- 172681 -

UTILISATION OF DRIED FISH WASTE AND FERMENTED FISH WASTE SILAGE IN JAPANESE QUAIL (*Coturnix coturnix japonica*) LAYER RATION

PREETA RAGHAVAN

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

KERALA AGRICULTURAL UNIVERSITY LIBRARY

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University, Thrissur

2007

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

DECLARATION

I hereby declare that this thesis, entitled **"UTILISATION OF DRIED FISH WASTE AND FERMENTED FISH WASTE SILAGE IN JAPANESE QUAIL (*Coturnix coturnix japonica*) LAYER RATION"** 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,

30.06.2007

PREETA RAGHAVAN

CERTIFICATE

Certified that this thesis, entitled **"UTILISATION OF DRIED FISH WASTE AND FERMENTED FISH WASTE SILAGE IN JAPANESE QUAIL (*Coturnix coturnix japonica*) LAYER RATION"** is a record of research work done independently by **Preeta Raghavan,** under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

30/6/07

Mannuthy
30.6.07

Dr. Amritha Viswanath
(Chairperson, Advisory Committee)
Associate Professor,
Department of Poultry Science,
College of Veterinary & Animal Sciences,
Mannuthy.

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Preeta Raghavan,** a candidate for the degree of Master of Veterinary Science in Poultry Science, agree that this thesis entitled **"UTILISATION OF DRIED FISH WASTE AND FERMENTED FISH WASTE SILAGE IN JAPANESE QUAIL (*Coturnix coturnix japonica*) LAYER RATION"** may be submitted by Preeta Raghavan, in partial fulfillment of the requirement for the degree.

Dr. Amritha Viswanath

(Chairperson, Advisory Committee)
Associate Professor,
Department of Poultry Science,
College of Veterinary & Animal Sciences,
Mannuthy.

Dr. A. Jalaludeen,

Director i/c & Head,
Department of Poultry Science,
College of Veterinary & Animal Sciences,
Mannuthy.
(Member)

Dr. P.A. Peethambaran,

Associate Professor,
Department of Poultry Science,
College of Veterinary & Animal Sciences, Mannuthy.
(Member)

Dr. A.D. Mercy,

Associate Professor,
Department of Animal Nutrition,
College of Veterinary & Animal Sciences,
Mannuthy.
(Member)

External Examiner

(S.C. EDWIN)
Associate Professor & Head,
Dept. of Poultry Science,
Veterinary College & Res. Institute,
Namakkal. 637002

ACKNOWLEDGEMENT

I am keeping my thesis on the heels of ***Lord Guruvayoorappa*** *and* ***Goddess Durga*** *for helping me to reach the shore safely for the things that I did and for the things that I did not.*

Words or deeds would really be insufficient to express my deep sense of indebtness and utmost gratitude to the Chairman of the Advisory Committee ***Dr.Amritha Viswanath,*** *Associate Professor, Department of Poultry Science for her scrupulous guidance, keen interest, steady help, unreserved regard, persuasion and whole hearted support offered to me from the start of research work upto the shaping of the manuscript.*

It is with immense pleasure that I record my sincere and heartfelt gratitude to ***Dr. A. Jalaludeen,*** *Director i /c, Centre for Advanced Studies in Poultry Science, for his affectionate encouragement, pleasant co-operation, moral support throughout my postgraduate study.*

I am in short of words to owe my gratitude to ***Dr.P.A.Peethambaran,*** *Associate Professor, Department of Poultry Science for his continuos supervision, valuable suggestions, expert advice, generous encouragement, constructive criticism and earnest help in the pursuit of research work.*

I am sincerely grateful to ***Dr. A.D. Mercy,*** *Associate Professor, Department of Animal Nutrition, COVAS, Mannuthy for her whole-hearted co-operation, fortnight views and constructive review of the manuscript as a member of the Advisory Committee.*

Nothing will be sufficient to express my deep sense of obligation to ***Dr. P.Anitha,*** *Assistant Professor, Department of Poultry Science for her personal attention, moral* *support, valuable guidance, timely help and spirit of understanding in the pursuit of this work.*

No words or deeds are sufficient to express my gratitude to ***Dr. Leo Joseph, Dr. K. Narayanankutty,*** *Senior Scientist, AICRP on Poultry Eggs for their affectionate encouragement, incessant support, timely help throughout the course of this work.*

I take this opportunity to express my special thanks and heartfelt gratitude to ***Dr. Richard Churchill*** *individually for getting me the research material. He has always extended his help and support whenever needed without any hesitation.*

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

I do express my sincere thanks to ***Suresh, Sajeesh, Tanuja, Dhanya, Reji*** *and* ***Annie*** *for their help, co-operation and affection in various analysis work.*

I find myself on look out for words as I place on record my heartfelt gratitude to my colleagues ***Dr. Simi.G.*** *and* ***Dr. Maldhure Nitin Arvind*** *whose tireless help, unconditional support and constant encouragement have helped me to successfully complete this work.*

No words can implicitly express the deep gratitude to my beloved seniors ***Dr. Preethymol Joseph, Dr. Raseena Karim*** *and* ***Dr. Lonkar Vijaysingh Dhansing*** *for their generous help, assistance and guidance and timely support.*

A bouquet of thanks to friends and junior colleagues ***Dr. Balaji. K, Dr. Bhadra. P.V., Dr.Chandani Herman*** *and* ***Dr. Shamna.T.P.,*** *for their help and co-operation.*

Words possess no enough power to reflect my thankfulness for the invaluable help and supportive companionship given by ***Dr. Kishore.K.J., Dr. Binoj Chacko*** *and* ***Dr. Pramod.***

I sincerely acknowledge staff and labourers in University Poultry Farm for their lots of help rendered.

I do express my sincere thanks to the staff of our department ***Mr. Paul, Mrs. Vilasini, Ms Indu, Mrs. Thressia, Mrs. Ramany, Mrs. Jiji, Mr. Saji, Mr.George, Mr. Sandeep, Mr. Shaahul, Mr.Biju, Ms.Remya, Mr. Sujith,*** *and* ***Mr. Shaahnavaaz.***

I cherish the spirit of understanding, invaluable help and co-operation rendered to me by beloved friends, roommates and classmates, ***Drs. Rajeshwari.T. Aswathy.G., Uma.V., Rajathi.S., Deepa.S., Asha Antony, Sany Thomas, Chitra.R.Nair, Reshmi.R..Chandran, Jessy.V., Dhanya.V. Pai.,*** *and* ***other postgraduate students.*** *I treasure the invaluable friendship of my friends* ***Drs. Avirat, Manoj, Ashwin, Leena, Meena and Mangeshwari.***

And there are no words in any language to express my feelings towards my parents and brother because of love, constant prayers and incessant encouragement offered to me by ***Papa (Mr.Raghavan), Mummy (Mrs. Ponnamma)*** *and* ***Brother (Pradeep).*** *Without their love, prayers and blessings my postgraduate study would not have been possible.*

Above all salutations a thousand times I adore, praise, thank and bow before ***The Lord, the Almighty,*** *who never let my prayers unheard and led me to the successful completion of this work.*

PREETA RAGHAVAN

CONTENTS

Chapter	Title	Page No.
1	INTRODUCTION	1
2	REVIEW OF LITERATURE	3
3	MATERIALS AND METHODS	21
4	RESULTS	32
5	DISCUSSION	52
6	SUMMARY	63
	REFERENCES	67
	ABSTRACT	

LIST OF TABLES

Table No.	Title	Page No.
1.	Per cent ingredient composition of experimental diets	27
2.	Per cent chemical composition of experimental diets, on dry matter basis	28
3.	Per cent chemical composition of dried fish waste and fermented fish waste silage	29
4.	Amino acid profile of dried fish waste and fermented fish waste silage	30
5.	Score card for taste panel evaluation	31
6.	Mean meteorological parameters in the experimental house during the period from September 2006 to February 2007	32
7.	Mean body weight (g) at 6 and 26 weeks of age and body weight gain in layer quails as influenced by experimental diets	33
8.	Mean age at first egg, 10 and 50 per cent production (days) in layer quails as influenced by experimental diets	34
9.	Mean quail housed egg number per bird as influenced by experimental diets	37
10.	Mean per cent quail housed egg production as influenced by experimental diets	37

Table No.	Title	Page No.
11.	Mean quail day number of eggs per bird as influenced by experimental diets	38
12.	Mean per cent quail day production as influenced by experimental diets	38
13.	Mean daily feed consumption per quail (g) as influenced by experimental diets	40
14.	Mean feed conversion ratio (kg feed per dozen eggs) as influenced by experimental diets	40
15.	Mean egg weight (g) as influenced by experimental diets	41
16.	Mean shape index of quail eggs as influenced by experimental diets	45
17.	Mean albumen index of quail eggs as influenced by experimental diets	45
18.	Mean yolk index of quail eggs as influenced by experimental diets	46
19.	Mean internal quality unit (IQU) of quail eggs as influenced by experimental diets	46
20.	Mean shell thickness (mm) of quail eggs as influenced by experimental diets	47
21.	Mean score of sensory evaluation of quail eggs as influenced by experimental diets	48
22.	Mortality number of Japanese quails as influenced by experimental diets	48
23.	Economics of quail rearing in cages from 7 to 26 weeks of age as influenced by experimental diets	50
24.	Summary of performance of Japanese quail layers (7 to 26 weeks) as influenced by experimental diets	51

LIST OF FIGURES

Figure No.	Title	Between pages
1.	Mean body weight (g) at 26 weeks of age in layer quails as influenced by experimental diets	32&33
2.	Mean body weight gain (g) of Japanese quails as influenced by experimental diets	32&33
3.	Mean age at first egg, 10 and 50 per cent production (days) in layer quails as influenced by experimental diets	33&34
4.	Mean quail housed egg number per bird as influenced by experimental diets	36&37
5.	Mean quail day egg number per bird as influenced by experimental diets	36&37
6.	Mean feed conversion ratio (kg feed per dozen eggs) as influenced by experimental diets	39&40
7.	Mean egg weight (g) as influenced by experimental diets	41&42

Dedicated to

My beloved Parents & Brother

Introduction

1. INTRODUCTION

Japanese quail farming offers a viable and practical solution to the problems of animal protein shortage and unemployment in developing countries. For small holder farmers it is an important source of income and employment generating venture besides providing nourishing food. Quails have become the third largest avian species in number, next to chicken and ducks in India at present. Quail rearing has been accepted by farmers as a potential alternative to chicken farming because of it's small size, short incubation period, early sexual maturity, high rate of egg production, less floor space requirement and increased resistance to common avian diseases. The annual egg mass production is 20 times higher than female quail's adult body weight, whereas in chicken it is only ten times.

In poultry production, feed is the most expensive recurring input and feed cost accounts for 70-75 per cent of total production cost. Most of the conventional feed ingredients used for poultry ration is also used for human consumption. Fish occupies an important position among the protein sources in poultry feed because of it's high lysine and methionine content. Fish is also used as major food item of human being because of its high content of omega-3 fatty acids which help in lowering of total cholesterol, relieve inflammatory conditions such as arthritis and also aids in brain development. Because of this use, good quality fish is not available for poultry feed and thus poultry nutritionists are trying to use alternative fish products to substitute fish.

Fisheries industry is well flourished in India owing to its long coastal belt and seafood export is one of the major sources of foreign exchange in our country. Currently, India's total annual, inland and marine fish production is 5.60, 2.80 and 2.83 million tonnes respectively. Among Indian states, Kerala is blessed with 590 kilometer coastline, which is about 10 per cent of country's coastline. In 2004, 31,500 tonnes of Surimi was exported from Kerala. Surimi is a available is 91,000 tonnes (Zynudin, 2007). This product with high moisture content and unpleasant appearance is thrown away as waste which causes serious environmental problems. This waste was dried to reduce pollution. The total quantity of dried Surimi waste available is 20,000 tonnes, which can be converted to protein-rich animal feed and thus valuable fish can be spared for human consumption.

