUCTION

The data on mean age at first egg, age at 10 and 50 per cent egg production as influenced by the dietary crude protein levels are presented in Table 4.

The age at first egg in the dietary groups $T_1$, $T_2$ and $T_3$ was 39, 40 and 42 days, respectively. The mean age at first egg in the treatment groups $T_1$, $T_2$ and $T_3$ was 42.00, 42.25 and 43.00 days, respectively. The mean age at 10 per cent production was 44.75, 45.00 and 43.50 days in the groups $T_1$, $T_2$ and $T_3$, respectively. Whereas, the age at 50 per cent production was 52.75 days for $T_1$ birds, 51.25 days for $T_2$ birds and 49.75 days for $T_3$ birds.

## 4.3 EGG PRODUCTION

### 4.3.1 Period wise egg production

#### *4.3.1.1 Period wise Quail Housed egg Number (QHN)*

The data on mean quail housed egg number in each 28-day period during layer phase (7 - 26 weeks of age) and the cumulative quail housed egg production during 7 to 26 weeks of age in various dietary groups are presented as cumulative quail housed egg number (QHN) in Table 5 and depicted graphically in figure 2.

The cumulative quail housed egg number (QHN) per quail during the entire period from 7 to 26 weeks of age was 106.48, 111.16 and 103.00 in groups $T_1$, $T_2$ and $T_3$, respectively.

In the dietary group $T_1$ reared on 23 per cent crude protein during starter and grower phase, the quail housed egg number (QHN) per quail in period I (7 - 10 weeks of age) averaged 16.31 eggs and increased to 21.81 eggs in period II

**Table 4. Age at first egg (AFE), 10 and 50 per cent production (days) as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Parameter | Dietary crude protein (CP) levels during starter (S) and grower (G) phase (%) | | |
|---|---|---|---|
| | **$T_1$**<br>S-23% CP<br>G-23% CP | **$T_2$**<br>S-25% CP<br>G-23% CP | **$T_3$**<br>S-27% CP<br>G-24% CP |
| **Age at first egg in flock (days)** | 39 | 40 | 42 |
| **Mean age at first egg (days)** | 42.00<br>± 1.08 | 42.25<br>± 0.85 | 43.00<br>± 0.41 |
| **Mean age at 10 per cent production (days)** | 44.75<br>± 1.44 | 45.00<br>± 1.00 | 43.50<br>± 0.50 |
| **Mean age at 50 per cent production (days)** | 52.75<br>± 3.20 | 51.25<br>± 1.65 | 49.75<br>± 0.75 |

Non significant

(11-14 weeks of age). The mean egg production declined to 20.66 eggs in period III (15-18 weeks of age). Then mean egg production increased to 23.16 eggs in period IV (19-22 weeks of age) and further increased to 24.55 eggs in period V (23-26 weeks of age).

In the dietary group $T_2$ fed with 25 per cent crude protein level during starter phase and 23 per cent crude protein during grower phase, the QHN averaged 16.73, 22.36, 23.27, 24.05 and 24.75 in periods I, II, III, IV and V respectively showing highest mean yield in the period V at 23 to 26 weeks of age. In the dietary group $T_3$ with 27 per cent crude protein level during starter phase and 24 per cent crude protein level during grower phase, QHN averaged 16.95, 20.52, 20.89, 22.03 and 22.61 in periods I, II, III, IV and V respectively showing the highest mean yield in period V. The quail housed egg number did not show any significant difference between groups except period V (23-26 weeks of age) in which group $T_3$ showed significantly ($P \leq 0.05$) lower egg number than other groups. But, the cumulative quail housed egg numbers among treatment groups were statistically comparable.

### *4.3.1.2 Quail Housed Per cent (QHP) egg production*

The mean quail housed per cent (QHP) production (Table 6) in dietary group $T_1$ (S-23% CP, G-23% CP) was 58.26 per cent in period I which increased to 77.90 per cent in period II and declined to 73.77 per cent in period III. Thereafter, the QHP increased to 82.70 per cent in period IV and 87.67 per cent in period V.

In the dietary group $T_2$ (S-25% CP, G-23% CP), QHP was 59.77 per cent in period I, increased to 79.85 per cent in period II, 83.09 per cent in the period III, 85.88 per cent in period IV and 88.39 per cent in period V.

**Table 5. Period wise Quail Housed Number (QHN) of eggs as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Period | Age in weeks | Quail Housed egg Number (QHN) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 7-10 | 16.31 ± 1.91 | 16.73 ± 1.25 | 16.95 ± 0.61 |
| II | 11-14 | 21.81 ± 1.74 | 22.36 ± 1.12 | 20.52 ± 1.52 |
| III | 15-18 | 20.66 ± 2.53 | 23.27 ± 1.31 | 20.89 ± 1.41 |
| IV | 19-22 | 23.16 ± 1.30 | 24.05 ± 1.10 | 22.03 ± 1.03 |
| V | 23-26 | $24.55^{a}$ ± 0.59 | $24.75^{a}$ ± 0.47 | $22.61^{b}$ ± 0.72 |
| Cumulative QHN | 7-26 | 106.48 ± 5.30 | 111.16 ± 4.53 | 103.00 ± 4.00 |

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

**Table 6. Period wise Quail Housed Per cent (QHP) of eggs as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Period | Age in weeks | Quail Housed Per cent (QHP) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 7-10 | 58.26 ± 6.83 | 59.77 ± 4.47 | 60.55 ± 2.18 |
| II | 11-14 | 77.90 ± 6.20 | 79.85 ± 4.01 | 73.27 ± 5.41 |
| III | 15-18 | 73.77 ± 9.06 | 83.09 ± 4.69 | 74.61 ± 5.04 |
| IV | 19-22 | 82.70 ± 4.65 | 85.88 ± 3.92 | 78.68 ± 3.47 |
| V | 23-26 | $87.67^{a}$ ± 2.10 | $88.39^{a}$ ± 1.66 | $80.75^{b}$ ± 2.56 |
| Cumulative QHP | 7-26 | 76.06 ± 3.79 | 79.40 ± 3.24 | 73.57 ± 2.86 |

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

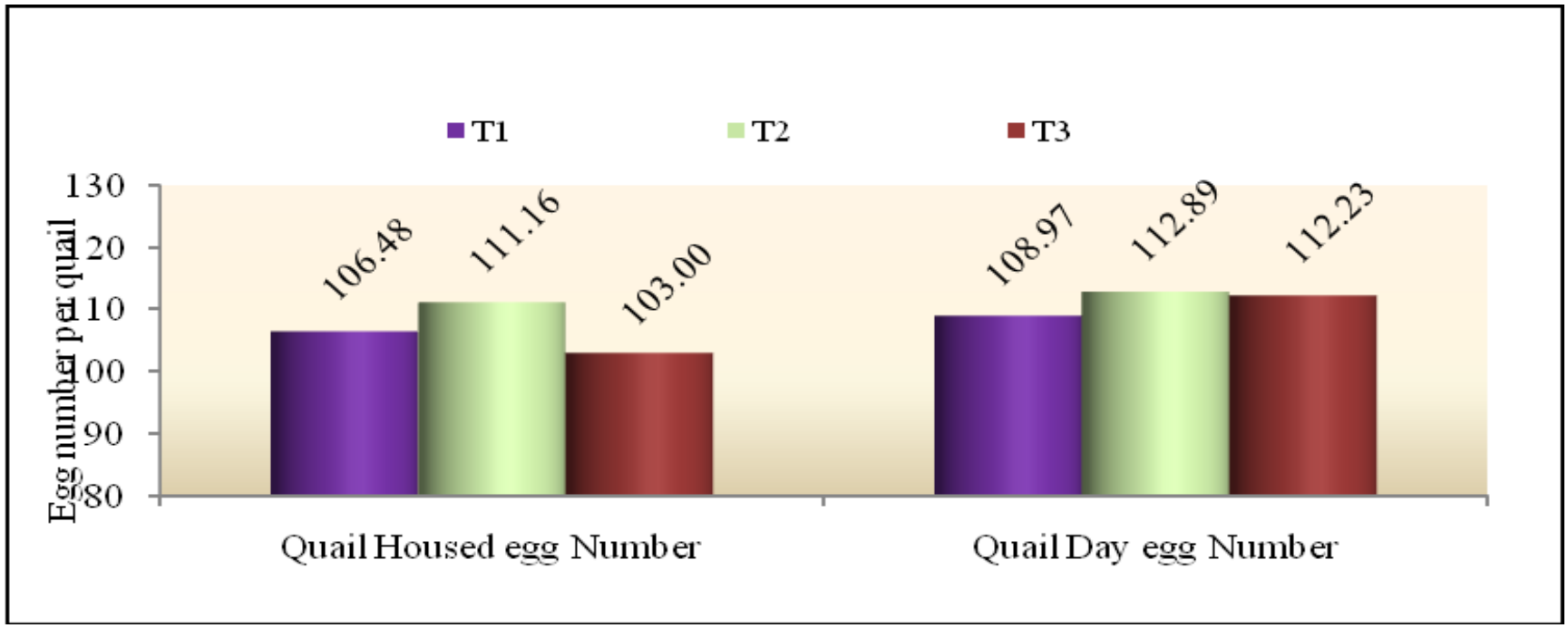


**Fig.2. Cumulative quail housed and quail day egg number from 7 to 26 weeks of age as affected by dietary crude protein levels during growing period**

In the dietary group $T_3$ (S-27% CP, G-24% CP), the QHP averaged 60.55, 73.27, 74.61, 78.68 and 80.75 per cent in periods I, II, III, IV and V, respectively showing highest production in period V.

The cumulative mean per cent quail housed egg production from 7 to 26 weeks of age was 76.06, 79.40 and 73.57 for the treatment groups $T_1$, $T_2$ and $T_3$, respectively.

Statistical analysis revealed significantly lower per cent production in group $T_3$ than other groups during 23 to 26 weeks of age which may be due to high mortality. But, the cumulative per cent production did not reveal significant difference between dietary groups.

### 4.3.2 Quail day egg production

#### *4.3.2.1 Quail Day egg Number (QDN)*

The data on quail day egg number (QDN) and quail day per cent (QDP) egg production are presented in Tables 7 and 8 respectively.

The cumulative quail day egg number (QDN) per quail during the entire period from 7 to 26 weeks of age was 108.97 in $T_1$, 112.89 in $T_2$ and 112.23 in $T_3$ groups of birds.

In the dietary group $T_1$ (S-23% CP, G-23% CP), the quail day egg number (QDN) averaged 16.31 eggs during the period I (7-10 weeks of age) and increased to 22.24 eggs in period II (11 to 14 weeks of age). However in period III (15-18 weeks of age), mean egg production declined to 21.21 eggs and again increased to 23.92 eggs in period IV (19 to 22 weeks of age). The mean egg production for period V (23 to 26 weeks of age) was 25.39 eggs.

In the dietary group $T_2$ (S-25% CP, G-23% CP), the QDN averaged 16.82, 22.70, 23.61, 24.43 and 25.43 in periods I, II, III, IV and V, respectively. Among $T_2$ group, the highest QDN was noticed in the period V. In the dietary group $T_3$ (S-27% CP, G-24% CP), QDN averaged 17.28, 22.02, 23.17, 24.84 and 25.48 in periods I, II, III, IV and V, respectively and the highest mean yield was in period V (23-26 weeks of age). Statistical analysis of the period wise and the cumulative QDN revealed no significant difference between dietary treatments.

#### *4.3.2.2 Quail Day Per cent (QDP) egg production*

The mean quail day per cent (QDP) egg production (Table 8) in dietary group $T_1$ (S-23% CP, G-23% CP) was 58.26 per cent in period I which increased to 79.43 per cent in period II and declined to 75.76 per cent in period III. Thereafter, the QDP increased to 85.42 per cent in period IV and 90.66 per cent in period V.

In the dietary group $T_2$ (S-25% CP, G-23% CP), QDP was 60.08 per cent in period I, increased to 81.08 per cent in period II, 84.31 per cent in the period III, 87.24 per cent in period IV and 90.83 per cent in period V.

In the dietary group $T_3$ (S-27% CP, G-24% CP), the QDP averaged 61.72, 78.66, 82.74, 88.72 and 91.01 per cent in periods I, II, III, IV and V, respectively.

The mean cumulative per cent egg production on quail day basis from 7 to 26 weeks of age was 77.84, 80.64 and 80.17 per cent in groups $T_1$, $T_2$ and $T_3$, respectively. There was no significant difference in quail day per cent egg production (QDP) due to dietary treatments.