The Central Institute of Fisheries Technology, Kochi has developed two products from fish waste viz. dried fish waste and fermented fish waste silage containing 51 and 41 per cent crude protein respectively. These are prepared from the wastes available during the preparation of Surimi from "Kilimeen"(*Nemipterous japonicas*). The waste includes skin, scale and bones. Dried fish waste is prepared by drying of Surimi waste. Fermented fish waste silage is prepared by drying of Surimi waste after microbial fermentation. The information regarding the use of dried fish waste and fermented fish waste silage is scanty in quails.

Hence an experiment was planned to determine the effect of replacing unsalted dried fish with dried fish waste and fermented fish waste silage as protein supplement in quail layer ration.

Review of Literature

2. REVIEW OF LITERATURE

Fish waste products are cheaper means of converting the tonnes of fish wastes into alternate fish waste products which can substitute valuable fish and spare them for human consumption. This can replace more conventional source of proteins for pig, chicken, ducks, sheep, cow, beef cattle and even camels. Studies of utilisation of dried fish waste and fermented fish waste silage in quails appears to be scanty. Hence the available literatures on other species have also been reviewed in this chapter.

2.1 METEOROLOGICAL PARAMETERS

Data pertaining to the meteorological parameters of Mannuthy (Latitude 10^0 32'', Longitude 76^0 16'', Altitude 22.25m above MSL) for five years were summarized by Somanathan (1980). He reported the highest mean maximum temperature of 32.35^0C during May and lowest during July (28.15^0C). The lowest mean minimum temperature recorded was 23.28^0 C during May. The daily average per cent relative humidity varied between 75.68 during May and 86.52 during July. Climatograph of this locality fell within the hot and humid climate.

Sheena (2005) reported a maximum temperature of 34.2^0C, minimum temperature of 23.3^0C, R.H. of 78.1 per cent at 8 a.m. and 43.5 per cent at 2 p.m. inside the experimental house at Mannuthy during December 2004 to May 2005.

2.2 CHEMICAL COMPOSITION OF DRIED FISH WASTE AND FERMENTED FISH WASTE SILAGE

Vedhanayagam *et al.* (1976) determined the chemical composition of fish silage prepared from thrash fish and observed crude protein, crude fibre, total ash, ether extract, nitrogen free extract, calcium and phosphorus as 63.90, 0.08, 18.01, 5.84, 12.17, 0.49 and 4.28 per cent respectively.

Whittemore and Taylor (1976a) reported the chemical composition of fish silage on dry matter basis. The crude protein, ether extract, ash and total dry matter per cent were 67.50, 3.75, 16.50 and 22.40 respectively.

Johnson and Skrede (1981) determined the proximate composition of concentrated fish silage and unconcentrated fish silage on dry matter basis. The dry matter, crude protein, ether extract and total ash of concentrated fish silage were 43.4 to 46.6 and, 72.3 to 74.5 and, 4.6 to 7.3 and 8.6 per cent respectively. The dry matter, crude protein, ether extract and total ash of unconcentrated fish silage were 13.1 to 15.1, 16.9 to 76.3, 3.8 to 13.9 and 8.6 to 10.0 per cent respectively.

Johnson *et al.* (1985) reported proximate composition of acid and fermented fish silages mixed with wheat bran. The dry matter, crude protein, ether extract, calcium and total phosphorous of acid and fermented fish silages were 93.6 and 62.5, 37.1 and 32.3, 21.0 and 20.3, 2.69 and 2.58, 1.66 and 1.34 per cent respectively and also reported that the recovery of amino acids relative to the total crude protein content from fermented silage meal was only 78.7 per cent as a result of formation of Mallaird reaction products during drying.

Rose *et al.* (1994) analysed the proximate composition of two fish silages preserved by formic acid and by natural fermentation and reported 21.7 and 30.8 per cent dry matter respectively. The crude protein, ash and ether extract content on dry matter basis were 55.8 and 35.5 per cent, 12.7 and 10.3 per cent, 14.3 and 8.2 per cent in acid fish silage and naturally fermented silage respectively.

According to White *et al.* (1999) the acid fish silage from silver hake and fermented fish silage contained per cent dry matter 21.8 and 32.9, ash 19.1 and 17.5, crude protein 66.5 and 43.9, crude fibre 13.4 and 9.3, carbohydrate 1 and 29.3 respectively.

Dale (2001) reported the average nutrient composition of catfish meal. The average crude protein, fat, ash, calcium and phosphorus content of catfish meal were 60.2, 8.9, 23.7, 8.0 and 1.1 per cent respectively.

Ngoan *et al.* (2001) analysed the proximate compositon of ensiled shrimp product and found the per cent dry matter, crude protein, ether extract, total ash , calcium and phosphorus as 28.0, 26.9, 2.8, 21.0, 6.5 and 1.0 per cent respectively.

Ponce and Gernat (2002) reported the proximate composition of Tilapia by-product meal. The dry matter, crude protein, ether extract, ash, crude fibre, calcium and phosphorus levels were 94.0, 63.5, 10.8, 18.5, 0.58, 5.73 and 3.4 per cent respectively.

Zahar (2002) reported the proximate composition of sardine waste. The dry matter, crude protein, total lipid and ash of sardine waste were found to be 28.3, 50.6, 20.1 and 24.3 per cent respectively.

Reddy *et al.* (2004) included squilla meal in White Leghorn layer diets at 0, 4, 4.5, 8.89 and 13.34 per cent levels replacing fish meal and concluded that it can be included up to 8.89 per cent levels without affecting egg production.

Jayant (2005) reported proximate composition of dried cuttle fish waste silage in an experiment in layer ducks. The per cent dry matter, crude protein, ether extract, crude fibre, total ash, nitrogen free extract, calcium and phosphorus of dried cuttle fish waste silage were 90.03, 22.21, 2.75, 16.44, 17.62, 40.98, 0.43 and 1.62 respectively.

Lekshmy (2005) reported proximate composition of dried cuttle fish waste silage in an experiment in Japanese quails. The dry matter, total ash, protein, fibre, calcium and phosphorus were 90.02, 17.62, 22.54, 16.43, 0.45 and 1.62 per cent respectively.

Gernat and Dale (2006) conducted an experiment in broilers by replacing soyabean meal in broiler diets with Tilapia by-product meal. They reported dry matter, crude protein, fat, ash, calcium and phosphorus as 94.0, 54.1, 12.6, 24.8, 7.5 and 3.6 per cent respectively.

Zynudin (2007) analysed the amino acid composition of dried surimi waste and fermented surimi waste silage and found that dried surimi waste contain more methionine than fermented fish waste silage.

2.3 BODY WEIGHT AND BODY WEIGHT GAIN

2.3.1 Effect of Dried Fish Waste on Body Weight and Body Weight Gain

Mundheim and Opstvedt (1982) observed significant increase in weight gain when Norwegian herring type fishmeal and soyabean meal were included in broiler ration instead of soyabean meal alone.

Babu *et al.* (1987) reported the body weight of Japanese quails fed ration containing six per cent fish meal of 26 per cent crude protein and 2450 kcal/kg ME as 123.1g.

Hammoumi *et al.* (1998) reported net increase in the body weight of broilers when fermented fish waste was included in broiler ration.

Hammoumi *et al.* (1999) observed increased weight gain when fermented fish waste was incorporated in poultry diet.

Ponce and Gernat (2002) reported significantly (P<0.0.5) increased body weight of broilers from 14 to 28 days of age when soyabean meal was replaced by Tilapia by-product meal at 10 or 20 per cent levels.

Maigualema and Gernat (2003) observed the effect of substituting Tilapia by-product meal to replace 0, 10, 20, 30 and 40 per cent crude protein of soyabean meal in broilers and found significant improvement in body weight from 14 to 28 days of age in 10 and 20 per cent replacement groups.

Gernat and Dale (2006) reported that broilers receiving 0, 25 and 50 per cent substitution of Tilapia by-product meal for soyabean meal showed significantly higher body weight throughout 42-day growing period.

2.3.2 Effect of Fermented Fish Waste Silage on Body Weight and Body Weight Gain

Vedhanayagam *et al.* (1976) fed White Leghorn chicks with starter ration containing fish silage prepared from trash fish and suggested that the body weight of chicks fed fish silage was higher than those fed fish meal. Silage was included at 7 and 10 per cent levels as substitute for fish meal.

Johnson *et al.* (1985) incorporated acid fish silage and fermented fish silage into wheat – based broiler diets at 25, 50 and 100 per cent levels replacing soyabean meal and observed no significant difference in live weight or live weight gain of broiler chicks.

Krogdahl (1985a) conducted an experiment in White Leghorn male chicks from 0 to 4 weeks of age when fish silage contributed 5, 10, 20 and 40 per cent of crude protein and reported that the chicks maintained on 20 per cent protein from concentrated viscera silage showed higher body weight than those fed the reference diet.

Krogdahl (1985b) conducted experiments in meat-type chicks where fish silage constituted 0, 10, 20 or 40 per cent of dietary crude protein and in ducks where fish viscera silage constituted 0, 20 or 40 per cent of dietary crude protein. A higher weight gain was observed in birds fed silage diets than those fed with reference diets.

Machin *et al.* (1990) fed chicks on a balanced diet containing 4.7 or 9.4 per cent crude protein from high oil fish silage (9.8 and 19.6 per cent of dietary dry matter) and 5.2 or 10 per cent crude protein from low oil fish silage (6.8 and 13.5 per cent of dietary dry matter) and reported the weight gain as 99 and 85 per cent for high oil fish silage and 98 and 91 per cent for low oil fish silage with corresponding fish meal group.

Tanaka *et al.* (1990) fed White Leghorn chicks of 4 weeks of age with diet containing 0 (control), 0.2, 0.5, 1.0 or 2.0 per cent fermented chub mackerel (CME). They observed improved body weight gain with CME supplemented groups.

Ochetim (1992) reported no significant difference in the body weight of layer and broiler birds by replacing meat and bone meal in an isocaloric and isonitrogenous ration with locally produced fish waste meal.

Espe *et al.* (1992) found no significant weight gain in chicken when herring offal silage was substituted for 0, 50, 100, 200, 300 and 400g per kg of fish meal protein. Chicken fed fish meal showed significantly lower weight gain when saithe offal silage substituted 150 and 300g per kg of fish meal protein.

Ahmed and Mahendrakar (1996) reported statistically non significant reduction in growth by feeding broiler with an isonitrogenous and isocaloric diet replacing 25 and 50 per cent of fish meal in the ration by fish viscera silage.

Raj *et al.* (1996) reported live weight of 2.29 kg and 1.984 kg in broilers at 8 weeks of age for fermented fish silage fed group and fish meal fed group respectively. In this trial there was 50 per cent replacement of fish meal by fish viscera silage.

Hammoumi *et al.* (1998) conducted a biological trial in broilers and observed a net increase in the weight of birds fed fish silage supplemented with barley flour and bran than those fed with commercial feed.

Magana *et al.* (1999) reported no significant difference between treatments when fish silage mixed with sorghum was fed to broilers at 5, 10 and 15 per cent levels but slighter weight gain was observed at 5 per cent level.

Mohan (1999) conducted an experiment by replacing fish meal with squilla meal protein in egger type chick rations at 0, 25, 50, 75 and 100 per cent levels and reported that body weight gain was not affected when squilla meal replaced fish meal.

Periyasamy (2004) conducted an experiment in broilers by including sardine fish head meal at 0, 5, 7.5 and 10 per cent levels in maize- soyabean based diets and reported best performance at 7.5 per cent inclusion level.