**Table 7. Period wise Quail Day Number (QDN) of eggs as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Period | Age in weeks | Quails Day Number (QDN) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 7-10 | 16.31 ± 1.91 | 16.82 ± 1.22 | 17.28 ± 0.60 |
| II | 11-14 | 22.24 ± 1.45 | 22.70 ± 0.99 | 22.02 ± 0.98 |
| III | 15-18 | 21.21 ± 2.20 | 23.61 ± 1.09 | 23.17 ± 0.91 |
| IV | 19-22 | 23.92 ± 1.16 | 24.43 ± 1.01 | 24.84 ± 1.03 |
| V | 23-26 | 25.39 ± 0.68 | 25.43 ± 0.77 | 25.48 ± 0.64 |
| Cumulative QDN | 7-26 | 108.97 ± 4.43 | 112.89 ± 4.05 | 112.23 ± 2.43 |

Non significant

**Table 8. Period wise Quail Day Per cent (QDP) of eggs as influenced by varied dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Period | Age in weeks | Quail Day Per cent (QDP) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 7-10 | 58.26 ± 6.83 | 60.08 ± 4.37 | 61.72 ± 2.14 |
| II | 11-14 | 79.43 ± 5.18 | 81.08 ± 3.54 | 78.66 ± 3.48 |
| III | 15-18 | 75.76 ± 7.87 | 84.31 ± 3.97 | 82.74 ± 3.23 |
| IV | 19-22 | 85.42 ± 4.14 | 87.24 ± 3.61 | 88.72 ± 3.66 |
| V | 23-26 | 90.66 ± 2.43 | 90.83 ± 2.74 | 91.01 ± 2.27 |
| Cumulative QDP | 7-26 | 77.84 ± 3.17 | 80.64 ± 2.89 | 80.17 ± 1.74 |

Non significant

### 4.3.3 **Weekly egg production**

The weekly mean quail housed egg productions and quail day egg productions in various dietary groups are presented in Table 9 and 10 respectively. The weekly fluctuations in egg production due to varied dietary crude protein levels during growing period are depicted in figure 3.

The weekly quail housed egg number and per cent egg production in three dietary groups presented in Table 9. Birds in all the treatment groups showed an increase in egg production from seven to ten weeks of age with egg production above 82 per cent at $10^{th}$ week of age. During $11^{th}$ and $12^{th}$ weeks of age the egg production was above 75 per cent. But a sudden decline in egg production was noticed at $13^{th}$ week of age and thereafter, the egg production increased and reached the peak (83.48 to 90.85%) at $15^{th}$ week of age. During 17, 18 and 19 weeks decline in egg production was observed in all groups, but a sharp increase was noticed in the subsequent weeks at the end of experiment. Egg production was above 80 per cent in all groups from 20 to 26 weeks of age and above 75 per cent at 10, 11, 12, 14, 16, 20, 21 and 26 weeks of age.

## 4.4 EGG MASS

The period wise and cumulative mean egg mass in various dietary groups are presented in Table 11 and depicted graphically in Figure 4.

During the period I (7-10 weeks of age), the mean egg mass per quail recorded was 174.18, 179.10 and 179.44 g for $T_1$, $T_2$ and $T_3$ groups respectively and the difference between groups was non-significant. During the period II (11-14 weeks of age), increase in egg mass was recorded in all dietary groups with the

**Table 9. Weekly mean quail housed egg number (QHN) and quail housed per cent (QHP) egg production as influenced by varied dietary crude protein levels during starter (S) and grower (G) phases**

| Age in weeks | Mean QHN per week | | | Mean QHP per week | | |
|---|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_1$ | $T_2$ | $T_3$ |
| 7 | 1.41 | 1.48 | 1.89 | 20.09 | 21.21 | 27.01 |
| 8 | 3.64 | 3.86 | 4.09 | 52.01 | 52.13 | 58.48 |
| 9 | 5.25 | 5.42 | 5.17 | 75 | 77.46 | 73.88 |
| 10 | 6.02 | 5.97 | 5.8 | 85.94 | 85.27 | 82.81 |
| 11 | 5.94 | 6.03 | 5.74 | 84.82 | 86.13 | 82.04 |
| 12 | 5.68 | 5.71 | 5.78 | 81.09 | 81.61 | 82.56 |
| 13 | 4.53 | 4.86 | 4.28 | 64.73 | 69.42 | 61.16 |
| 14 | 5.75 | 5.94 | 5.41 | 82.14 | 84.82 | 77.23 |
| 15 | 6.36 | 6.34 | 5.84 | 90.85 | 90.62 | 83.48 |
| 16 | 5.73 | 6.22 | 5.48 | 81.92 | 88.84 | 78.35 |
| 17 | 4.61 | 5.28 | 4.73 | 65.85 | 75.45 | 67.63 |
| 18 | 3.95 | 5.42 | 4.83 | 56.47 | 77.46 | 68.97 |
| 19 | 4.94 | 5.36 | 4.91 | 70.54 | 76.56 | 70.09 |
| 20 | 5.92 | 6 | 5.59 | 84.6 | 85.71 | 79.91 |
| 21 | 6.02 | 6.17 | 5.67 | 85.54 | 88.17 | 81.03 |
| 22 | 6.28 | 6.52 | 5.86 | 89.73 | 93.08 | 83.71 |
| 23 | 6.28 | 6.22 | 5.69 | 89.73 | 88.84 | 81.25 |
| 24 | 6.33 | 6.27 | 5.63 | 90.4 | 89.51 | 80.36 |
| 25 | 6.09 | 6.16 | 5.78 | 87.05 | 87.95 | 82.59 |
| 26 | 5.86 | 6.11 | 5.52 | 83.71 | 87.28 | 78.79 |
| 7-26 | 106.48 | 111.16 | 103 | 76.06 | 79.4 | 73.57 |

**Table 10. Weekly mean quail day egg number (QDN) and quail day per cent (QDP) egg production as influenced by varied dietary crude protein levels during starter (S) and grower (G) phases**

| Age in weeks | Mean QDN per week | | | Mean QDP per week | | |
|---|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_1$ | $T_2$ | $T_3$ |
| 7 | 1.41 | 1.48 | 1.89 | 20.09 | 21.21 | 27.01 |
| 8 | 3.64 | 3.86 | 4.15 | 52.01 | 55.13 | 59.28 |
| 9 | 5.25 | 5.42 | 5.34 | 75.00 | 77.46 | 76.24 |
| 10 | 6.02 | 5.97 | 5.80 | 85.94 | 85.27 | 82.81 |
| 11 | 5.94 | 5.94 | 5.48 | 84.82 | 84.82 | 78.34 |
| 12 | 5.59 | 5.63 | 5.34 | 79.91 | 80.36 | 76.34 |
| 13 | 4.62 | 4.94 | 4.63 | 65.94 | 70.55 | 66.12 |
| 14 | 5.92 | 6.02 | 5.85 | 84.60 | 86.04 | 83.53 |
| 15 | 6.56 | 6.44 | 6.35 | 93.78 | 92.02 | 90.78 |
| 16 | 5.90 | 6.31 | 6.07 | 84.34 | 90.18 | 86.74 |
| 17 | 4.69 | 5.35 | 5.30 | 67.03 | 76.41 | 75.77 |
| 18 | 4.05 | 5.50 | 5.42 | 57.88 | 78.62 | 77.44 |
| 19 | 5.09 | 5.44 | 5.54 | 72.74 | 77.78 | 79.17 |
| 20 | 6.10 | 6.10 | 6.31 | 87.21 | 87.14 | 90.12 |
| 21 | 6.23 | 6.27 | 6.40 | 88.97 | 89.52 | 91.37 |
| 22 | 6.49 | 6.61 | 6.60 | 92.76 | 94.49 | 94.23 |
| 23 | 6.47 | 6.32 | 6.40 | 92.47 | 90.31 | 91.49 |
| 24 | 6.54 | 6.44 | 6.35 | 93.43 | 91.94 | 90.65 |
| 25 | 6.31 | 6.36 | 6.51 | 90.15 | 90.82 | 92.98 |
| 26 | 6.08 | 6.32 | 6.23 | 86.83 | 90.22 | 88.93 |
| 7-26 | 108.97 | 112.89 | 112.23 | 77.84 | 80.64 | 80.17 |

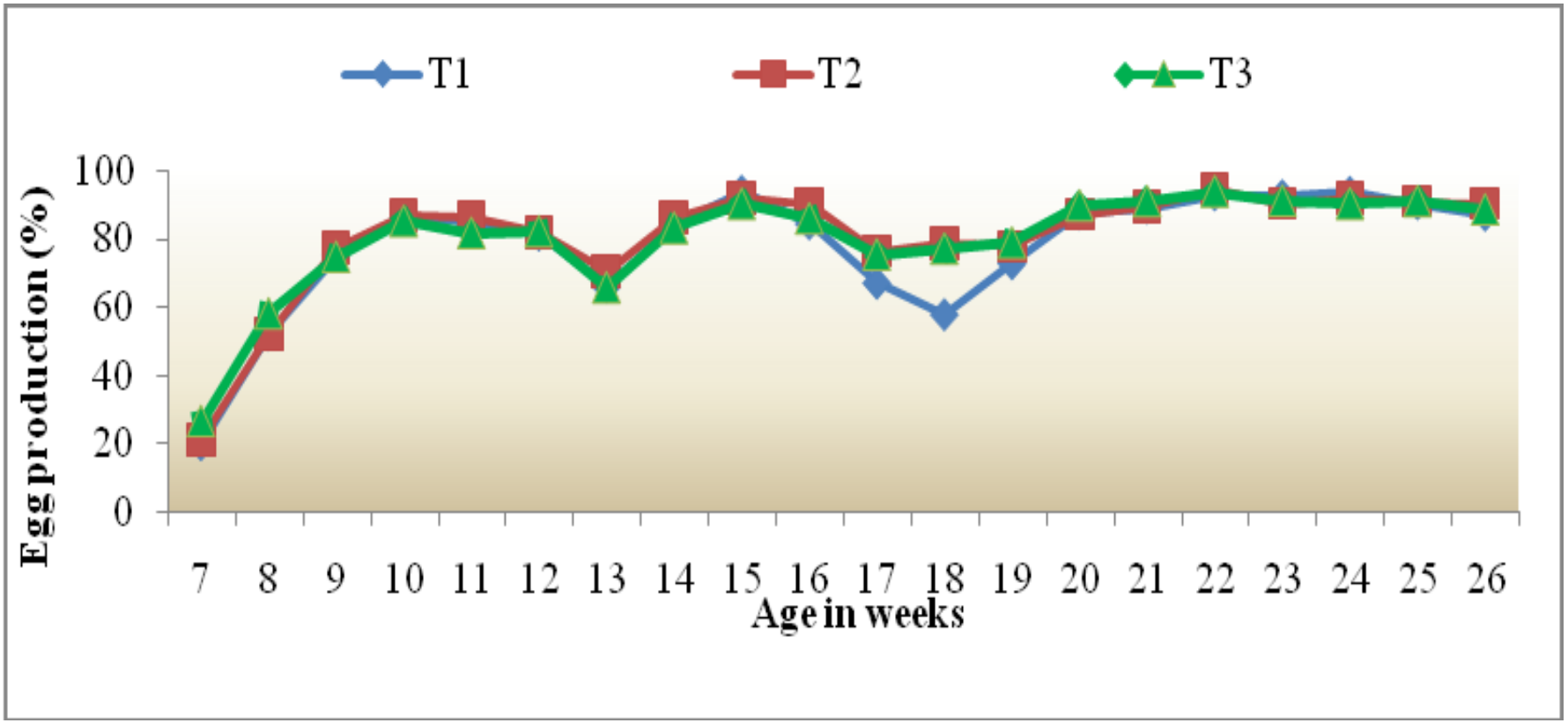


**Fig.3. Weekly quail housed egg production (%) as affected by dietary crude protein levels during growing period**

highest egg mass per quail (250.16 g) in group $T_2$ and the lowest (237.75 g) in group $T_3$. The egg mass in the group $T_1$ was 242.40 and the difference was not significant.

During the period III (15-18 weeks of age), the egg mass in dietary group $T_1$ declined from 250.16 to 234.96 g but increase in egg mass was noticed in dietary groups $T_2$ and $T_3$ (271.68 and 261.38 g respectively). During the period IV (19-22 weeks of age), increase in egg mass was recorded in all dietary groups with the highest egg mass (288.84 g) in dietary group $T_3$ followed by $T_2$ (285.66 g) and $T_1$ (275.02 g).

Among the five 28-day periods of egg production studied, the highest egg mass per quail was recorded during period V (23-26 weeks of age) in all groups with the values 296.00, 294.18 and 296.20 g in groups $T_1$, $T_2$ and $T_3$, respectively.

The highest cumulative mean egg mass per quail during the entire period of experiment (7 to 26 weeks of age) was 1281.14 g in group $T_2$ followed by 1255.26 g in group $T_3$ and 1221.23 g in group $T_1$. However, no significant difference in cumulative egg mass was noticed between the different treatment groups.

## 4.5 MEAN EGG WEIGHT

The period wise mean egg weight and overall mean egg weight during the period from 7 to 26 weeks of age are presented in Table 12 and depicted graphically in Figure 5.

At $10^{th}$ week of age (Period I), the mean egg weight was 10.86, 10.88 and 10.84 g in dietary groups $T_1$, $T_2$ and $T_3$, respectively. In period II, the mean egg weights in the groups $T_1$, $T_2$ and $T_3$ were 11.15, 11.12 and 11.10 g, respectively.