Jayant (2005) observed reduction in body weight of layer ducks at 44 weeks of age by partial and complete replacement of dried fish with dried cuttle fish waste silage in duck layer ration.

Lekshmy (2005) observed the body weight gain in Japanese quails of 7 to 26 weeks of age as 44.73, 41.76 and 38.85g when fed a ration containing unsalted dried fish, 8.5 and 17 per cent dried cuttle fish waste silage respectively.

Sheena (2005) recorded body weight at 6 weeks of age as 172.24g and weight gain of 32.92g respectively from 7 to 26 weeks of age in Japanese quails fed with a ration containing 8 per cent unsalted dried fish.

Preethymol (2006) observed body weight at six weeks of age as 180g, body weight at twenty six weeks of age as 225.83g and weight gain from 7 to 26 weeks of age as 45.83g in Japanese quails fed with a ration containing 10 per cent unsalted dried fish.

Raseena (2006) reported the body weight at six weeks of age as 185g, body weight at twenty six weeks of age as 222.27g and weight gain from 7 to 26 weeks of age as 37.74g respectively in Japanese quails fed with a ration containing 10 per cent unsalted dried fish.

2.4 AGE AT SEXUAL MATURITY

Sheena (2005) reported age at first egg and age at 50 per cent production as 44 to 48 and 56 to 60 days respectively.

Preethymol (2006) reported the age at first egg and 50 per cent production as 42 days, 49 to 54 days respectively.

Raseena (2006) reported the age at first egg, 10 and 50 per cent production as 42 days , 43 to 44 days and 47 to 48 days respectively.

2.5 EGG PRODUCTION

Yamane *et al.* (1979) observed that Japanese quails fed a diet with 19.2 per cent crude protein and 13.21 MJ ME per kg containing 1.06 per cent lysine and 0.55 per cent methionine plus cystiene from 90 to 135 days of age had a bird day production of 83.6 per cent and it increased to 88.8 per cent when the CP of the diet was 23.2 per cent containing 1.44 per cent lysine and 0.69 per cent methionine plus cystiene.

Krogdahl (1985a) reported higher total egg production and laying rate in chicken fed 20 per cent protein from concentrated fish viscera silage instead of fish meal in layer ration.

Shrivastav *et al.* (1993) observed 65.02 per cent hen day production in Japanese quails fed with 7 per cent fish meal.

Ravikiran and Devegowda (1998) reported that egg production was significantly improved to 90.8 and 92.6 per cent in 28-week-old layers fed basal diet supplemented with 0.04 and 0.08 per cent methionine respectively, in comparison with 87.7 per cent production of the control group received basal diet with 18 per cent CP, 0.88 per cent lysine and 0.32 per cent methionine for 6 weeks during summer stress (32-39^{0}C).

Kjos *et al.* (2001) found no significant difference in the egg production of White Leghorn layers by replacing fish meal with fish silage at a level of 12 per cent of dietary protein. The hen day egg production observed in fish meal and fish silage groups were 91.5 and 92.1 respectively.

Elangovan *et al.* (2002) observed an average hen day egg production of 88.9 per cent during 7 to 20 weeks production period when fed with a basal diet containing 5 per cent fish meal.

Jayant (2005) reported no significant difference in total egg production of layer ducks when dried fish in duck layer ration was replaced by 11.45 and 22.90 per cent dried cuttle fish waste silage.

Lekshmy (2005) reported decrease in egg production of Japanese quails when 100 per cent unsalted dried fish was replaced by 8.5 and 17 per cent of dried cuttle fish waste silage, whereas at fifty per cent replacement she reported quail day egg production of 91.98 per cent.

Sheena (2005) reported average hen day egg production of 60.77 per cent from 7 to 26 weeks of age in Japanese quails fed with a layer ration containing 8 per cent unsalted dried fish.

Preethymol (2006) reported overall average quail day egg production of 80.50 per cent during 7 to 26 weeks production period in Japanese quails when fed with a basal diet containing 10 per cent unsalted dried fish.

Raseena (2006) reported average hen day egg production of 83.73 per cent during 7 to 26 weeks production period in Japanese quails when fed with a basal diet containing 10 per cent unsalted dried fish.

2.6 EGG WEIGHT

Krogdahl (1985a) conducted a trial in White Leghorn layers fed with 0, 20 or 40 per cent of dietary protein contributed by fish silage and observed no significant difference in their egg weight.

Ochetim (1992) reported no significant difference in the egg weight by replacing meat and bone meal with locally available fish waste meal in layer ration.

Shrivastav *et al.* (1993) fed breeding Japanese quails with a ration containing 7 per cent fish meal and found average egg weight of 10.28g.

Mohan (1999) found no significant difference in the egg weight among treatment groups when squilla meal was included at 0, 25, 50, 75 and 100 per cent levels replacing fish meal in layer ration.

Kjos *et al.* (2001) reported no significant difference in egg weight between treatments by replacing fish meal with fish silage in layer rations.

Elangovan *et al.* (2002) reported an average egg weight of 11.6g when 5 per cent fish meal was included in Japanese quail layer ration.

Jayant (2005) reported decrease in egg weight of layer ducks by partial and complete replacement of dried fish with dried cuttle fish waste silage in duck layer ration.

Lekshmy (2005) reported no significant difference in the egg weight of Japanese quails fed with a layer ration containing unsalted dried fish replaced with 8.5 per cent and 17 per cent dried cuttle fish waste silage.

Sheena (2005) observed an average egg weight of 11.14g when 8 per cent of unsalted dried fish was included in Japanese quail layer ration.

Preethymol (2006) observed an average egg weight of 11.17g by feeding Japanese quails with layer ration containing 10 per cent unsalted dried fish.

Raseena (2006) reported an average egg weight of 11.27g when 10 per cent unsalted dried fish was included in Japanese quail layer ration.

2.7 FEED CONSUMPTION

Vedhanayagam *et al.* (1976) observed increased feed consumption in White Leghorn chicks fed with fish silage in chick ration than that of chicks fed with fish meal in chick ration.

Johnson *et al.* (1985) reported no significant difference in the feed intake of broilers fed 0, 25, 50 or 100 per cent acid or fermented fish silage than those fed fish meal incorporated into wheat based diet at the expense of soya meal.

Krogdahl (1985a) reported no difference in feed intake when fish viscera silage contributed 0 to 40 per cent of crude protein in high protein diets of White Leghorn birds.

Espe *et al.* (1992) observed no significant difference in feed consumption of chicken by replacing 0, 50, 100, 200, 300 and 400g per kg of fish meal protein with herring offal silage.

Ochetim (1992) reported no significant difference in the feed intake of both layer and broiler birds when meat and bone meal was replaced by locally available fish waste in their rations.

Ahmed and Mahendrakar (1996) observed no significant difference in feed intake of broilers by replacing 25 and 50 per cent of meal in an isocaloric and isonitrogenous diet with fermented fish silage. They reported apparently lower feed consumption in broilers fed with fermented fish silage.

Raj *et al.* (1996) reported higher feed consumption and higher feed conversion efficiency by replacing 50 per cent of fish meal in the broilers diet with fermented fish silage.

Hammoumi *et al.* (1999) reported increased feed intake when fermented fish waste was incorporated in poultry diet.

Magana *et al.* (1999) observed no significant difference between treatment in feed intake when broiler were fed with tuna fish waste silage mixed with sorghum (silage to sorghum ratio of 70:30) at 5,10 and 15 per cent levels in broiler diet.

Singh *et al.* (1999) reported feed intake of 21.4g per bird per day in Japanese quails fed with a basal ration containing 10 per cent fish meal.

Kjos *et al.* (2001) reported no significant difference in feed consumption when fish meal in layer ration was replaced by fish silage.

Elangovan *et al.* (2002) reported an average feed intake of 27g per bird per day during 7 to 20 weeks of period in Japanese quails when fed with a ration containing 5 per cent fish meal.

Maigualema and Gernat (2003) reported increased feed consumption in broilers on 7, 14, 21, 28, 35, and 42 days of age when 25 per cent Tilapia by-product meal was included in broiler ration.

Reddy *et al.* (2004) conducted a trial by replacing fish meal with 0, 4.45, 8.89 and 13.34 per cent levels of squilla meal in ration of White Leghorn layers and found no significant effect on feed consumption.

Jayant (2005) reported increase in mean feed consumption from 25 to 44 weeks of age when fed with a layer ration containing 11.45 and 22.90 per cent dried cuttle fish waste silage instead of unsalted dried fish in duck layer ration.

Lekshmy (2005) reported reduced feed intake in Japanese quail layers by complete replacement as compared to partial replacement of unsalted dried fish with dried cuttle fish waste silage.

Preethymol (2006) recorded feed consumption of Japanese quails during 7 to 10, 11 to 14, 15 to 18, 19 to 22, 23 to 26 and 7 to 26 weeks of age and reported as 27.01, 29.64, 32.08, 32.00, 32.61 and 30.67 grams per bird per day respectively.

Gernat and Dale (2006) reported that broilers receiving 0, 25 and 50 per cent substitution of Tilapia-byproduct meal for soyabean meal showed higher feed consumption throughout 42-day growing period.

2.8 FEED CONVERSION RATIO

Espe *et al.* (1992) observed non significant difference in feed efficiency in broilers fed with herring offal silage.

Ochetim (1992) observed better feed efficiency in broilers when fed with locally available fish waste than that on meat and bone meal.

Magana *et al.* (1999) reported non significant difference in feed efficiency in broilers fed fish silage.

Raj *et al.* (1996) observed better feed efficiency in broilers fed with fermented fish silage replacing 50 per cent fish meal.

Ponce and Gernat (2002) reported significant increase in feed efficiency of broilers when 10 or 20 per cent Tilapia by-product meal replacing soyabean meal in their ration.

Maigualema and Gernat (2003) reported significantly poorer feed efficiency by replacing 75 and 100 per cent Tilapia by-product meal instead of soyabean meal

Lekshmy (2005) reported better feed efficiency when 50 per cent fish meal protein was replaced with dried cuttle fish waste silage in Japanese quail layers.

Sheena (2005) reported a feed efficiency of 0.67 per dozen eggs from 6 to 26 weeks of age for Japanese quails when fed a ration containing 10 per cent unsalted dried fish.

Gernat and Dale (2006) reported poor feed efficiency in broilers fed with 75 and 100 per cent Tilapia by-product meal by replacing soyabean meal in broiler ration.

2.9 EGG QUALITY

Shrivastav *et al.* (1993) reported shape index, albumen index and yolk index of Japanese quail eggs as 77.79, 0.107 and 0.447 respectively by including 7 per cent fish meal in quail layer ration.

Kjos *et al.* (2001) observed no significant difference in egg quality parameters when fish silage replaced fish meal in layer diets. He observed the albumen thickness as 7.5 and 8.07 mm and the Haugh unit score as 87 and 90 in fish meal and fish silage fed groups respectively.

Elangovan *et al.* (2002) fed Japanese quails with the basal diet containing 5 per cent fish meal and reported shape index, albumen index, yolk index, internal quality unit and shell thickness as 77.9, 0.129, 0.478, 62.3 and 0.193 mm respectively.

Erener *et al.* (2003) reported shape index and shell thickness of Japanese quails eggs as 80.47 and 186.2 μm respectively when fed with a diet containing 2 percent fish meal from 8 to 20 weeks of age.

Reddy *et al.* (2004) replaced fish mixture with squilla meal in White Leghorn layers and found no significant difference in egg quality parameters.

Jayant (2005) observed no significant difference in the egg quality traits of duck eggs when dried fish in duck layer ration was replaced by dried cuttle fish waste silage.

Lekshmy (2005) fed Japanese quails with a layer ration containing dried cuttle fish waste silage instead of 100 per cent unsalted dried fish and observed shape index, albumen index, yolk index, internal quality unit and shell thickness as 78.55, 0.136, 0.469, 60.14 and 0.183 mm respectively.

Sheena (2005) fed Japanese quails with layer ration containing 8 per cent unsalted dried fish and reported shape index, albumen index, yolk index, internal quality unit and shell thickness as 78.12, 0.105, 0.44, 53.28 and 0.180 mm respectively.

Preethymol (2006) fed Japanese quail layers with basal diet containing 10 per cent unsalted dried fish and observed shape index, albumen index, yolk index, internal quality unit and shell thickness as 77.86, 0.109, 0.481, 60.81 and 205.1μm respectively.

Raseena (2006) fed Japanese quail layers with basal diet containing 10 per cent unsalted dried fish and observed shape index, albumen index, yolk index, internal quality unit and shell thickness as 77.69, 0.11, 0.48, 58.52 and 0.19mm respectively.

2.10 SENSORY EVALUATION OF QUAIL EGGS

Pearson *et al.* (1983) reported that the occurrence of egg taint may be partly due to wide variations in the trimethylamine oxide content of fish meal.

Faid (1997) reported that inclusion of fish waste resulted in decreased trimethytlamine .

Gernat and Dale (2006) reported that there was no fishy flavours in the breast meat or drumstick although off-flavours were detected in the thigh meat and skin by Tilapia- by product meal substitutions upto 50 per cent for soyabean meal in broiler rations.

2.11 LIVABILITY

Johnson *et al.* (1985) reported no significant difference in the livability pattern of broilers fed acid fish silage and fermented fish silage at 0, 25, 50 or

100 per cent levels replacing soyabean and was comparable with groups fed 50 per cent fish meal.

Ochetim (1992) fed broilers and layers with locally available fish waste meal replacing meat and bone meal and found no significant difference in the livability of birds in both cases.

Ahmed and Mahendrakar (1996) replaced fish meal with 25 and 50 per cent levels of fish silage in an isocaloric and isonitrogenous broiler diet. The mortality rate was 10 per cent for fish meal group and 15 and 12.5 per cent in 25 and 50 per cent fish silage groups respectively.

Jayant (2005) replaced dried fish with 11.45 and 22.9 per cent dried cuttle fish waste silage in duck layer ration and observed livability pattern as 100 per cent in dried fish fed group and 100 and 96.87 per cent in 11.45 per cent and 22.9 per cent dried cuttle fish waste silage fed groups respectively.

Lekshmy (2005) replaced dried fish with 8.5 and 17 per cent dried cuttle fish waste silage in Japanese quail layer ration and observed livability pattern as 93.75 per cent in dried fish fed group and 93.75 and 96.25per cent in 8.5 per cent and 17 per cent dried cuttle fish waste silage fed groups respectively.

2.12 ECONOMICS

Vedhanayagam *et al.* (1976) reported that cost of feed per kilogram gain in body weight was lower in broilers fed 7 per cent and 10 per cent trash fish silage than those fed 10 per cent fish meal. This was due to the better feed efficiency in silage fed groups.

Jayant (2005) observed that the cost of feed per egg was higher in layer ducks fed 11.45 per cent and 22.90 per cent dried cuttle fish waste silage instead of 10 per cent dried fish.

Materials and Methods

Lekshmy (2005) observed that the cost of feed per egg was lower in Japanese quails fed 8.5 per cent and 17 per cent dried fish cuttle fish waste silage instead of 10 per cent unsalted dried fish in Japanese quail layer ration.

Materials and Methods

3. MATERIAL AND METHODS

An experiment was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy, to evaluate the effect of replacing unsalted dried fish with dried fish waste and fermented fish waste silage in Japanese quail layer rations and to evaluate its economics . The experiment was carried out during the period from September 2006 to February 2007.

3.1 EXPERIMENTAL MATERIALS

3.1.1 Birds

A total of one hundred and forty four Japanese quail pullets of five weeks of age received from the Revolving Fund Hatchery of the Centre for Advanced Studies in Poultry Science, Mannuthy were utilized for the study. The parent stocks of these quails were maintained at the University Poultry Farm, Mannuthy.

3.1.2 Rations

Quail layer rations with crude protein content of 22 per cent and ME of 2650 Kcal per kg feed formed the experimental rations. The details of the treatment groups and experimental diets are given below.

T1--Control ration containing 22 per cent crude protein, ME of 2650 Kcal per kg feed, with unsalted dried fish as animal protein source.

T2--Control ration in which 100 per cent crude protein from unsalted dried fish was replaced with dried fish waste

T3--Control ration in which 100 per cent crude protein from unsalted dried fish was replaced with fermented fish waste silage.

All rations were made isocaloric and isonitrogenous. The ingredient composition of experimental diets is presented in Table 1. Proximate analysis of the ration was carried out according to the procedure described by AOAC (1990) and chemical composition of diets are presented in Table 2. Amino acid content of dried fish waste and fermented fish waste silage is presented in Table 4.

3.1.3 NUTRITIVE VALUE OF FISH WASTES

3.1.3.1 Dried Fish Waste

Proximate analysis of dried fish waste is presented in the Table 3. The results of the analysis showed that the dry matter, crude protein, ether extract, crude fibre, nitrogen free extract, total ash, calcium and phosphorus levels are 90.97, 51.63, 4.32, 0.06, 30.13, 13.86, 2.56 and 1.92 per cent respectively. Metabolizable energy value of dried fish waste (calculated) is 3827 kcal /kg.

3.1.3.2 Fermented Fish Waste Silage

Proximate analysis of fermented fish waste silage is presented in the Table 3. The results of the analysis showed that the dry matter, crude protein, ether extract, crude fibre, nitrogen free extract, total ash, calcium and phosphorus levels are 91.91, 41.63, 3.04, 0.08, 38.24, 17.01, 1.48 and 2.68 per cent respectively. Metabolizable energy value of fermented fish waste silage (calculated) is 2230 kcal /kg.

3.2 EXPERIMENTAL METHODS

The experiment was conducted during the laying phase of Japanese quails from 6 to 26 weeks of age. The experimental cages, feeders and waterers were cleaned and disinfected before housing.

The quails were housed at five weeks of age for cage adaptation. One hundred and forty four Japanese quail pullets were weighed individually and distributed randomly to three treatment groups with four replicates of twelve birds each at six weeks of age. The mean body weight of quails within each treatment was kept uniform at the commencement of the experiment.

Each replicate was housed in cage of dimension 60 x 60 x 20 cm maintaining uniform standard management conditions. Light was provided for 16 hours to enhance egg production. The birds were fed experimental feed *ad libitum* and clean drinking water was provided throughout the experimental period. Data collection was carried out for five periods of twenty eight days each from 7 to 26 weeks of age.

Dried fish waste and fermented fish waste silage used for experiment were obtained from Central Institute of Fisheries Technology, Kochi.

1. Preparation of dried fish waste:

Fish waste from *Nemipterous japonicas* ('Kilimeen') obtained after surimi preparation was dried as much in the sun and powdered.

2. Preparation of fermented fish waste silage:

Fish waste from *Nemipterous japonicas* ('Kilimeen') obtained after surimi preparation was cooked for 30 minutes with 30 per cent water (w/v) and 10 per cent molasses, cooled and added five per cent starter culture of *Lactobacillus plantarum.* Kept for ensilation for 13-15 days with daily stirring in aseptic condition. It was dried and powdered.

The following parameters were studied during the course of the experiment.

3.2.1 Metereological Parameters

Temperature and humidity inside the experimental house was recorded daily to assess the *influence of micro environment* on egg production performance. The dry bulb and wet bulb thermometer readings were taken at 9 a.m. and 2 p.m. daily. The maximum and minimum temperature were recorded on all days during the experimental period. From this data period wise maximum and minimum temperature and per cent relative humidity were arrived at.

3.2.2 Body Weight

Body weight of individual birds were recorded at the end of sixth and twenty sixth week of age to study the pattern of body weight gain in different feeding regimes.

3.2.3 Age at Sexual Maturity

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

3.2.4 Egg Production

Egg production was recorded daily from seven to twenty six weeks of age, replicate wise and expressed on quail housed and quail day egg production basis.

3.2.5 Egg Weight

All the eggs laid by the birds among the treatment groups were collected for three consecutive days at the end of each laying period and weighed individually with 0.01 g accuracy based on which mean egg weight was worked out replicate wise.

3.2.6 Feed Consumption

The weight of feed given was recorded replicate wise in each period and the balance feed available in the feeders at the end of each period of 28 days was measured. From this data mean daily feed consumption per bird was calculated.

3.2.7 Feed Conversion Ratio (FCR)

Feed Conversion Ratio (FCR) was calculated period wise based on egg number and represented as FCR per dozen eggs.

3.2.8 Egg Quality

At the end of each twenty eight day period, five eggs were randomly collected from each replicate for egg quality study. Shape, Albumen and yolk indices, internal quality unit and shell thickness were measured. The heights of albumen and yolk were measured using Ame's tripod stand micrometer. The width of yolk and albumen were measured by using hand slide callipers. The shell thickness was measured by using Mitutiyo digimatic micrometer.

The formulae applied for calculating shape, albumen and yolk indices were

Shape index

Width of the egg (mm) / Length of the egg (mm) X 100

Albumen index

Height of thick albumen (mm) / Average width of thick albumen (mm)

Yolk index

Height of yolk (mm) / Diameter of the yolk (mm)

The internal quality of quail egg was calculated (Kondaiah *et al.*, 1981) by using the formula: Internal quality unit (IQU) =100 log (H + 4.18 – 0.8989 $W^{0.6374}$)

3.2.9 Sensory Evaluation of Eggs

Sensory evaluation of both control and treatment groups of hard boiled eggs collected from last period was conducted by a eight member semi-trained taste panel in terms of colour, flavour, juiciness, texture and overall acceptance on a nine point hedonic scale. The score card used is given in Table 5.

3.2.10 Livabilty

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

3.2.11 Economics

Economics of egg production by incorporating fermented fish waste silage and dried fish waste in the layer diet of Japanese quail was calculated taking into account of prevailing cost of the feed ingredients and quail eggs during the study period.

KERALA AGRICULTURAL UNIVERSITY LIBRARY THRISSUR
-172681-

3.2.12 Statistical Analysis

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

Table 1. Per cent ingredient composition of experimental diets

Ingredients	T1	T2	T3
Maize	50.00	42.00	50.00
Wheat bran	-	04.00	-
Soyabean meal	24.00	23.00	27.00
Unsalted dried fish	08.00	-	-
Gingelly oil cake	05.00	05.00	02.00
Rice polish	06.00	10.50	04.00
Dried fish waste	-	08.50	-
Fermented fish waste silage	-	-	10.00
Shell grit	05.00	05.00	05.00
Mineral mixture[1]	01.75	01.75	01.75
Salt	00.25	00.25	00.25
Total	100.00	100.00	100.00
Added per 100 kg feed			
Nicomix A+B2+D3+K[2]	15.00	15.00	15.00
Meriplex[3]	20.00	20.00	20.00
Herbolysine[4]	50.00	50.00	50.00
Methionine[5]	25.00	25.00	25.00
Choline chloride[6]	50.00	50.00	50.00
Toxiroak[7]	50.00	50.00	50.00

1. Mineral mixture: Supermin P mineral mixture without salt (Kwality Agrovet industries , Salem) Composition. Calcium: 30.0 per cent, Phosphorus: 9.0 per cent, Iron: 0.2 per cent, Iodine: 0.01 per cent, Zinc: 0.05 per cent ,Acid Insoluble Ash (max): 2.5 per cent and Moisture : 3 per cent.