**Table 11. Period wise egg mass (g) per quail as influenced by varied dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Period | Age in weeks | Mean egg mass per quail (g) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 10 | 174.18 ± 20.22 | 179.10 ± 12.45 | 179.44 ± 6.20 |
| II | 14 | 242.40 ± 17.50 | 250.16 ± 11.69 | 237.75 ± 12.46 |
| III | 18 | 234.96 ± 29.46 | 271.68 ± 16.11 | 261.38 ± 12.95 |
| IV | 22 | 275.02 ± 14.64 | 285.66 ± 13.66 | 288.84 ± 14.15 |
| V | 26 | 296.00 ± 8.52 | 294.18 ± 9.63 | 296.20 ± 8.61 |
| Cumulative mean egg mass (g) | 7-26 | 1221.23 ± 59.22 | 1281.14 ± 52.56 | 1255.26 ± 39.37 |

Non significant

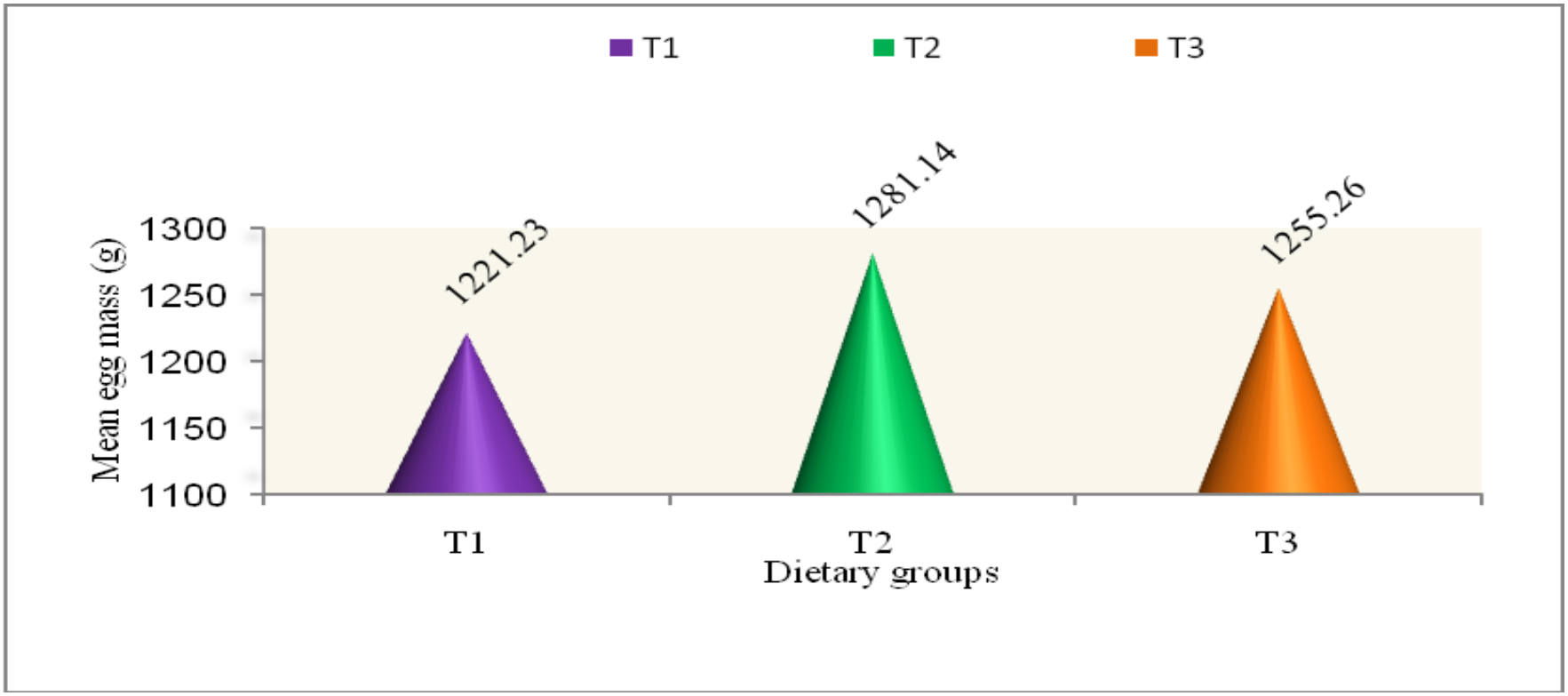


**Fig.4. Mean egg mass (g) of Japanese quails from 7 to 26 weeks of age as influenced by dietary crude protein levels during growing period**

**Table 12. Period wise egg weight (g) as influenced by varied dietary crude protein levels during starter (S) and grower (G) phases. Mean ± S. E. (n=64)**

| Period | Age in weeks | Egg weight (g) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 10 | 10.86 ± 0.09 | 10.88 ± 0.11 | 10.84 ± 0.07 |
| II | 14 | 11.15 ± 0.08 | 11.12 ± 0.11 | 11.10 ± 0.15 |
| III | 18 | 11.51 ± 0.06 | 11.69 ± 0.17 | 11.55 ± 0.09 |
| IV | 22 | 11.61 ± 0.03 | 11.72 ± 0.10 | 11.68 ± 0.10 |
| V | 26 | 11.66 ± 0.08 | 11.63 ± 0.07 | 11.67 ± 0.07 |
| Cumulative mean egg weight (g) | 7 - 26 | 11.39 ± 0.07 | 11.46 ± 0.09 | 11.39 ± 0.08 |

Non significant

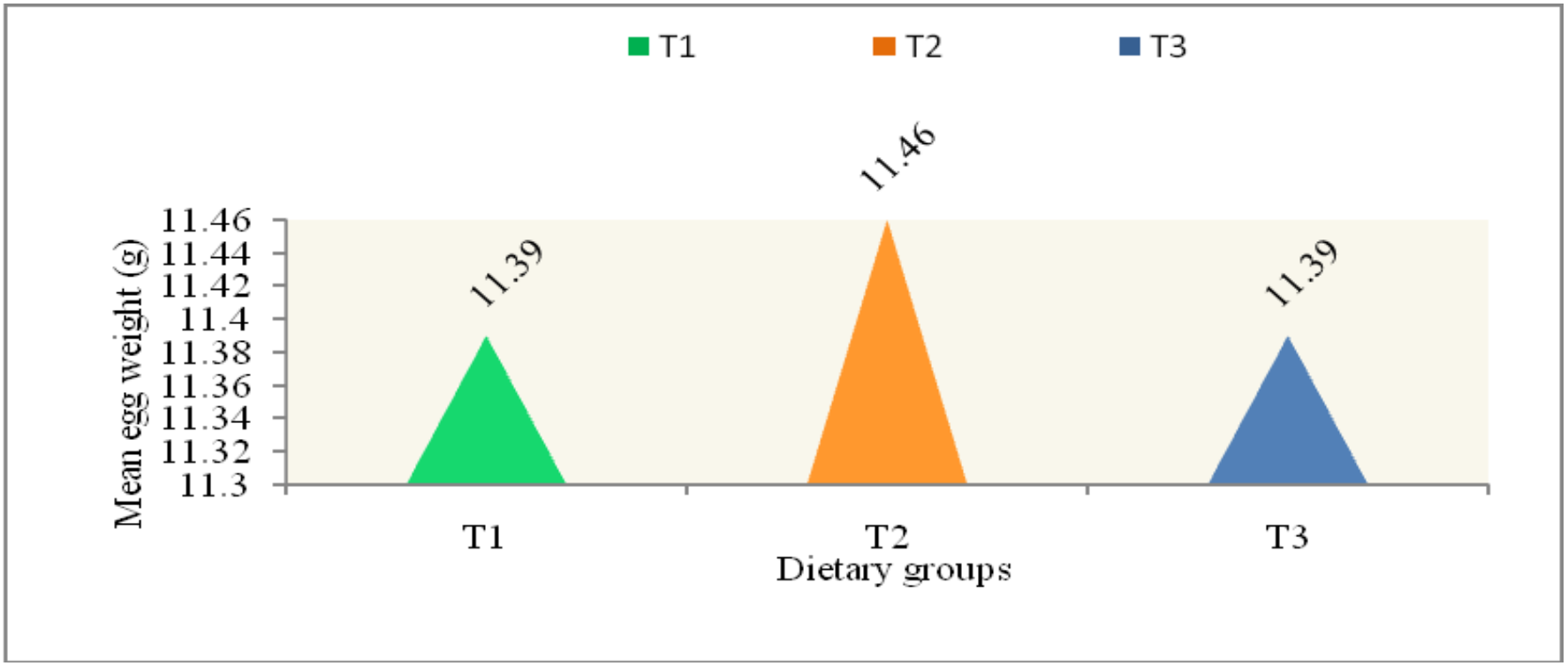


**Fig.5. Mean egg weight (g) of Japanese quails from 7 to 26 weeks of age as affected by different crude protein levels during growing period**

The mean egg weight showed increase in all groups and were statistically similar.

During period III (15-18 weeks of age), the mean egg weight recorded were 11.51 g for $T_1$, 11.69 g for $T_2$ and 11.55 g for $T_3$. During period IV (19-22 weeks of age) it was 11.61, 11.72 and 11.68 g for $T_1$, $T_2$ and $T_3$, respectively.

During period V (23-26 weeks of age), the mean egg weight recorded among the dietary groups $T_1$, $T_2$ and $T_3$ were 11.66, 11.63 and 11.67 g, respectively. The highest mean EW recorded in the study was 11.72 g in the $T_2$ group, at 22 weeks of age.

The cumulative mean egg weight during 7 to 26 weeks was the highest in the $T_2$ (11.46 g) and it was same for $T_1$ and $T_3$ (11.39 g). There was no significant difference in mean egg weight between the three treatment groups.

## 4.6 FEED CONSUMPTION

Statistical analysis of the data pertaining to cumulative feed intake per quail during starter phase (0 to 3 weeks of age) and grower phase (4 to 6 weeks of age), subsequent mean daily feed consumption per quail in each 28 day period and the cumulative mean feed consumption per quail (7 to 26 weeks of age) did not show significant difference between the dietary groups.

Cumulative feed consumption per quail (g) as influenced by varied dietary crude protein levels during growing period is presented in Table 13 and depicted graphically in Figure 6. During starter phase (0-3 weeks of age), the cumulative feed intake per quail in groups $T_1$, $T_2$ and $T_3$ was 223.72, 229.79 and 230.22 g, respectively. During grower phase (4-6 weeks of age), the cumulative feed intake

**Table 13. Cumulative feed consumption per quail (g) during starter and grower phase as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ±S. E. (n=200)**

| Age in weeks | Cumulative feed consumption per quail (g) | | |
|---|---|---|---|
| | **$T_1$**<br>S-23% CP<br>G-23% CP | **$T_2$**<br>S-25% CP<br>G-23% CP | **$T_3$**<br>S-27% CP<br>G-24% CP |
| 0 - 3 | 223.72<br>± 4.02 | 229.79<br>± 1.89 | 230.22<br>± 0.94 |
| 4 - 6 | 533.47<br>± 6.86 | 525.12<br>± 8.51 | 510.56<br>± 8.20 |

Non significant

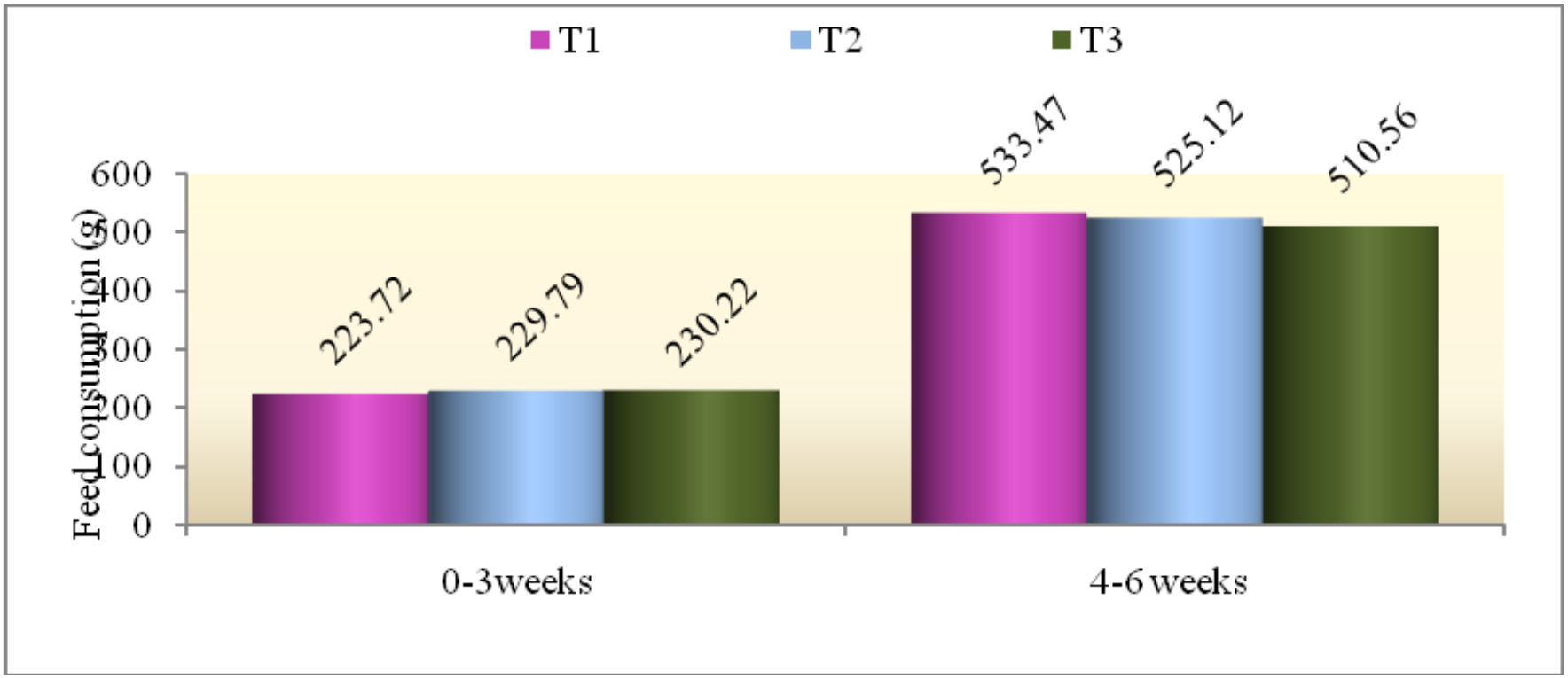


**Fig.6. Cumulative feed consumption per quail at 3rd and 6th week of age as affected by dietary crude protein levels during growing period**

for $T_1$, $T_2$ and $T_3$ group of birds were 533.47, 525.12 and 510.56 g, respectively.

The period wise mean daily feed consumption is presented in Table 14. During period I (7-10 weeks of age), the average feed intake in groups $T_1$, $T_2$ and $T_3$ was 29.16, 28.91 and 28.76 g, respectively and were statistically comparable with each other.

During period II (11-14 weeks), the mean feed consumption was 33.66, 34.47 and 34.65 g in dietary groups $T_1$, $T_2$ and $T_3$, respectively. The difference was narrow between the dietary groups. In the corresponding groups, in period III (15-18 weeks), the feed intake was 32.95, 34.36 and 34.05 g. During period IV (19-22 weeks), the mean daily feed consumption of quails in groups $T_1$, $T_2$ and $T_3$ were 33.16, 33.62 and 34.32 g, respectively.

During period V (23-26 weeks), the mean daily feed consumption values were 32.83, 33.62 and 33.33 for the dietary treatment groups $T_1$, $T_2$ and $T_3$, respectively. The feed consumption per quail per day during layer phase (7 to 26 weeks of age) was 32.35 for $T_1$, 32.00 for $T_2$ and 33.02 g for $T_3$ birds.

The cumulative feed consumption of quail from 7 to 26 weeks of age was 4.53 kg in groups $T_1$ and it was 4.62 kg in both groups $T_2$ and $T_3$. Throughout the study, no significant difference in average daily feed consumption observed between treatment groups.

## 4.7 FEED CONVERSION RATIO (FCR)

### 4.7.1 Feed Conversion Ratio (FCR) per kilogram weight gain during growing period.

**Table 14. Period wise feed consumption per quail (g) as influenced by varied dietary crude protein levels during starter (S) and grower (G) phases. Mean ±S. E. (n=64)**

| Period | Age in weeks | Mean daily feed consumption per quail(g) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 7-10 | 29.16 ± 0.12 | 28.91 ± 0.22 | 28.76 ± 0.20 |
| II | 11-14 | 33.66 ± 0.33 | 34.47 ± 0.08 | 34.65 ± 0.46 |
| III | 15-18 | 32.95 ± 0.56 | 34.36 ± 0.07 | 34.05 ± 0.47 |
| IV | 19-22 | 33.16 ± 0.40 | 33.62 ± 0.55 | 34.32 ± 0.16 |
| V | 23-26 | 32.83 ± 0.11 | 33.62 ± 1.46 | 33.33 ± 0.39 |
| Periodwise mean / day | 7-26 | 32.35 ± 0.25 | 32.00 ± 0.21 | 33.02 ± 0.13 |
| Cumulative mean /quail (kg) | | 4.53 ± 0.03 | 4.62 ± 0.03 | 4.62 ± 0.02 |

Non significant

The feed conversion ratio (FCR) per kg weight gain as influenced by varied dietary crude protein levels during growing period is presented in Table 15 and graphically depicted in Figure 7.

The mean FCR values during starter phase (0 to 3 weeks of age) when quail chicks fed with iso-caloric diets with per cent crude protein levels of 23, 25 and 27 in dietary treatment groups $T_1$, $T_2$ and $T_3$ were 2.96, 3.03 and 3.02, respectively.

The mean FCR values during grower phase (4 to 6 weeks of age) when quail chicks fed with iso-caloric diets with per cent crude protein levels of 23, 23 and 24 in dietary treatment groups $T_1$, $T_2$ and $T_3$ were 5.67, 5.48 and 5.42, respectively. No significant difference was observed for feed efficiency among dietary treatment groups at third and sixth week of age.

The mean FCR values during growing period (0 to 6 weeks of age) in dietary treatment groups $T_1$, $T_2$ and $T_3$ were 4.43, 4.36 and 4.39, and no significant difference in FCR was noted among the groups.

**4.7.2 Feed Conversion Ratio (FCR) per dozen eggs.**

FCR per dozen eggs (7 to 26 weeks of age) is presented in Table 16 and the cumulative means are depicted graphically in figure 8

During period I (7-10 weeks of age), the FCR values in all dietary groups were high with the poorest FCR (0.61) in group $T_1$, followed by $T_2$ (0.59) and $T_3$ (0.56). In period II, FCR improved in all groups and the values for groups $T_1$ and $T_3$ was 0.53 and for $T_2$ it was 0.51. In period III the FCR values remained as 0.53, 0.49 and 0.50 in $T_1$, $T_2$ and $T_3$ groups, respectively and in period IV the FCR improved in all groups and the values were 0.49, 0.47 and 0.47 in $T_1$, $T_2$ and $T_3$ groups, respectively.

**Table 15. Feed conversion ratio (FCR) per kilogram weight gain during starter (0-3 weeks) and grower (4-6 weeks) phases as influenced by different dietary crude protein levels. Mean ±S. E. (n=200)**

| Age in weeks | Mean feed conversion ratio (kg feed / kg weight gain) | | |
|---|---|---|---|
| | **$T_1$**<br>S-23% CP<br>G-23% CP | **$T_2$**<br>S-25% CP<br>G-23% CP | **$T_3$**<br>S-27% CP<br>G-24% CP |
| 0 - 3 | 2.96<br>± 0.03 | 3.03<br>± 0.04 | 3.02<br>± 0.01 |
| 4 - 6 | 5.67<br>± 0.05 | 5.48<br>± 0.11 | 5.42<br>± 0.17 |
| 0 - 6 | 4.43<br>± 0.02 | 4.36<br>± 0.08 | 4.39<br>± 0.09 |

Non significant

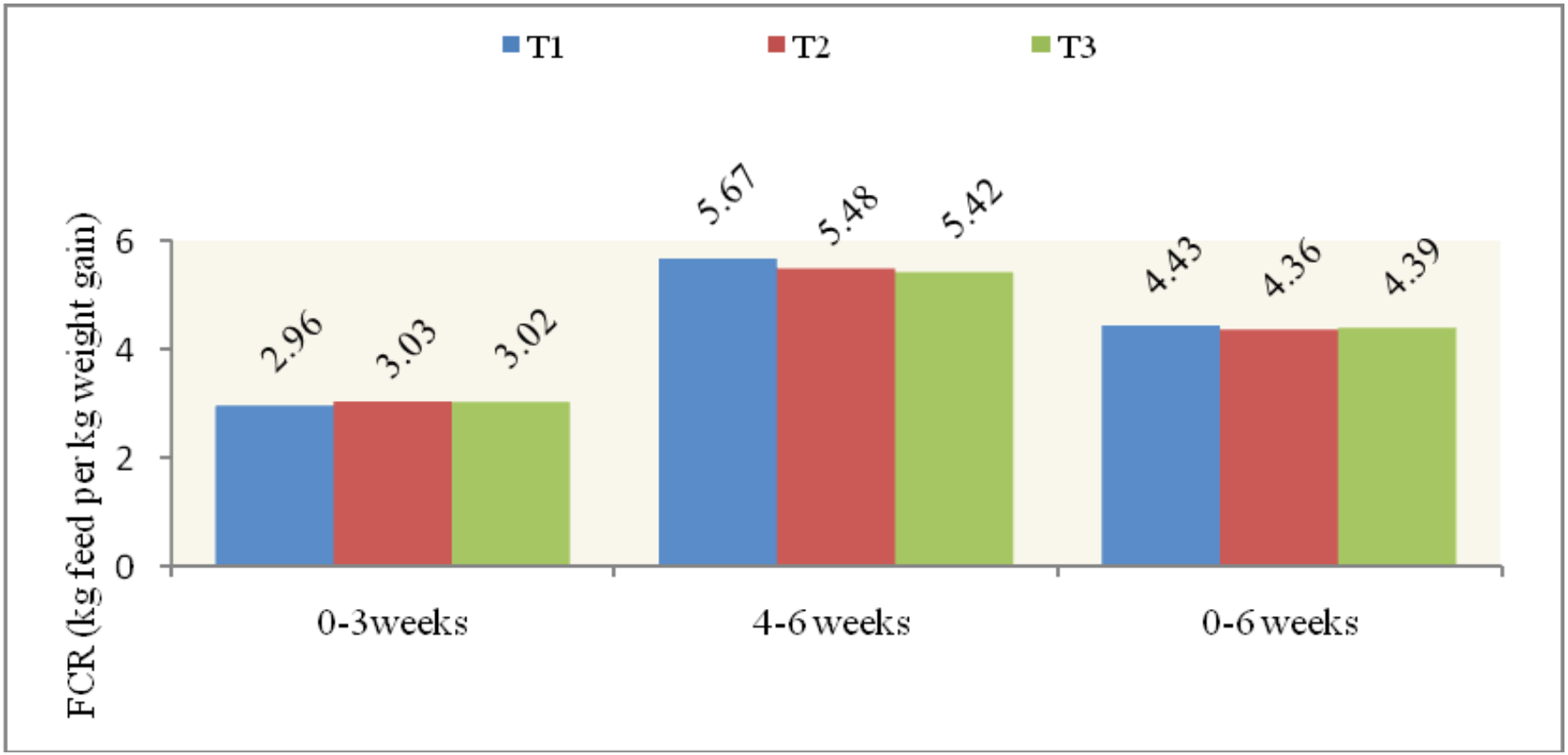


**Fig.7. Feed Conversion Ratio during starter phase (0 to 3 weeks), grower phase (4 to 6 weeks) and growing period (0 to 6 weeks) in quails as affected by dietary crude protein levels**

In period V (23-26 weeks of age), the FCR further improved and the value was 0.44 for both groups $T_1$ and $T_3$ and 0.45 for group $T_2$.

The FCR values among dietary groups were statistically comparable during period I to V. The data on cumulative FCR during layer phase (7-26 weeks of age) among the dietary groups showed that the FCR values were similar in all groups. The values were 0.50, 0.49 and 0.50 in the groups $T_1$, $T_2$ and $T_3$, respectively which were statistically non-significant.

### 4.7.3 Feed Conversion Ratio (FCR) per kilogram eggs

The Feed Conversion Ratio (FCR) per kg eggs in each 28-day period and the cumulative mean FCR from 7 to 26 weeks of age are presented in Table 17 and the cumulative means are depicted graphically in figure 9.

During period I, the FCR per kg eggs was 4.80, 4.59 and 4.51 for $T_1$, $T_2$ and $T_3$ groups respectively, without significant difference between groups. In the period II, FCR improved in all groups and the values were 4.10, 3.88 and 4.12 for $T_1$, $T_2$ and $T_3$ groups, respectively.

During the period III, the FCR values were 4.00, 3.58 and 3.68 in $T_1$, $T_2$ and $T_3$ groups, respectively. In period IV values remained as 3.59, 3.37 and 3.39 in $T_1$, $T_2$ and $T_3$ groups, respectively. In period V, the FCR improved slightly and it was 3.14 for $T_1$, 3.19 for $T_2$ and 3.16 for $T_3$ groups.

The cumulative mean FCR values per kg eggs from 7 to 26 weeks of age for dietary treatment groups $T_1$, $T_2$ and $T_3$ were 3.79, 3.58 and 3.64, respectively and were statistically comparable to each other.