2. Nicomix A+B2+D3+K(Nicholas Primal India Ltd., Mumbai) Composition per gram: Vitamin A: 82,000 IU, Vitamin D3: 12,000 IU, VitaminB2: 50 mg, Vitamin K: 10 mg

3. Meriplex B-Complex powder: (Meriplex FDS® from Wockhardt Ltd.,

Wockhardt Towers, Bandra Kurla Complex, Mumbai-400 051). Each gram containing Vit.B_1 8 mg, Vit.B_6 16 mg, Vit.B_{12} 80 mg, Vit.E 80 mg, Niacin 120 mg, Folic acid 8 mg and Pantothenate 80 mg.

4. Herbolysine, Indian Herbs Research & Supply, Co.Ltd, Saharanpur, U.P.
5. Methionine, Petcare, Bangalore
6. Choline chloride, Petcare, Bangalore
7. Toxiroak: Hydrated sodium, calcium, aluminium silicate and herbal ingredients

Table 2. Per cent chemical composition of experimental diets, on dry matter basis

Sl No.	Components	T1	T2	T3
1.	Dry matter	90.00	91.00	91.00
2.	Crude protein	22.38	22.30	22.02
3.	Ether extract	4.20	3.57	5.50
4.	Crude fibre	3.56	4.80	4.04
5.	NFE	62.03	52.55	54.79
6.	Total ash	7.83	16.80	13.65
7.	Acid insoluble ash	2.01	2.30	3.20
8.	Calcium	3.26	3.22	3.15
9.	Total Phosphorus	0.63	0.68	0.70
10.	ME (Kcal/kg)*	2670	2686	2651
11.	Lysine*	1.06	0.71	0.80
12.	Methionine*	0.38	0.53	0.52

*Calculated values

Table 3. Per cent chemical composition of dried fish waste and fermented fish waste silage

Serial No	Parameters	Dried fish waste	Fermented fish waste silage
1.	Dry matter	90.97	91.91
2.	Crude protein	51.63	41.63
3.	Ether extract	04.32	03.04
4.	Crude fibre	00.06	00.08
5.	Nitrogen free extract	30.13	38.24
6.	Total ash	13.86	17.01
7.	Acid insoluble ash	06.52	07.45
8.	Calcium	02.56	01.48
9.	Total Phosphorus	01.92	02.68
10.	ME (kcal/kg) (calculated value)	3827	2230

Table 4. Amino acid profile of dried fish waste and fermented fish waste silage

Serial No.	Amino acid	Dried fish waste	Fermented fish waste silage
1.	Taurine	1.41	0.63
2.	Aspartic acid	8.65	9.76
3.	Threonine	3.40	4.39
4.	Glutamic acid	10.37	9.96
5.	Proline	1.34	1.43
6.	Glycine	30.35	29.07
7.	Alanine	14.05	13.14
8.	Cysteine	0.00	0.00
9.	Valine	3.22	4.25
10.	Methionine	3.14	2.88
11.	Isoleucine	2.68	0.50
12.	Leucine	4.79	3.35
13.	Tyrosine	1.54	5.65
14.	Phenylalanine	3.02	2.19
15.	Tryptophan	1.54	1.65
16.	Histidine	1.09	1.32
17.	Arginine	1.74	2.17

Source: Zynudin (2007), CIFT, Cochin

Table 5. Score card for taste panel evaluation

Code No. of product: Date:

Name:

Time:

Score

9- Excellent (Can think of no improvement)

8- Very good (Slight improvement might be made)

7- Good (Minor improvement desirable)

6- Fair (Improvement is desirable)

5- Moderately fair (Improvement is desirable)

4- Just fair (Improvement is desirable)

3- Poor (Slightly undesirable)

2- Moderately poor (Moderately undesirable)

1- Extremely poor (Highly undesirable)

Sample No.	Colour	Flavour	Juiciness	Texture	Overall acceptance
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Remarks

Signature

Results

4. RESULTS

The results of an experiment carried out to study the utilisation of dried fish waste and fermented fish waste silage in Japanese quail layer ration are presented in this chapter.

4.1 METEOROLOGICAL PARAMETERS

The data pertaining to microclimate viz., the mean maximum and minimum temperatures (^{0}C) and the per cent relative humidity inside the experimental house during the period from September 2006 to February 2007 are presented in Table 6. During the experimental period, the mean maximum temperature ranged from 31.51 to 33.43^{0}C, while mean minimum temperature ranged from 21.70 to 24.00^{0}C. The maximum temperature was significantly ($P<0.05$) high during period IV as compared to period I, II and III and was comparable to period V. The minimum temperature was significantly ($P<0.05$) lower in period III and V when compared to that in periods I and II.

The per cent relative humidity ranged from 69.50 to 84.13 during forenoon and 34.00 to 62.50 during afternoon. The per cent relative humidity was significantly high ($P<0.05$) during first period both during forenoon and afternoon when compared to that in subsequent periods.

Table 6. Mean meteorological parameters in the experimental house during the period from September 2006 to February 2007

Period	Age in weeks	Temperature (°C)		Relative humidity (%)	
		Maximum	Minimum	F.N.	A.N.
I	7-10	31.51^{C} ±0.24	23.51^{AB} ±0.42	84.13^{A} ±1.61	62.5^{A} ±1.19
II	11-14	31.53^{C} ±0.24	24.00^{A} ±0.11	69.75^{B} ±2.66	47.5^{B} ±2.84
III	15-18	32.18^{BC} ±0.33	21.70^{C} ±0.70	69.50^{B} ±0.87	38.5^{C} ±2.39
IV	19-22	33.43^{A} ±0.34	22.10^{BC} ±0.33	75.25^{B} ±4.49	34.75^{C} ±2.75
V	23-26	32.88^{AB} ±0.17	21.70^{C} ±0.70	71.75^{B} ±1.03	34.00^{C} ±2.35
Overall mean	7-26	32.30 ±0.20	22.60 ±0.29	74.08 ±1.59	43.45 ±2.62

Note: Mean values bearing the same superscript within a column differ significantly ($P<0.05$).

Fig.1.Mean body weight (g) at 26 weeks of age in layer quails as influenced by experimental diets

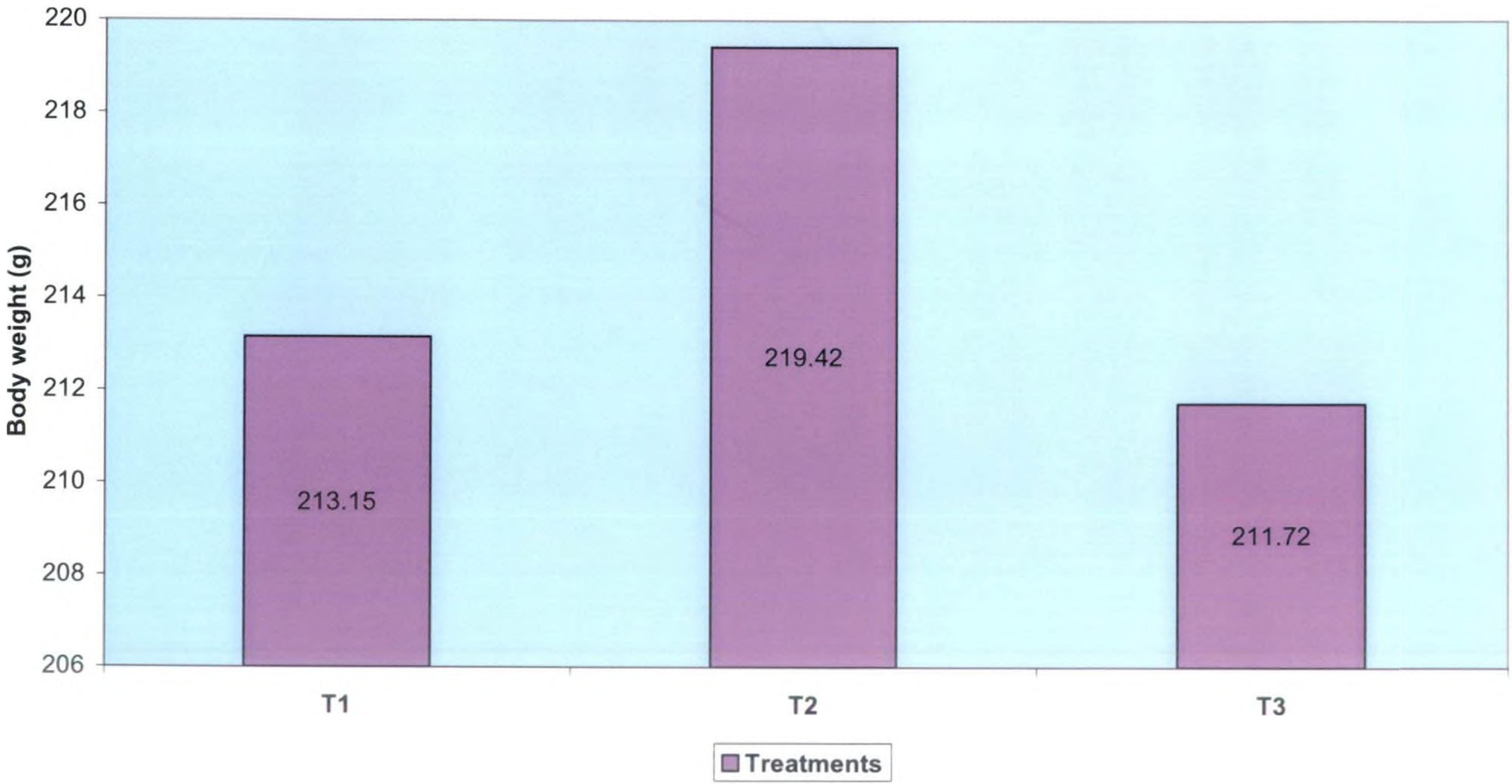
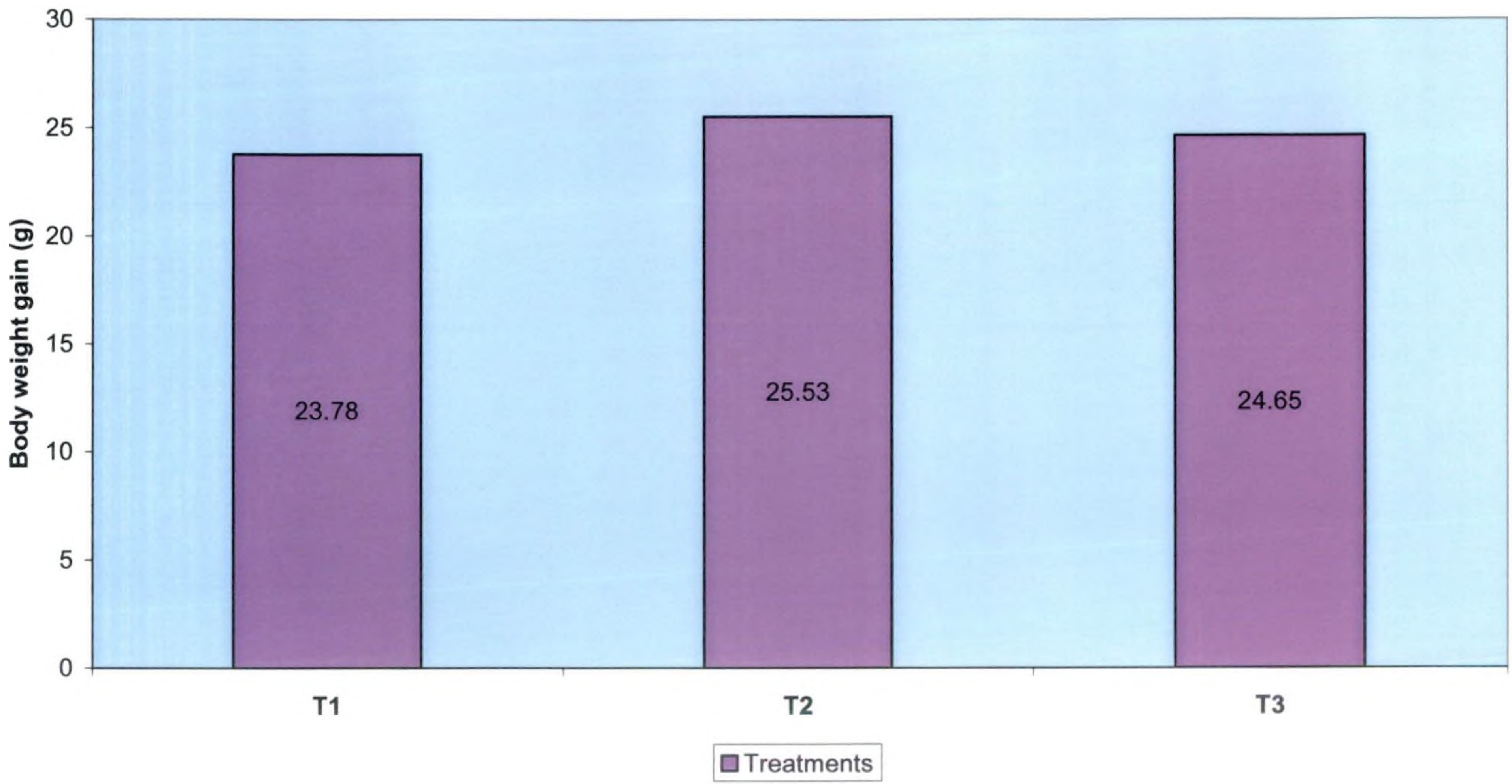