**Table 16. Period wise feed conversion ratio (per dozen eggs) as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ±S. E. (n=64)**

| Period | Age in weeks | Mean Feed Conversion Ratio (kg feed / dozen eggs) | | |
|---|---|---|---|---|
| | | **T1** S-23% CP G-23% CP | **T2** S-25% CP G-23% CP | **T3** S-27% CP G-24% CP |
| I | 7-10 | 0.61 ± 0.07 | 0.59 ± 0.04 | 0.56 ± 0.06 |
| II | 11-14 | 0.53 ± 0.02 | 0.51 ± 0.02 | 0.53 ± 0.02 |
| III | 15-18 | 0.53 ± 0.04 | 0.49 ± 0.02 | 0.50 ± 0.02 |
| IV | 19-22 | 0.49 ± 0.02 | 0.47 ± 0.03 | 0.47 ± 0.02 |
| V | 23-26 | 0.44 ± 0.01 | 0.45 ± 0.06 | 0.44 ± 0.01 |
| Cumulative FCR | 7-26 | 0.50 ± 0.01 | 0.49 ± 0.02 | 0.50 ± 0.01 |

Non significant

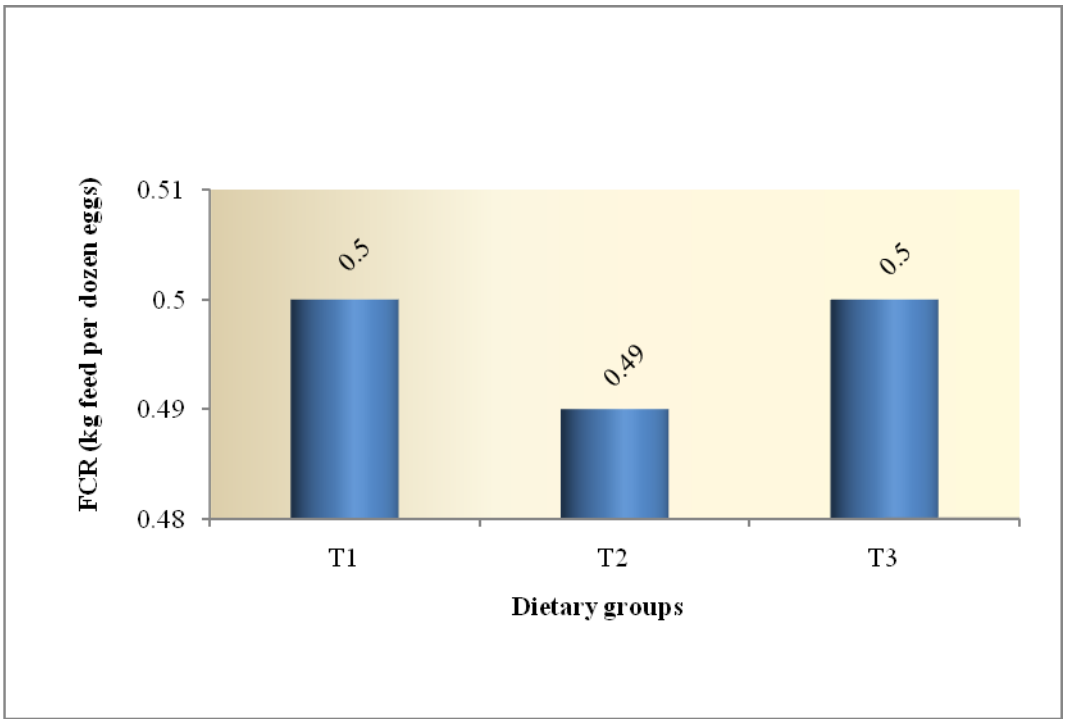


**Fig.8. Mean feed conversion ratio (per dozen eggs) from 7 to 26 weeks of age in quails as influenced by dietary crude protein levels during growing period**

**Table 17. Period wise feed conversion ratio (per kilogram eggs) as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ±S. E. (n=64)**

| Period | Age in weeks | Mean Feed Conversion Ratio (kg feed / kg eggs) | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| I | 7-10 | 4.80 ± 0.53 | 4.59 ± 0.32 | 4.51 ± 0..13 |
| II | 11-14 | 4.10 ± 0.20 | 3.88 ± 0.18 | 4.12 ± 0.23 |
| III | 15-18 | 4.00 ± 0.32 | 3.58 ± 0.20 | 3.68 ± 0.19 |
| IV | 19-22 | 3.59 ± 0.17 | 3.37 ± 0.22 | 3.39 ± 0.19 |
| V | 23-26 | 3.14 ± 0.08 | 3.19 ± 0.03 | 3.16 ± 0.12 |
| Cumulative FCR | 7-26 | 3.79 ± 0.12 | 3.58 ± 0.16 | 3.64 ± 0.05 |

Non significant

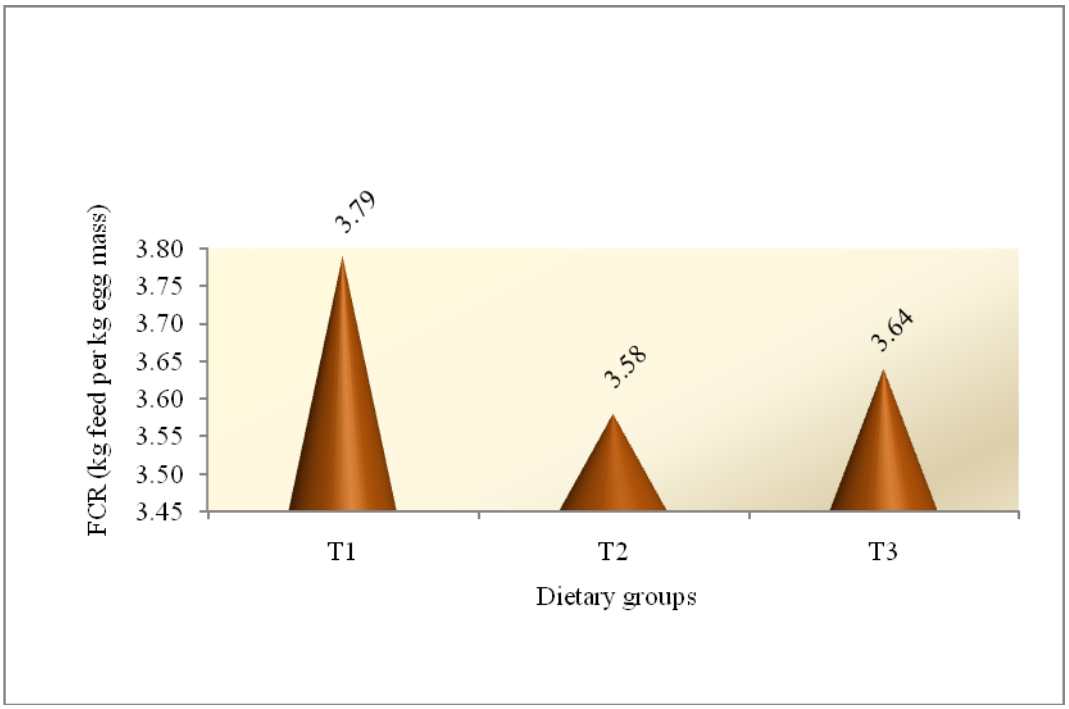


**Fig.9.Mean feed conversion ratio (per kg eggs) from 7 to 26 weeks of age in quails influenced by dietary crude protein(CP) levels during growing period**

## 4.8 COST AND RETURN

The economics of production in Japanese quail as influenced by different dietary crude protein levels during starter (S) and grower (G) phases were worked out and presented in Table 18.

The cost of day-old quail chicks and quail pullets at 6$^{th}$ week of age for each dietary treatment group was Rs. 1000.00 and 1280.00, respectively.

The cumulative feed intake in the groups $T_1$, $T_2$ and $T_3$ during starter phase (0-3 weeks) were 43.64, 45.22 and 45.43 kg with the total feed cost of Rs. 694.74, 755.62 and 814.56, respectively. Cumulative feed intake in both treatment groups $T_1$ and $T_2$ during grower phase (4-6 weeks) was 100.90 kg with feed cost of Rs.1606.33. In dietary group $T_3$ cumulative feed intake was of 96.20 kg with total feed cost of Rs.1590.19. During Layer phase (7-26 weeks) cumulative feed intake in the treatment groups $T_1$, $T_2$ and $T_3$ were 291.40, 298.00 and 278.70 kg with total feed cost of Rs. 4808.10, 4917.00 and 4598.55 respectively.

The return by the sale of eggs in the treatment groups $T_1$, $T_2$ and $T_3$ were Rs.6715.00, 7061.00 and 6497.00, respectively.

The total return by the sale of 6 weeks old quails in the treatment groups $T_1$, $T_2$ and $T_3$ were Rs. 3368.00, 3416.00 and 3380.00, respectively.

The total return by the sale of 26 weeks old quails in the treatment groups $T_1$ and $T_2$ was Rs. 992 and in treatment group $T_3$ it was Rs. 912.

The margin per quail chick housed (male + female) was significantly higher in treatment groups $T_1$ and $T_2$ than group $T_3$ during growing period (0-6 weeks) and mean values were Rs 0.32, 0.36 and -0.63 in $T_1$, $T_2$ and $T_3$, respectively.

During layer phase (7-26 weeks), the margin per quail pullet housed in the treatment groups $T_1$, $T_2$ and $T_3$ was calculated as Rs. 25.29, 29.00 and 23.91.

**Table 18. Cost and return of quail rearing in cages from 0 to 26 weeks of age as influenced by different dietary crude protein levels during starter (S) and grower (G) phases**

| Sl. No | Particulars | $T_1$ (S-23% CP G-23% CP) | | | $T_2$ (S-25% CP G-23% CP) | | | $T_3$ (S-27% CP G-24% CP) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Unit cost(Rs) | Quantity | Cost(Rs) | Unit cost (Rs | Quantity | Cost(Rs) | Unit cost(Rs) | Quantity | Cost (Rs) |
| A | Cost | | | | | | | | | |
| 1 | Quail chicks | 5.00/ chick | 200 | 1000 | 5.00/ chick | 200 | 1000 | 5.00/ chick | 200 | 1000 |
| 2 | Quail pullets | 20.00/pullet | 64 | 1280 | 20.00/pullet | 64 | 1280 | 20.00/pullet | 64 | 1280 |
| 3 | Feed (0-3weeks) | 15.92/kg | 43.64 kg | 694.74 | 16.71/kg | 45.22 kg | 755.62 | 17.93/kg | 45.43 kg | 814.56 |
| 4 | Feed (4-6weeks) | 15.92/kg | 100.9 kg | 1606.33 | 15.92/kg | 100.9 kg | 1606.33 | 16.53/kg | 96.2 kg | 1590.19 |
| 5 | Feed(7-26weeks) | 16.50/kg | 291.4kg | 4808.10 | 16.50/kg | 298.0 kg | 4917.00 | 16.50/kg | 278.7 kg | 4598.55 |
| B | Return | | | | | | | | | |
| 1 | Sale of eggs | 1.00/egg | 6715 | 6715 | 1.00/egg | 7061 | 7061 | 1.00/egg | 6497 | 6497 |
| 2 | Sale of birds ($6^{th}$ week) | 20.00/F<br>16.00/M | 94F<br>93M | 1880 1488 | 20.00/F<br>16.00/M | 94F 96M | 1880<br>1536 | 20.00/F<br>16.00/M | 101F 85M | 2020 1360 |
| 3 | Sale of birds ($26^{th}$ week) | 20.00/F | 62F | 992 | 20.00/F | 62F | 992 | 20.00/F | 57F | 912 |
| C | Margin (0-6weeks) | | | 66.93 | | | 54.05 | | | -24.75 |
| D | Margin (7-26weeks) | | | 1618.9 | | | 1856.00 | | | 1530.45 |
| E | *Margin/QH (0-6weeks) | | | $0.32^{a}$ ±0.19 | | | $0.36^{a}$ ±0.46 | | | $-0.63^{b}$ ±0.10 |
| F | Margin/QH(7-26weeks) | | | 25.29 | | | 29.00 | | | 23.91 |

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

## 4.9 LIVABILITY

The mean livability per cent of Japanese quails during starter (0 to 3 weeks), grower (4 to 6 weeks) and layer phase (7 to 26 weeks) as influenced by different crude protein levels during growing period are presented in Table 19. During starter phase, mean livability per cent values were 97.55, 98.38 and 98.67 for $T_1$, $T_2$ and $T_3$ respectively, which did not differ significantly. During grower phase, mean livability per cent values were 98.50, 98.97 and 97.06 in dietary group $T_1$, $T_2$ and $T_3$ respectively, which did not differ significantly. During laying period I (7-10 weeks of age), $T_1$, $T_2$ and $T_3$ group showed livability per cent of 100.00, 99.50 and 98.27, respectively. During period II (11-14 weeks of age), livability per cent in $T_1$, $T_2$ and $T_3$ groups were 97.94, 100.00 and 97.55, respectively. During period III (15-18 weeks of age), dietary group $T_3$ showed livability per cent of 97.80 and no mortality was recorded in other groups. The overall livability was 100 per cent in all groups during period IV (19-22 weeks of age). During period V (23-26 weeks of age), dietary group $T_2$ showed livability per cent of 99.00 and no mortality was recorded in other groups. Cumulative mean livability per cent values (7-26 weeks of age) were 99.59, 99.70 and 98.72 for $T_1$, $T_2$ and $T_3$ respectively, which did not differ significantly.

## 4.10 METEOROLOGICAL OBSERVATIONS

The mean maximum and minimum temperature ($^0$C) and the mean per cent relative humidity (R.H) inside the experimental house at 28 days interval from September 2009 to February 2010 are presented in Table 20. The maximum temperature averaged 29.11, 30.14, 29.90, 30.00 and 31.25ºC in periods I, II, III, IV and V, respectively with an overall mean of 30.08ºC. In the above periods, the minimum temperature averaged 24.86, 24.25, 24.43, 24.36 and 23.18ºC with an overall mean of 24.21ºC during the entire period of experiment.

**Table 19. Livability per cent in Japanese quail during the period of 0 to 26 weeks of age as influenced by different dietary crude protein levels during starter (S) and grower (G) phases. Mean ±S. E.**

| Age in weeks | Mean livability (%) | | |
|---|---|---|---|
| | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| 0-3 | 97.55 ± 1.19 | 98.38 ± 0.35 | 98.67 ± 0.66 |
| 4-6 | 98.50 ± 0.33 | 98.97 ± 0.81 | 97.06 ± 1.35 |
| 7-10 | 100.00 ± 0.00 | 99.50 ± 0.50 | 98.27 ± 1.05 |
| 11-14 | 97.94 ± 2.07 | 100.00 ± 0.00 | 97.55 ± 1.42 |
| 15-18 | 100.00 ± 0.00 | 100.00 ± 0.00 | 97.80 ± 1.28 |
| 19-22 | 100.00 ± 0.00 | 100.00 ± 0.00 | 100.00 ± 0.00 |
| 23-26 | 100.00 ± 0.00 | 99.00 ± 1.00 | 100.00 ± 0.00 |
| 7-26 (Cumulative mean) | 99.59 ± 0.41 | 99.70 ± 0.19 | 98.72 ± 0.37 |

Non significant

During experimental period, the mean maximum temperature was the lowest in period I ($29.11^0$C) and the highest in period V ($31.25^0$C). The mean minimum temperature was the lowest in period V ($23.18^0$C) and the highest ($24.86^0$C) in period I.

The relative humidity averaged 76.33, 72.48, 71.72, 72.84 and 52.24 per cent in periods I, II, III, IV and V, respectively. The overall mean relative humidity from 7 to 26 weeks of age was 69.12 per cent.

**Table 20. Mean maximum and minimum temperature ($^0$C) and per cent relative humidity inside the experimental house during the period from September 2009 to February 2010**

| Periods | Age in weeks | Temperature ( $^0$C ) | | Relative Humidity (%) |
|---|---|---|---|---|
| | | Maximum | Minimum | |
| I ( Sept 24 – Oct 21) | 7-10 | 29.11 | 24.86 | 76.33 |
| II ( Oct 22 – Nov 18) | 11-14 | 30.14 | 24.25 | 72.48 |
| III (Nov 19 – Dec 16) | 15-18 | 29.90 | 24.43 | 71.72 |
| IV (Dec 17 – Jan 13) | 19-22 | 30.00 | 24.36 | 72.84 |
| V (Jan 14 – Feb 10) | 23-26 | 31.25 | 23.18 | 52.24 |
| Overall mean | 7-26 | 30.08 | 24.21 | 69.12 |

# *Discussion*

# 5. DISCUSSION

Effect of different crude protein levels during growing period on growth and production performance of Japanese layer quails are discussed in this chapter.

## 5.1 BODY WEIGHT

The data presented in Table 3 indicated that, at third week of age, the mean body weight (BW) of quails was 83.55, 83.35 and 83.67 g in groups $T_1$, $T_2$ and $T_3$, respectively. The statistical analysis of data revealed no significant difference in body weight between the treatment groups. Shamna (2008) reported similar body weight in Japanese quails at third week of age when fed with diet containing 26 per cent crude protein. The present finding agrees with Oliveira *et al.* (2002) who reported no significant difference in body weight gain of quails at three weeks of age due to dietary protein levels. Contrary to the above findings, Correa *et al.* (2008) reported significantly lower body weight for 23 and 25 per cent crude protein diet groups than 27 per cent protein diet group in meat type quails.

In the present study, the mean body weight of male quails at sixth week of age were 169.05, 171.11 and 169.38 g and that of females were 185.62, 187.30 and 186.48 g in groups $T_1$, $T_2$ and $T_3$, respectively. The difference in body weight among the groups was non-significant. Shamna (2008) reported lower body weight in quails (156.57 to 169.63 g) at 6 weeks of age. The present finding agrees with the reports of Barque (1994), Sinha and Verma (1984), Narayanankutty (1987), Hyankova (1999), Minoguchi (2000), Soares *et al.* (2003), Djouvinov (2005), Correa (2005), Freitas *et al.* (2006), Fridrich (2005) and Flauzino (2007), who could not observe any significant difference in the body weight gain of Japanese quails, fed with different dietary crude protein levels

during growing period. The results of the present study showed that diet containing 23 per cent protein during starter and grower phases could produce comparable performance as that of high protein diets used during growing period. Therefore, present findings indicated that Japanese quails can be reared in cage system on diet containing 23 per cent protein from 0 to 6 weeks of age and the feed cost can be considerably reduced. Broiler starter ration (23% crude protein) available in the market can be advantageously used for rearing Japanese quails.

In the present study, the mean body weight of quails at 26 weeks of age was 229.95, 229.98 and 229.26 g in groups $T_1$, $T_2$ and $T_3$, respectively. The mean values in all groups were similar and statistically comparable. This result is in agreement with the findings of Preethymol (2006) and Raseena (2006) who reported mean body weight in the range of 220.52 to 225.83 g in layer Japanese quails at 26 weeks of age. However, the mean body weight of quails at 26 weeks of age recorded in the present study is higher than those (199.43 and 205.51 g) reported by Lekshmi (2005) and Bhadra (2008) respectively. This may be due to the variation in the managemental and the feeding system adopted during growing period.

## 5.2 AGE AT FIRST EGG AND 10 AND 50 PER CENT PRODUCTION

The data presented in Table 4 indicated that the mean age at first egg in $T_1$, $T_2$ and $T_3$ was 42.00, 42.25 and 43.00 days, respectively. The different dietary protein levels during growing period did not show any effect on this trait. Similar results were obtained by Preethymol (2006), Preeta (2007), Raseena (2006) and Amrutkar (2009) who reported mean AFE at 42 days. However the AFE in the present study was lower than the values (55.00, 46.25, 47.00 and 48.00 days) reported by Padmakumar (1993), Lekshmi (2005), Sheena (2005) and Bhadra (2008), respectively.

The mean age at 10 and 50 per cent production revealed that the values were very similar among all the treatment groups for each of the trait. The group $T_1$ attained 50 per cent production from 10 per cent production in eight days time; it was 6 days in $T_2$ and 7 days in $T_3$. It was also observed that while $T_1$ and $T_2$ group recorded 50 per cent production in 10 days from the age of AFE, the same was 8 days in $T_3$. It appeared that different crude protein levels during growing period did not affect the expression of this trait. The age at 10 and 50 per cent production obtained in this study were in agreement with those reported by Raseena (2006), Preeta (2007) and Amrutkar (2009), but the values were lower than those reported by Padmakumar (1993), Lekshmi (2005), Sheena (2005) and Bhadra (2008) for the same traits.

## 5.3 EGG PRODUCTION

### 5.3.1 Period wise egg production

#### *5.3.1.1 Period wise Quail Housed egg Number (QHN) and Per cent Production (QHP)*

The results presented in Table 5 and 6 showed that the cumulative mean Quail Housed egg Number per quail during the period from 7 to 26 weeks of age was 106.48, 111.16 and 103.00 with corresponding per cent production of 76.06, 79.40 and 73.57 in groups $T_1$, $T_2$, and $T_3$, respectively. Statistical analysis revealed no significant difference among dietary groups. The results of the study indicated that dietary protein levels during growing period did not influence the subsequent egg production of quails from 7 to 26 weeks of age. Similar results were obtained by Minoguchi *et al.* (2000), Soares *et al.* (2003) and Djouvinov (2005) who reported no significant effect on subsequent egg production due to different levels of dietary crude protein during growing period. Contrary to the above findings, Shrivastav *et al.* (1979b) reported that egg production of quails fed 24 and 27 per cent protein were higher than that of quails fed 21 per cent protein during growing period.

The cumulative egg number recorded in treatment groups from 7 to 26 weeks of age were similar to the values reported by Preethymol (2006) and Raseena (2006) but were higher than those reported by Preeta (2007) and Bhadra (2008) for the same period. Period wise mean egg number in all groups showed a considerable increase from period I to period II. But this trend of increase was not noticed in period III and a reduction in egg number was noted. The reduction in egg production could be attributed to nutritional factors, as the diet during that period was devoid of animal protein source. The inclusion of good quality animal protein in the feed resulted increase in egg number in subsequent two periods (IV and V) in all treatment groups. The difference in dietary protein levels during growing period did not affect the egg production of quails in treatment groups at any period of egg production. The cumulative quail housed egg number (QHN) per bird obtained in the present study is close to the values reported by Preethymol (2006) and Raseena (2006) but higher by 20 to 26 eggs than that reported by Lekshmi (2005), Sheena (2005) and Preeta (2007).

#### *5.3.1.2 Period wise Quail Day egg Number (QDN) and Per cent Production (QDP)*

Period wise quail day egg number and per cent (Table 7 and 8) showed the same trend as that of quail housed egg number and per cent. The difference between cumulative quail day and quail housed egg number in the group I, II and III were 2.49, 1.73 and 9.23 which indicated a higher per cent of mortality in group III during laying period.

### 5.3.2 Weekly egg production

The weekly quail housed egg number and per cent egg production in three dietary groups presented in Table 9 showed an increase in egg production from seven to ten weeks of age with per cent production above 80 in all groups. During $11^{th}$ and $12^{th}$ weeks of age, the egg production remained over 80 per cent while

there was sudden decline at 13th week of age. Thereafter, the egg production increased and reached the peak at 15th week of age. During 17, 18 and 19 weeks there was further decline in egg production in all groups, but sharp increase was noticed from 20 weeks onwards and egg production was above 85 per cent in $T_1$ and $T_2$ and above 80 per cent in $T_3$ group from 22 to 25 weeks of age. The decline in egg production observed during 17 to 19 weeks of age in all treatment groups which might be due to the nutritional factor associated with lack of animal protein in the diet during this period.

## 5.4 EGG MASS

The highest cumulative mean egg mass per quail (Table 11) during the entire period of experiment (7 to 26 weeks of age) was 1281.14 g in group $T_2$ followed by 1255.26 g in group $T_3$ and 1221.23 g in group $T_1$. However, the magnitude of variation between the treatment groups did not show significant difference statistically. Contrary to present findings Shrivastav *et al.* (1979b) reported that egg mass of quail fed 21 per cent protein during growing period was significantly ($P \leq 0.05$) lower than those fed with 24 or 27 per cent. Mean egg mass per quail from 7 to 26 weeks of age recorded in this study is similar to that reported by Preethymol (2006), but higher than value (957.17 g) reported by Bhadra (2008) during the same period.

## 5.5 MEAN EGG WEIGHT

The period wise and cumulative mean egg weight calculated for the experimental period did not reveal any significant difference between treatment groups.

During period I (7 to 10 weeks), the mean egg weight was 10.86, 10.88 and 10.84 g in dietary groups $T_1$, $T_2$ and $T_3$, respectively which increased in subsequent periods. Mean egg weight was in the range of 11.15 to 11.66 g in group $T_1$, 11.12 to 11.69 g in group $T_2$ and 11.10 to 11.68 g in $T_3$ during the entire

experimental period. The statistically comparable egg weight recorded in the treatment groups in all periods indicated that the dietary crude protein during growing period did not influence egg weight also.

Similar to present findings, Shrivastav *et al.* (1979b) reported that egg weight of quails fed 21 per cent protein during growing period was statistically similar with those fed with 24 or 27 per cent proteins. Minoguchi *et al.* (2000) also reported that egg weight of quails fed 20 and 24 per cent protein level during growing period was not significantly different. The mean egg weight value for the entire period (7 to 26 weeks of age) is similar to that reported by Preethymol (2006), Raseena (2006) and Preeta (2007) for the same period. On the other hand Sreenivasaiah (1998), Lekshmi (2005), Sheena (2005) and Bhadra (2008) reported lower values ranging from 10.00 to 10.81 g. However, the egg weight recorded in the present study could be considered optimum.

## 5.6 FEED CONSUMPTION

Cumulative feed consumption per quail (g) as influenced by varied dietary crude protein levels during growing period presented in Table 13 revealed that during starter (0-3 weeks) and grower phase (4-6 weeks), the cumulative feed consumption of quails in three treatment groups were not significantly differ. This finding agrees with Shamna (2008) who reported cumulative feed intake ranged 202.79 to 221.91g during starter phase (0 to 3 weeks) and 523.32 to 548.17g during grower phase (4 to 6 weeks). Present finding also agrees with that of Shrivastav *et al.* (1979a), Babu *et al.* (1986), Narayanankutty *et al.* (1987), Barque *et al.* (1994), Djouvinov (2005), Freitas *et al.* (2006), Flauzino (2007) and Karaalp *et al.* (2009) who reported no significant difference in feed consumption of quail chicks fed with different dietary crude protein levels during growing period (0 to 6 weeks). Contrary to present findings, Correa *et al.* (2008) reported significantly lower feed intake for the diets containing 23 and 25 per cent protein than the diet containing higher crude protein level (27%).