Fig.2. Mean body weight gain (g) of Japanese quails as influenced by experimental diets



4.2 BODY WEIGHT AND BODY WEIGHT GAIN

Data on the mean body weight at six and twenty six weeks of age and body weight gain as influenced by different dietary treatments viz., control quail layer ration (T1), layer ration containing dried fish waste (T2), layer ration containing fermented fish waste silage (T3) are presented in the Table 7.

The mean body weight of birds belonging to the dietary treatment groups T1, T2 and T3 at six weeks of age was 189.37, 192.69 and 187.07g respectively with an overall mean of 189.71g. Statistical analysis of the data did not reveal significant difference between treatment groups. The mean body weight of birds for treatments T1, T2 and T3 at twenty six weeks of age were 213.15, 219.42 and 211.72g respectively with an overall mean of 214.76g (Fig.1). Statistical analysis of the data on twenty six weeks body weight did not reveal significant difference between treatment groups.

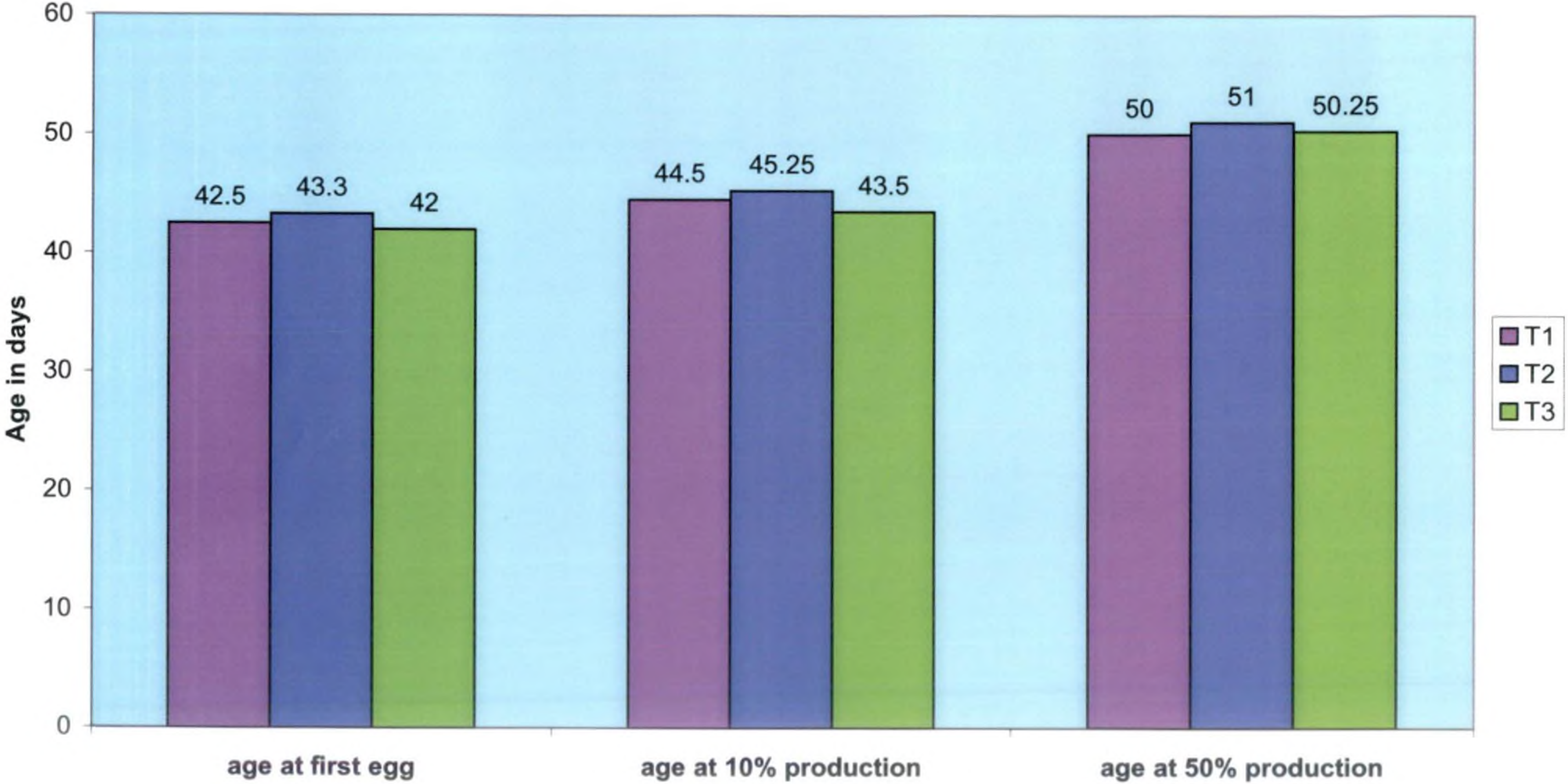
The mean body weight gain during the experimental period among the different treatment groups viz., T1, T2 and T3 were 23.78, 25.53 and 24.65g respectively. Statistical analysis of the data on body weight gain did not differ significantly. Birds fed with dried fish waste recorded highest body weight gain of 25.53g when compared with other treatment groups. The mean body weight gain of birds maintained on different treatments are graphically represented in Fig.2.

Table 7. Mean body weight (g) at 6 and 26 weeks of age and body weight gain in layer quails as influenced by experimental diets

Trait	T_1	T_2	T_3	Overall mean^{ns}
Body weight at 6 weeks of age (g)	189.37 ±4.70	192.69 ±2.40	187.07 ±0.92	189.71 ±1.75
Body weight at 26 weeks of age (g)	213.15 ±2.40	219.42 ±2.87	211.72 ±6.79	214.76 ±2.55
Gain in body weight (g)	23.78 ±6.19	25.53 ±6.21	24.65 ±7.10	24.65 ±3.41

ns: non significant

Fig.3. Mean age at first egg, 10 and 50 per cent production (days) in layer quails as influenced by experimental diets



4.3 AGE AT SEXUAL MATURITY, 10 AND 50 PER CENT PRODUCTION

Data on mean age at first egg, age at 10 and 50 per cent production are presented in Table 8 and graphically represented in Fig.3. All birds in the treatments viz., T1, T2 and T3 attained sexual maturity at the age of 42.50, 43.30 and 42.00 days respectively. Quails fed with fermented fish waste silage attained early sexual maturity.

The mean age at 10 per cent production for different treatment groups viz., T1, T2 and T3 were 44.5, 45.25 and 43.5 days respectively. The age at 50 per cent production for different treatment groups viz., T1, T2 and T3 were 50, 51 and 50.25 days respectively. Birds fed with diet containing dried fish waste (T2), attained 50 per cent production at 51 days and birds fed diet containing fermented fish waste silage (T3) attained 50 per cent production at 50.25 days of age. Quail fed control diet (T1) attained age at 50 per cent production at 50 days of age. Statistical analysis of the data on mean age at first egg, age at 10 per cent production and 50 per cent production did not reveal any significant difference between treatment groups.

Table 8. Mean age at first egg, 10 and 50 per cent production (days) in layer quails influenced by experimental diets

Trait	T_1	T_2	T_3	Overall mean^{ns}
Age at first egg (days)	42.50 ±0.50	43.30 ±0.48	42.00 ±0.00	42.58 ±0.26
Age at 10 per cent production (days)	44.50 ±0.96	45.25 ±1.32	43.50 ±0.96	44.42 ±0.61
Age at 50 per cent production (days)	50.00 ±0.70	51.00 ±1.47	50.25 ±2.72	50.42 ±0.97

ns: non significant (P>0.05)

4.4 EGG PRODUCTION

4.4.1 Quail Housed Egg Production

The data on mean quail housed egg number and per cent quail housed egg production from seven to twenty six weeks of age are presented in Table 9 and Table 10 respectively and graphically represented in Fig.4.

Statistical analysis of the data on cumulative mean quail housed egg number (QHN) for seven to twenty six weeks of age did not reveal any significant difference between the treatments. The overall cumulative mean quail housed egg number was highest (91.74) for the group fed with dried fish waste (T2) than T1 and T3.

Statistical analysis of data on mean quail housed egg number for the five periods indicated significant difference ($P \leq 0.05$) between treatments for the second and fifth periods only. During the second period (11 to 14 weeks of age) quails fed with control diet (T1) and (T3) recorded significantly ($P \leq 0.05$) higher quail housed number than T2. During fifth period T2 recorded significantly higher quail housed number (23.46) but was statistically similar to T3. Quails fed control layer ration (T1) recorded statistically similar quail housed number to that of T3. Statistical analysis of the data on quail housed egg number for the periods III and IV did not reveal any significant difference between treatments.

The overall mean per cent quail housed egg production (Table 10) for T1, T2 and T3 were 55.72, 65.53 and 60.00 respectively. The mean per cent quail housed egg production showed similar trend as quail housed egg number. Statistical analysis of the data on mean per cent quail housed egg production for five periods recorded significant difference between treatments for period II and V only. During second period quails fed control diet (T1) and fermented fish silage (T3) recorded significantly higher egg production than T2. But during period V quails fed dried fish waste (T2) recorded significantly higher percent quail housed production than T1 and T3. However, T3 was statistically similar to T2 and T1 was statistically similar to T3.

4.4.2 Quail Day Egg Production

The data on mean quail day egg production and per cent quail day egg production are presented in Table 11 and 12 respectively and graphically represented in Fig.5.

Cumulative mean quail day egg number (QDN) were 80.57, 92.79 and 85.64 respectively for T1, T2 and T3. Statistical analysis of data on mean quail day egg number did not reveal any significant difference between treatments. However, quails fed with dried fish waste (T2) and fermented fish waste silage (T3) recorded numerically higher quail day egg number than control group (T1).

Statistical analysis of data on mean quail day egg number for five periods recorded significant difference ($P<0.05$) between treatments for first, second and fourth periods only. During the first period significantly higher quail day egg production was recorded for quails fed dried fish waste (T2) but it was statistically similar to control group (T1). Quails fed with control diet (T1) recorded statistically similar quail day egg production to that of T3. But during second period T2 recorded significantly lower quail day egg production to that of T1 and T3. During fourth period the trend in egg production is changed and quails fed dried fish waste (T2) recorded significantly higher quail day egg production. During fifth period even though statistical analysis did not reveal any significant difference between treatments T2 recorded numerically higher quail day egg production than T1 and T3.