The mean daily feed consumption of quail in the groups $T_1$, $T_2$ and $T_3$ during the first 28 day period of layer phase was 29.16, 28.91 and 28.76 g, respectively. During this period the egg production in the groups (Table 14) was between 58 to 61 per cent. From the second 28 day period (11 to 14 weeks) onwards, the egg production increased and reached above 80 per cent and that resulted in the increase in feed consumption of quails in all groups in subsequent periods. Like wise, the egg weight in all groups increased from period II onwards due to increased feed consumption. The mean daily feed intake of quails in treatment groups showed no significant difference in layer phase also. The mean daily feed intake per quail from 7 to 26 weeks was 32.35, 32.00 and 33.02 g for dietary groups $T_1$, $T_2$ and $T_3$, respectively. The feed intake during layer phase was also not affected by protein levels during rearing period.

Sreenivasaiah (1998) stated that Japanese quails consume 25 to 28 g feed per bird per day during production period. The comparatively higher feed consumption recorded in this study might be due to the higher body weight of quails at 6 weeks of age along with fairly good egg production and egg mass. Similar findings on feed consumption was reported by Preethymol (2006), Preeta (2007) and Raseena (2006) in layer Japanese quails from 7 to 26 weeks of age.

## 5.7 FEED CONVERSION RATIO (FCR)

### 5.7.1 Feed Conversion Ratio (FCR) per kilogram weight gain during growing period.

The mean values of feed conversion ratio during 0 to 3 weeks of age (Table 15) in groups $T_1$, $T_2$ and $T_3$ were 2.96, 3.03 and 3.02, respectively with per cent crude protein levels of 23, 25 and 27, respectively. No significant difference was observed for feed efficiency among dietary treatment groups at third week of

age. But Shamna (2008) reported slightly better feed efficiency ranged between 2.42 to 2.57 during starter phase (0 to 3 weeks) when fed with diet containing 26 per cent crude protein during 0 to 6 weeks of age. Contrary to above findings, Rajini and Narahari (1998) and Correa *et al.* (2008) reported significantly better feed efficiency with a diet containing 27 per cent protein than 23 and 25 per cent protein levels.

In the grower phase, the FCR values for the groups ($T_1$ and $T_2$) fed with 23 per cent protein were 5.67 and 5.48, while the group ($T_3$) fed with 24 per cent protein showed the FCR value as 5.42. This narrow difference in protein levels among the groups did not produce any significant difference in FCR and were close to the FCR reported by Shamna (2008). Statistically similar FCR values due to dietary protein levels observed in the present study agrees with Sinha and Verma (1984), Babu *et al.* (1986), Narayanankutty (1987), Soares *et al.* (2003), Fridrich *et al.* (2005), Freitas *et al.* (2006), Flauzino (2007) and Karaalp *et al.* (2009). Contrary to above findings, Correa *et al.* (2008) reported significantly poor feed efficiency for 23 and 25 per cent protein levels than 27 per cent protein during 0 to 6 weeks of age.

The variations in dietary protein levels did not influence the feed consumption and weight gain during starter and grower phases which resulted in the non-significant difference in feed conversion ratio between groups during these periods.

### 5.7.2 Feed Conversion Ratio (FCR) per dozen eggs and kilogram eggs during layer phase.

Feed conversion ratio calculated per dozen eggs as well as per kilogram eggs did not show any significant difference between groups for 28-day period or for the whole experimental period. Even though the FCR values were comparatively higher in all treatment groups during 7-10 weeks of age, FCR

improved in subsequent periods due to increase in egg production. The cumulative mean FCR calculated based on egg number was 0.49 for group $T_2$ and 0.50 for groups $T_1$ and $T_3$ and that based on egg mass were 3.79, 3.58 and 3.64 in the groups $T_1$, $T_2$ and $T_3$, respectively.

The present findings on FCR in quails were slightly higher than those reported by Raseena (2006), Preethymol (2006) and Bhadra (2008), who reported FCR values in the range of 0.46 to 0.49 per dozen eggs and 3.35 to 3.51 per kg eggs in layer quails for the same period which might be due to the comparatively higher feed consumption of quails recorded in this study. However, FCR values were better than those reported in layer quails by Lekshmi (2005), Sheena (2005) and Preeta (2007) for the same period.

## 5.8 COST AND RETURN

The data presented in Table 18 detailed the expenditure incurred for various items, returns obtained and the margin per quail housed during growing period (0 to 6 weeks) and layer phase (7 to 26 weeks).

The reduction in protein level in feed resulted in a reduction in the cost of raising quail chicks during growing period. In $T_3$ (S-27% CP, G-24% CP) group, cost of one kg feed during starter and grower phase was Rs. 17.93 and 16.53, respectively. The cumulative feed intake during starter and grower phase per quail was 223.72 and 533.47 g, respectively. Therefore the cost of feed worked out to Rs. 12.83 per quail during growing period (0 to 6 weeks). Similarly the cost of feed in $T_2$ (S-25% CP, G-23% CP), and $T_1$ (S-23% CP, G-23% CP) worked out to Rs. 12.20 and 12.05 per quail, respectively. The higher feed cost in group $T_3$ was due to the high protein levels. It could be observed that a progressive reduction in feed cost per quail occurred from $T_3$ to $T_1$. This reduction of initial investment produced significantly higher margin per quail in group $T_1$ than other groups during growing period (0 to 6 weeks).

Based on the above findings, it was concluded that the reduction in protein content of the feed up to 23 per cent during growing period could be made without adversely affecting the subsequent production performance in layer quails.

## 5.9 LIVABILITY

During starter phase (0-3 weeks) the mean livability per cent values were 97.55, 98.38 and 98.67 for $T_1$, $T_2$ and $T_3$, respectively and during grower phase (4-6 weeks) livability per cent were 98.50, 98.97 and 97.06 respectively, which did not differ significantly. Result on livability in present study is similar with finding of Shamna *et al.* (2008) who reported mean livability per cent of 97.90 to 100.00 in Japanese quails during 0 to 6 weeks of age. Contrary to these findings, Mishra (1993) reported that mortality was significantly higher when quails were raised on high protein diets than low protein diets whereas Baldini *et al.* (1995) reported that bobwhite quails reared on higher crude protein level showed best livability when fed with different protein levels.

The mean livability per cent of quails in different groups during layer phase (7-26 weeks of age) was 99.59, 99.70 and 98.72 for $T_1$, $T_2$ and $T_3$ respectively, which did not differ significantly. Result on livability per cent of quail observed in this study was similar to the finding of Bhadra (2008) who reported mean livability per cent of Japanese quails ranging from 95.00 to 100.00 during 7 to 26 weeks of age.

## 5.10 METEOROLOGICAL OBSERVATIONS

The data pertaining to microclimate inside the experimental house during the period of the experiment from September 2009 to February 2010 (Table 3) showed that almost the whole experimental period was synchronized

with winter season except last 28-day period, in which slight increase in temperature was noticed with decreased relative humidity. In the present study, the mean maximum temperature ranged from 29.11 to 31.25$^0$C in periods I to V with an overall mean of 30.08$^o$C. The mean minimum temperature ranged from 23.18 to 24.86$^0$C with an average of 24.21$^0$C. The mean per cent relative humidity in the study ranged from 52.24 to 76.33 per cent in period I to V with an overall mean of 69.12 per cent in the afternoon.

Data showed that the range of temperature and humidity was normal during the period of study and the quails were not exposed to any extreme climate. Therefore, it was concluded that climate did not cause any adverse effect on the production performance of the quails. Present findings were nearly similar with the maximum temperature (29.80 to 31.60$^0$C) and minimum temperature (22.50 to 23.60$^0$C) reported by Amrutkar (2009) for the period from August 2008 to December 2008 at Mannuthy region.

# *Summary*

# 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 production performance of Japanese quail when reared on different protein levels.

The experiment was carried out during the period from 13th August 2009 to 10th February 2010. Six hundred (600), day-old Japanese quail chicks belonging to single hatch were weighed individually and distributed randomly to three treatment groups with four replicates of 50 quails each. The quails were housed replicate wise in battery brooders for two weeks with floor space of 54 $cm^2$ per chick. At third week of age, the quail chicks were shifted to grower cages and provided floor space of 96 $cm^2$ per bird. At the end of sixth week, sixteen female quails were selected from each replicate and housed in layer cages providing floor space of 233 $cm^2$ per bird. Standard managemental conditions were maintained throughout the experiment.

Three types of iso-caloric (2800 kcal/kg) diets containing 23, 25 and 27 per cent crude protein levels (CP) were formulated and fed in three treatment groups to quails during starter phase (0 to 3 weeks). The dietary protein levels in groups $T_2$ and $T_3$ reduced to 23 and 24 per cent respectively during grower phase (4 to 6 weeks) with same level of energy whereas initial nutrient levels were maintained for group $T_1$. During layer phase (7 to 26 weeks), all groups were fed with diet containing 22 per cent crude protein and 2650 metabolizable energy per kg feed.

Individual body weight of quails was recorded at third, sixth and twenty sixth week of age. All eggs laid by the quails in each replicate group were collected and weighed in mass daily. Based on replicate wise egg mass recorded, egg mass per quail and egg weight were calculated for each 28-day period.

Cumulative feed intake per quail was recorded during starter (0 to 3 weeks) and grower phase (4 to 6 weeks) whereas mean daily feed consumption was recorded during each 28-day period of layer phase.

The maximum and minimum temperature ($^0$C) and per cent relative humidity inside the experimental house were recorded daily. Economics over feed cost was calculated based on the prevailing cost of feed ingredients. The sale price of eggs and quails were used for evaluating the economics.

The summary of results obtained in the present study is presented in Table 21. The results obtained in the present study are summarized below:-

1. Average weights of quails were 83.55, 83.35 and 83.67 g at three weeks of age (inclusive of males and females), 169.05, 171.11 and 169.38 g in case of males at six weeks of age, 185.62, 187.30 and 186.48 g in case of females at six weeks of age and 229.95, 229.98 and 229.26 g (females only) at 26 weeks of age in groups $T_1$, $T_2$ and $T_3$ respectively. The body weights at all these ages did not show significant difference between treatment groups.

2. The cumulative feed intake per quail in groups $T_1$, $T_2$ and $T_3$ from 0 to 3 weeks (223.72, 229.79 and 230.22 g) and 4 to 6 weeks (533.47, 525.12 and 510.56 g) was comparable among each other, whereas period wise mean daily feed consumption per quail during the entire period of experiment averaged 32.35, 32.00 and 33.02 g in groups $T_1$, $T_2$ and $T_3$, respectively.

3. The cumulative FCR based on body weight gain was 2.96, 3.03 and 3.02 for 0 to 3 weeks but higher values of 5.67, 5.48 and 5.42 were recorded for 4 to 6 weeks of age and values were comparable among each other at both these ages. The cumulative FCR per dozen eggs was 0.50 for dietary groups $T_1$ and $T_3$ and that in $T_2$ was 0.49. The cumulative FCR per kg eggs in $T_1$, $T_2$ and $T_3$ were 3.79, 3.58 and 3.16 respectively, which did not differ significantly.

4. The mean age at first egg was 42.00, 42.25 and 43.00 days and the mean age at 50 per cent production was 52.75, 51.25 and 49.75 days in dietary groups $T_1$, $T_2$, and $T_3$, respectively.

5. Quail Housed egg Number (QHN) as well as Quail Housed Per cent egg production (QHP), Quail Day egg Number (QDN) as well as Quail Day Per cent egg production (QDP), egg mass and mean egg weight during each 28-day period of layer phase and from 7 to 26 weeks of age did not differ significantly between groups.

6. The quail housed cumulative egg number during the period from 7 to 26 weeks of age was 106.48, 111.16 and 103.00 in groups $T_1$, $T_2$ and $T_3$, respectively and the corresponding percentages were 76.06, 79.40 and 73.57.

7. The mean cumulative egg number on quail day basis was 108.97, 112.89 and 112.23 in the groups $T_1$, $T_2$ and $T_3$, respectively and corresponding percentages were 77.84, 80.64 and 80.17.

8. The cumulative mean egg mass per quail on quail day basis in $T_1$, $T_2$ and $T_3$ were 1221.23, 1281.14 and 1255.26 g, respectively.

9. The cumulative mean egg weight calculated based on the egg mass recorded, was 11.39, 11.46 and 11.39 g in the groups $T_1$, $T_2$ and $T_3$, respectively and the differences between mean values were non-significant.

10. The feed cost in the groups $T_1$, $T_2$ and $T_3$ were Rs. 15.92, 16.71 and 17.93 per kg diet during starter phase (0 to 3weeks) and Rs. 15.92, 15.92 and 16.53 during grower phase (4 to 6 weeks), respectively. The margin of returns per quail housed over feed cost was significantly lower in group $T_3$ (Rs -0.63) than $T_2$ (Rs 0.36) and $T_1$ (Rs 0.32) during growing period (0 to 6 weeks) whereas during layer phase it was Rs 25.29, 29.00 and 23.91 in the groups $T_1$, $T_2$ and $T_3$, respectively.

12. The overall mean maximum temperature was 30.08$^0$C, minimum temperature was 24.21$^0$C and the overall mean relative humidity was 69.12 per cent, inside the experimental house from September 2009 to February 2010.

The results of this study revealed that modifying the growing quail diet with 23 crude protein rather than higher protein levels (25 and 27% crude protein) did not adversely affect body weight, egg production and egg weight in Japanese quails. The production performance was equally high in all the dietary groups. The margin of return per quail housed was highest and feed cost was the lowest in group ($T_1$) fed with 23 per cent crude protein during growing period. The overall evaluations of the study indicated that broiler starter diet with 23 per cent crude protein resulted in equally good production performance with lower production cost and higher profit. As no separate starter and grower quail feeds are available in the local market, it can be recommended that diet with 23 per cent crude protein can be economically and efficiently used during growing period for the Japanese quail.

**Table 21. Summary of performance of Japanese quails (0 to 26 weeks) influenced by different dietary crude protein levels during starter (S) and grower (G) phases**

| Sl. No: | Traits | Treatments | | |
|---|---|---|---|---|
| | | **$T_1$** S-23% CP G-23% CP | **$T_2$** S-25% CP G-23% CP | **$T_3$** S-27% CP G-24% CP |
| | ***Growing period (0-6 weeks)*** | | | |
| 1 | Mean BW at 3rd week (g) | 83.55 | 83.35 | 83.67 |
| 2 | Mean BW at 6th week (g) (Male) | 169.05 | 171.11 | 169.38 |
| 3 | Mean BW at 6th week (g) (Female) | 185.62 | 187.30 | 186.48 |
| 4 | Cumulative feed intake (0-3 weeks) | 223.72 | 229.79 | 230.22 |
| 5 | Cumulative feed intake (4-6 weeks) | 533.47 | 525.12 | 510.56 |
| 6 | Feed Conversion Ratio (0-3 weeks) | 2.96 | 3.03 | 3.02 |
| 7 | Feed Conversion Ratio (4-6 weeks) | 5.67 | 5.48 | 5.42 |
| 8 | Mean age at first egg (days) | 42.00 | 42.25 | 43.00 |
| 9 | Mean age at 50% production (days) | 52.75 | 51.25 | 49.75 |
| 10 | *Margin / QH (0-6 weeks) Rs. | $0.32^a$ | $0.36^a$ | $-0.63^b$ |
| | ***Cumulative mean values from 7 to 26 weeks of age*** | | | |
| 11 | Mean BW at 26th week (g) (Female) | 229.95 | 229.98 | 229.26 |
| 12 | QH egg number | 106.48 | 111.16 | 103.00 |
| 13 | QH per cent | 76.06 | 79.40 | 73.57 |
| 14 | QD egg number | 108.97 | 112.89 | 112.23 |
| 15 | QD per cent | 77.84 | 80.64 | 80.17 |
| 16 | Egg weight (g) | 11.39 | 11.46 | 11.39 |
| 17 | Egg mass (g) | 1221.23 | 1281.14 | 1255.26 |
| 18 | Feed intake / day (g) | 32.35 | 32.00 | 33.02 |
| 19 | FCR / dozen eggs | 0.50 | 0.49 | 0.50 |
| 20 | FCR / kg egg mass | 3.79 | 3.58 | 3.16 |
| 21 | Margin / QH (7-26 weeks) Rs. | 25.29 | 29.00 | 23.91 |

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

# *References*

# REFERENCES


Amrutkar, S. A. 2009. Influence of mating ratio on fertility and hatchability in Japanese quails M.V.Sc. thesis, Kerala Agriculture University, Thrissur, 69 p.

Babu, M., Prabhakaran, R. and Sundararasu, V. 1986. Protein requirement of Japanese quails. *Indian J. Poult. Sci.* 21: 272-274.

Baldini, J. T; Roberts, R. E and Kirkpatrick, C.M. 1995. A study of the protein requirements of Bobwhite quail reared in confinement in battery brooders to eight weeks of age. *Poult. Sci*. 29: 161-166.

Barque, R. A., Nawaz, H., Ahmad, G. and Yaqoob, M. 1994. Effect of varying energy and protein levels on the performance of Japanese quails. *Pak. J. Agric. Sci.* 31: 224-227.

Bhadra, P.V. 2008. Dietary supplementation of Turmeric and Tulasi in Layer quails. M.V.Sc. thesis, Kerala Agriculture University, Thrissur, 91 p.

Binoj Chacko 2006. Reducing crude protein by supplementing l-lysine and dl-methionine in Japanese quail rations M.V.Sc. thesis, Tamil Nadu Veterinary and Animal Sciences University, Namakkal. 73 p.

BIS. 1992. Nutrient requirement for poultry. Bureau of Indian Standards, I.S: 13574.

Correa, G.S.S., Silva, M.A., Fontes, D.O., Correa, A.B., Euler, A.C.C., Fridrich,

A.B., Ferreira, I.C., Ventura, R.V., Rufino, J.E. and Valente, B.D. 2005. Effect of protein and energy levels on carcass yield of European quails. *Arq. Bras. Med. Vet. Zootec.* 57: 266-271.

Correa, G. S. S., Silva, M. A., Correa, A. B., Sources, D. O., Santos, G. G. and Lima, N. H. R. 2008. Crude protein level for meat type quail during the growing period. *Bras. Vet.* 60: 209-217.

Djouvinov, D. and Mihailov, R. 2005. Effect of low protein level on performance of growing and laying Japanese quails (*Coturnix coturnix japonica*). *Bulg. J. Vet. Med.* 8: 91-98.

Flauzino, P. L. 2007. Performance and biometry of organs of Japanese quail fed diets containing different levels of protein. Master thesis, University of Brasilia faculty of Agronomy and Veterinary Medicine. 46 p.

Freitas, A. C., Fuentes, M. F., Freitas, E. R., Espinoza, F. S., Oliveira, B. M. and Espíndola, G. B. 2006. Levels of crude protein and metabolizable energy in the diet for quail. *R. Bras. Zootec.* 35: 1705-1710.

Fridrich, A. B., Valente, B. D., Felipe-Silva, A. S., Silva, M. A., Correa, G. S. S., Fontes, D. O. and Ferreira, I. C. 2005. Exigencia de proteína bruta para codornas européias no período de crescimento. *Arq. Bras. Med. Vet. Zootec.* 57: 261-265.

Hashiguchi, M. and Yamamoto, Y. **2006.** Effect of dietary protein levels on body growth and carcass fat and protein deposition in female Japanese quail**.** ***EPC 2006 - XII European Poultry Conference, 10-14 September 2006, Verona, Italy*****.** **269.**

Hyankova, L., Dedkova, L., Knizetova, H. and Klecker, D. 1997. Responses in growth, food intake and food conversion efficiency to different dietary protein concentrations in meat-type lines of Japanese quail. *Br. Poult. Sci.* 38: 564-570.

Hyankova, L. and Knizetova, H. 2009. Divergent selection for shape of growth curve in Japanese quail. 5. Growth pattern and low protein level in starter diet. *Br Poult Sci.* 50: 451-8 (Abstr.).

Karaalp, M., Sezer, M. and Kilinc, K. 2009. Effect of various dietary crude proteins on growth and excreta nitrogen in Japanese quails. *Indian Vet. J.* 86: 383-386.

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.

Marks, H. L. 1993. The influence of dietary protein level on body of Japanese quail lines selected under high and low protein diets. *Poult. Sci.* 72: 1012-1017 (Abstr.).

Minoguchi, N., Ohguchi, H., Yamamoto, R., Saito, T. and Mizuno K. 2000. The effects of reducing in dietary crude protein on the laying performance of Japanese quail using phase feeding system. Research Bulletin of the Aichi-ken Agricultural Research Center.32: **p.241**-246.

Mishra, S. K., Panda, B., Mohapatra, S. C., Shrivastav, A. K. and Singh, R. P. 1993. Response of genotype to dietary protein levels for growth and carcass quality traits in Japanese quail. *Indian J. Poult. Sci.* 18: 106-115.

Murakami, A. E., Moraes, V. M. B., Ariki, J., Junqueira, O.M. and Kronka, S.N. 1993. Níveis de proteína e energia para codornas japonesas (*Coturnix coturnix japonica*) em crescimento. *Revista Brasileira de Zootecnia*. 22: 534-540.

N. R. C. 1994. Nutrient Requirements of poultry, Nineth edition. National Academy press, Washington. DC.pp 35-39.

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, 114 p.

Oliveira, E. G., Almeida, M. I. M., Mendes, A. A., Viega, N. and Dias, K. 2002. Growth performance of meat quails of both sexes fed diets with four protein levels. *Arch. Vet. Sci.* 7: 75-80. (Poult. Abstr., 2003. 29: 1827).

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

Panda, B., Reddy, V. R. and Sadagopan, V.R. 1977. Nutrients requirements and feeding of Japanese quail. *Indian Poult. Gaz.* 61: 153-167.

Panda, B. 1986. Production and processing of quails in tropics. *Poult. Guide.* 23: 21-31.

Phogat, S. B. and Chopra, S. K. 1984. Production and management of quails. *Poult. Guide.* 21: 63-67.

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, 114 p.

Rajini, R.A. and Narahari, D. 1998. Dietary energy and protein requirements of growing Japanese quails in the tropics. *Indian J. Anim. Sci***.** 68: 1082-1086.

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, 117 p.

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.

Shamna, T. P. 2008. Evaluation of dietary inclusion of azolla for growth in quail (*Coturnix coturnix japonica*). M.V.Sc. thesis, Kerala Agricultural University, Thrissur, 84 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, 92 p.

Shim, K. F. 1984. A review of nutrition of Japanese quail. *World Poult. Sci. J.* 40: 261-274.

Shrivastav, A. K., Panda, B. and Reddy, V. R. 1979a. Protein and energy requirements for grower quails. *Indian J. Poult. Sci*.14, Suppl. No. N6.

Shrivastav, A. K., Panda, B. and Reddy, V. R. 1979b. Effect of protein and energy during growing period on subsequent layer performance in Japanese quail. *Indian J. Poult. Sci*.14, Suppl. No. N7.

Shrivastav, A. K. and Panda, B. 1991. Effect of reducing dietary protein during different finishing periods in quail broilers. *Indian J. Anim. Sci.* 61: 206-210.

Shrivastav, A. K. and Panda, B. 1999. A review of quail nutrition research in India. *World Poult. Sci. J.* 55: 73-81.

Sinha, R. P. and Verma, A. K. 1984. Effect of different levels of dietary protein in Japanese quail *(Coturnix coturnix japonica)* feeding. *Indian J. Anim. Health.* 23: 77-80.

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods*. Eighth edition. Afiliated East-West Press, East-west press Pvt. Ltd., New Delhi, India. 313 p.

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.

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

Vohra, P and Roudybush. T. 1971. The effect of various levels of dietary protein on the growth and egg production of *Coturnix coturnix japonica*. *Poult. Sci.* 50: 1081-1084.

Wahab, A. M. A. 2002. Quails could reduce protein deficiency in poor countries. *World Poult.* 18: 39.

# PRODUCTION PERFORMANCE OF JAPANESE QUAILS REARED ON DIFFERENT PROTEIN LEVELS

**PADWAL N. P.**

**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**

**2010**

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

## ABSTRACT

The experiment was conducted in Japanese quails from 0 to 26 weeks of age including starter, grower and layer phases to study the production performance of Japanese quail when reared on different protein levels. Six hundred (600), day-old Japanese quail chicks belonging to single hatch were allotted randomly to three treatment groups with four replicates of fifty quails each. At the end of sixth week, sixteen female quails were selected from each replicate and housed in layer cages to assess the production performance of one hundred and ninety two (192) layer quails in three treatment groups of four replicates for the period of twenty weeks. Three types of iso-caloric diets (2800 kcal/kg) with different protein levels viz; 23, 25 and 27 per cent were used for three treatment groups $T_1$, $T_2$ and $T_3$, respectively during starter phase (0-3 weeks of age). The protein levels used during grower phase (4 to 6 weeks) were 23 per cent in groups $T_1$ and $T_2$ and 24 per cent in group $T_3$. During layer phase (7-26 weeks of age), all treatment groups were fed with same type of diet containing 22 per cent crude protein and 2650 kcal/kg ME.

The body weight during experimental period at 3, 6 and 26 weeks of age did not differ significantly between dietary treatments. The results revealed that during starter (0 to 3 weeks) and grower phase (4 to 6 weeks) cumulative feed intake and FCR based on body weight gain did not differ significantly between dietary treatments. During Layer phase (7 to 26 weeks), the age at first egg, 10 and 50 per cent production was similar in all the treatment groups. Mean values of quail housed and quail day egg number and per cent production, egg mass, mean egg weight, mean cumulative daily feed consumption, period wise and cumulative FCR per dozen eggs and per kg eggs during layer phase did not differ significantly in all the treatment groups.

The overall livability per cent during starter, grower and layer phases were not adversely affected due to different dietary protein levels during growing period. The margin of returns per quail housed over feed cost was significantly ($P \leq 0.05$) lower in group $T_3$ (Rs -0.63) than $T_2$ (Rs 0.36) and $T_1$ (Rs 0.32) during growing period (0 to 6 weeks)

The evaluation of the results revealed that quail chicks fed with diet containing 23 per cent crude protein in comparison with high protein (25 and 27 per cent crude protein) diets during growing period did not affect body weight gain and egg production traits. Therefore it can be recommended that diet with 23 per cent crude protein can be efficiently and economically used during the growing period of the layer Japanese quail.