The overall mean per cent quail day egg production were57.55, 66.28 and 61.17 respectively for T1, T2 and T3 respectively. Statistical analysis of data on overall mean quail day per cent production of eggs did not differ significantly between treatments.

Fig.4. Mean quail housed egg number per bird as influenced by experimental diets

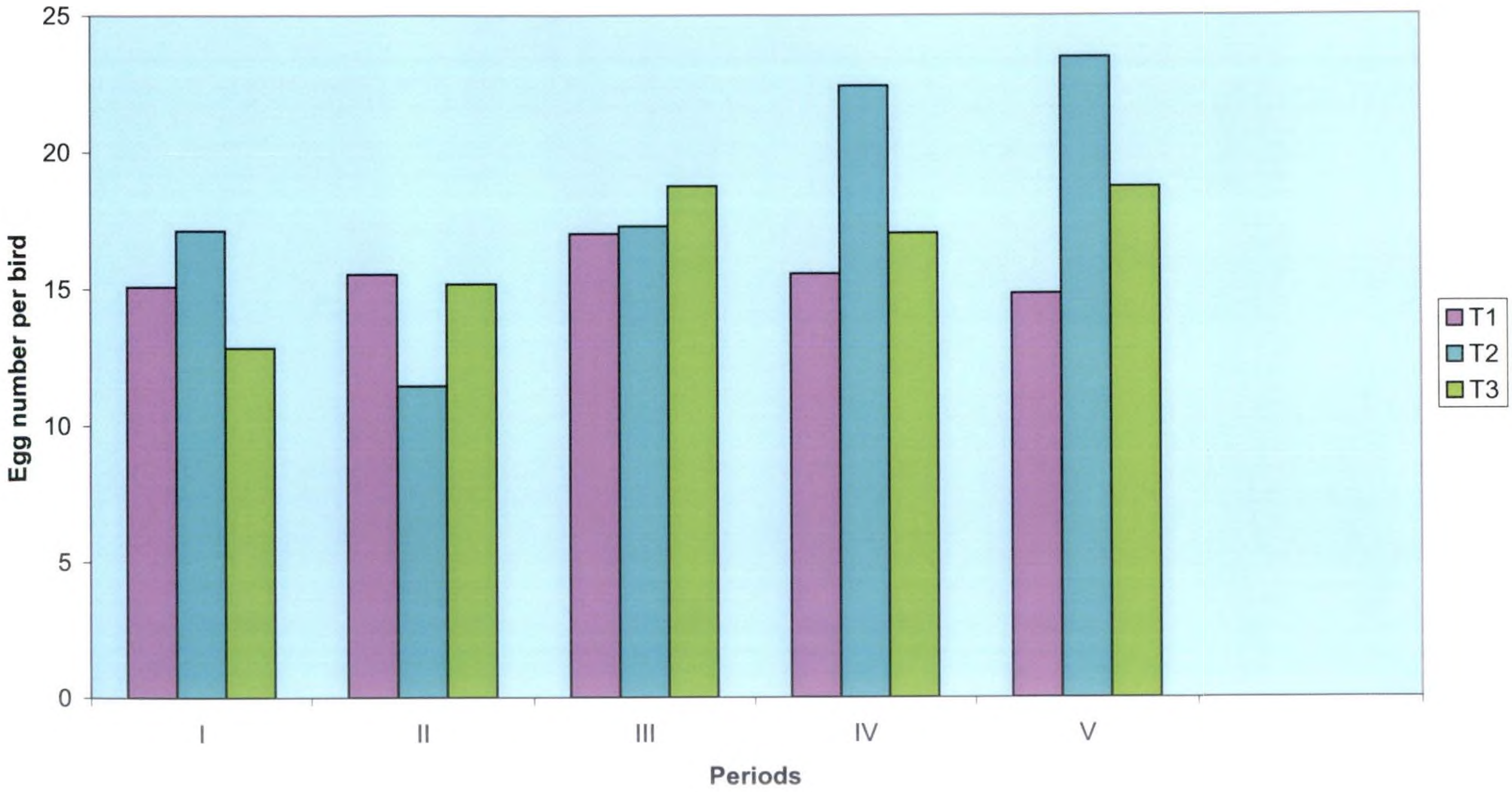
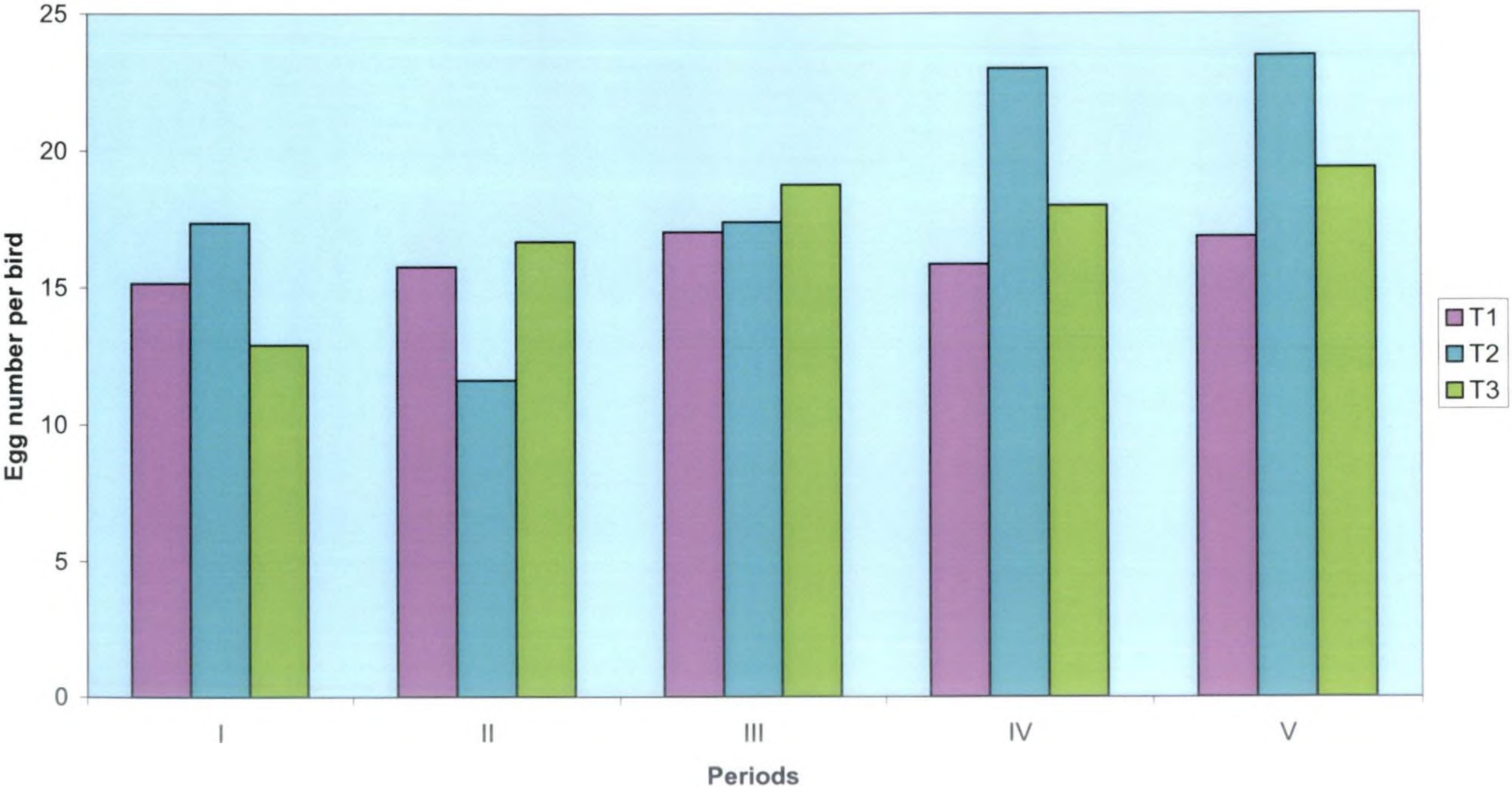


Fig.5. Mean quail day egg number per bird as influenced by experimental diets



The mean per cent quail day egg production showed same trend as a quail day egg number. The statistical analysis of the data on mean per cent quail day egg production for the period from six weeks to twenty six weeks of age failed to show any significant difference between treatment groups.

Table 9. Mean quail housed egg number per bird as influenced by experimental diets

Period	Age in weeks	Mean Quail housed number		
		T_1	T_2	T_3
I	7-10	15.08 ±0.49	17.13 ±2.21	12.83 ±0.41
II	11-14	15.54^{a} ±0.78	11.44^{b} ±1.37	15.18^{a} ±0.58
III	15-18	17.01 ±1.33	17.29 ±0.43	18.75 ±1.59
IV	19-22	15.55 ±2.23	22.42 ±0.55	17.03 ±2.73
V	23-26	14.82^{b} ±2.58	23.46^{a} ±1.13	18.72^{ab} ±3.09
Cumulative mean^{ns} ± S.E.	7-26	77.96 ±6.88	91.74 ±1.01	82.51 ±6.38

Note: Mean values bearing the same superscript within a row did not differ significantly (P<0.05).ns: non significant

Table 10. Mean per cent quail housed egg production as influenced by experimental diets

Period	Age in weeks	Mean per cent quail housed production		
		T_1	T_2	T_3
I	7-10	53.87 ±1.76	61.16 ±7.90	45.83 ±1.45
II	11-14	55.49^{a} ±2.79	40.85^{b} ±4.89	54.22^{a} ±2.71
III	15-18	60.76 ±4.76	61.75 ±1.52	66.98 ±5.68
IV	19-22	55.54 ±7.97	80.06 ±1.97	60.83 ±9.74
V	23-26	52.94^{b} ±9.21	83.80^{a} ±4.04	72.14^{ab} ±11.02
Overall mean ± S.E.^{ns}	7-26	55.72 ±4.92	65.53 ±0.72	60.00 ±4.55

Note: Mean values bearing different superscript within a row differ significantly (P<0.05).ns: non significant

Table 11. Mean quail day egg number per bird as influenced by experimental diets

Period	Age in weeks	Mean Quail day egg number		
		T_1	T_2	T_3
I	7-10	15.14[ab] ±0.46	17.35[a] ±2.18	12.89[b] ±0.38
II	11-14	15.74[a] ±0.85	11.60[b] ±1.29	16.66[a] ±1.36
III	15-18	17.01 ±1.33	17.38 ±0.37	18.75 ±1.59
IV	19-22	15.84[b] ±2.12	22.99[a] ±0.92	17.98[ab] ±2.25
V	23-26	16.85 ±3.43	23.46 ±1.13	19.36 ±3.26
Cumulative mean[ns] ± S.E.	7-26	80.57 ±7.27	92.79 ±1.30	85.64 ±6.23

Note: Mean values bearing different superscript within a row differ significantly (P<0.05). ns: non significant

Table 12. Mean per cent quail day production of eggs as influenced by experimental diets

Period	Age in weeks	Mean per cent quail day egg production		
		T_1	T_2	T_3
I	7-10	54.06[ab] ±1.65	61.97[a] ±7.79	46.03[b] ±1.37
II	11-14	56.20[a] ±3.01	41.43[b] ±4.61	59.49[a] ±4.85
III	15-18	60.76 ±4.76	62.06 ±1.33	66.98 ±5.68
IV	19-22	56.57[b] ±7.59	82.12[a] ±3.29	64.22[ab] ±8.05
V	23-26	60.17 ±12.25	83.80 ±4.04	69.14 ±11.63
Overall mean[ns] ± S.E.	7-26	57.55 ±5.19	66.28 ±0.93	61.17 ±4.45

Note: Mean values bearing the same superscript within a row did not differ significantly (P<0.05). ns: non significant

4.5 FEED CONSUMPTION

The mean daily feed intake per bird for different treatment groups is presented in Table 13. The overall mean daily feed intake of Japanese quails from seven to twenty six weeks of age were 30.89, 31.42 and 31.33g respectively for treatments T1, T2 and T3. Statistical analysis of data recorded significant difference ($P<0.05$) between treatments. Quails fed control diet (T1) recorded significantly lower feed consumption than T2 and T3.

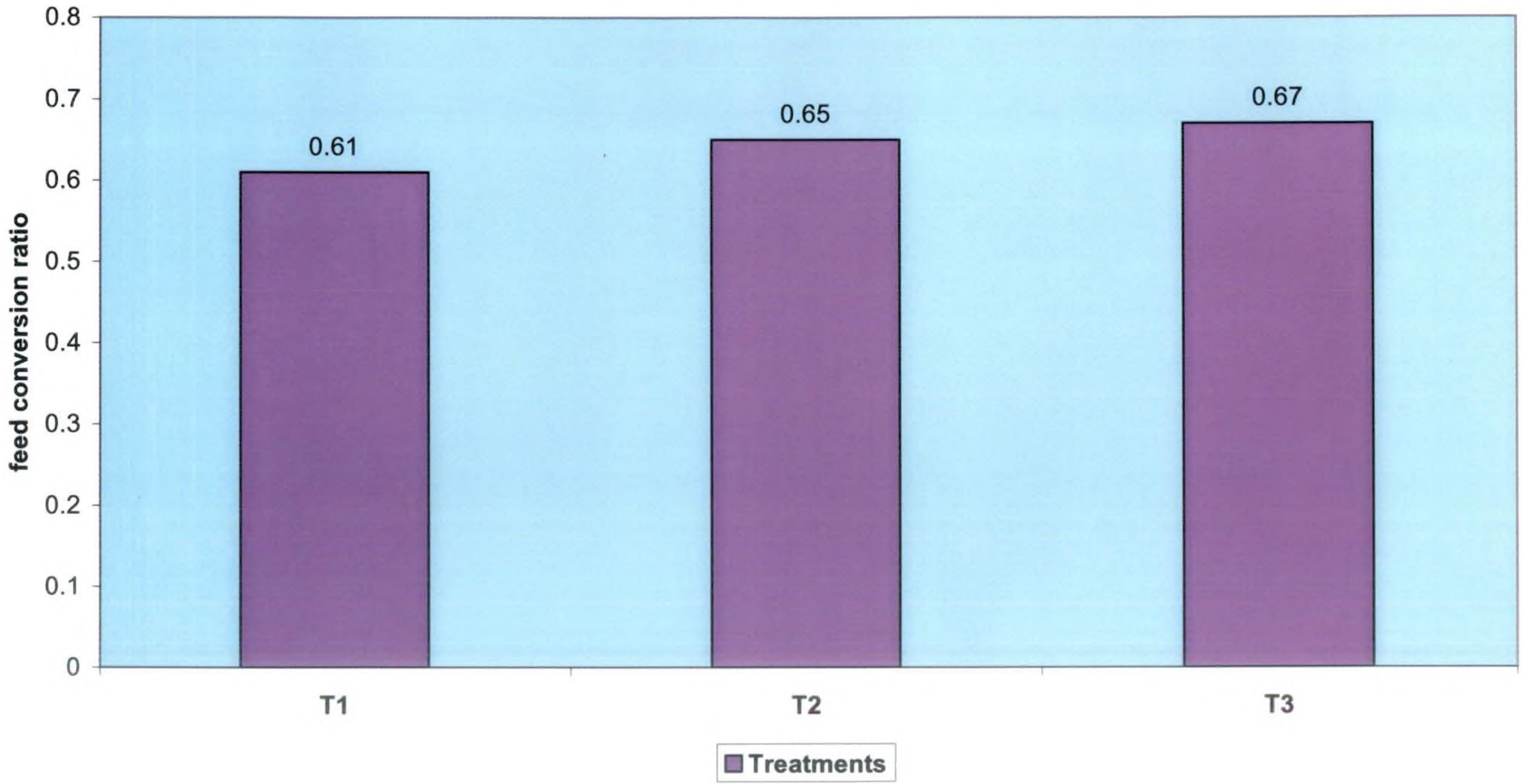
The mean daily feed consumption for different periods revealed significant difference in first, third and fourth periods only. During the first period T1 and T2 recorded significantly higher feed consumption than T3. During the third period T1 recorded significantly lower feed consumption but it was statistically similar to T2. Quails fed dried fish waste (T2) recorded statistically similar feed consumption to that of T3. During fourth period quails fed control diet recorded significantly lower feed consumption but it was statistically similar to T3. T3 recorded statistically similar feed consumption to T2. During fifth period numerically lower feed consumption was recorded in T1 and T3 than T2.

4.6 FEED CONVERSION RATIO (FCR) (kg of feed/ dozen eggs)

The mean feed conversion ratio expressed in kilograms of feed consumed per dozen eggs as influenced by different dietary treatments in Japanese quails from seven to twenty six weeks of age is presented in Table 14 and graphically represented in Fig. 6. The overall mean feed conversion ratio for the treatments T1, T2 and T3 were 0.61, 0.65 and 0.67 respectively. Statistical analysis of data did not reveal significant difference between treatments.

Statistical analysis of data on mean FCR for different periods reveals significant difference between treatments for second period only. Quails fed control diet (T1) and T3 recorded significantly higher feed efficiency than T2.

Fig. 6. Mean feed conversion ratio (kg feed per dozen eggs) as influenced by experimental diets



The mean feed efficiency of all the treatments was non significant during other periods.

Table 13. Mean daily feed consumption per quail (g) as influenced by experimental diets

Period	Age in weeks	Mean daily feed consumption per quail (g)		
		T_1	T_2	T_3
I	7-10	26.33[a] ±0.06	26.25[a] ±0.29	25.78[b] ±0.21
II	11-14	29.35 ±0.04	29.42 ±0.26	29.75 ±0.17
III	15-18	32.6[b] ±0.06	33.68[ab] ±0.07	34.27[a] ±0.10
IV	19-22	32.74[b] ±0.26	33.63[a] ±0.05	33.14[ab] ±0.30
V	23-26	33.40 ±0.19	34.10 ±0.36	33.74 ±0.18
Overall mean	7-26	30.89[b] ±0.11	31.42[a] ±0.14	31.33[a] ±0.06

Note: Mean values bearing different superscript within a row differ significantly ($P<0.05$). ns: non significant

Table 14. Mean feed conversion ratio (kg feed per dozen eggs) as influenced by experimental diets

Period	Age in weeks	Mean feed conversion ratio (kg feed per dozen eggs)		
		T_1	T_2	T_3
I	7-10	0.59 ±0.09	0.54 ±0.09	0.67 ±0.02
II	11-14	0.63[b] ±0.03	0.88[a] ±0.09	0.61[b] ±0.05
III	15-18	0.65 ±0.05	0.65 ±0.01	0.63 ±0.06
IV	19-22	0.73 ±0.09	0.49 ±0.02	0.65 ±0.08
V	23-26	0.77 ±0.16	0.49 ±0.02	0.67 ±0.17
Overall FCR[ns]	7-26	0.61 ±0.16	0.65 ±0.02	0.67 ±0.05

Note: Mean values bearing the same superscript within a row did not differ significantly ($P<0.05$). ns: non significant

4.7 EGG WEIGHT

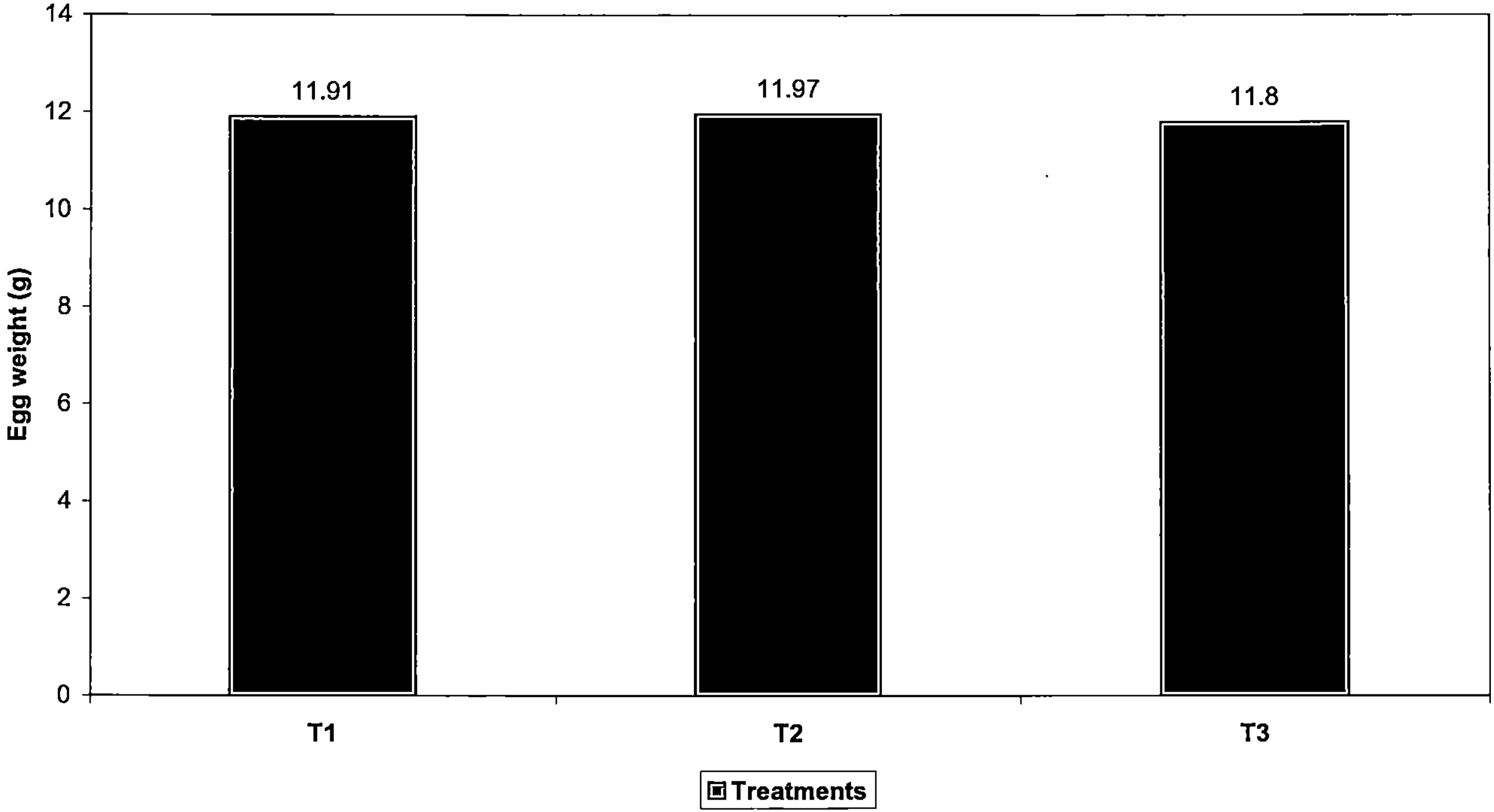
The mean egg weight (g) of layer quails as influenced by dietary inclusion of standard quail layer ration containing dried fish waste and fermented fish waste silage from 7 to 26 weeks of age are given in the Table 15 and represented graphically in the Fig.7. The overall mean egg weight for T1, T2 and T3 were 11.91, 11.96 and 11.80g respectively. Statistical analysis of data on overall mean egg weight did not reveal significant difference between treatments. The mean egg weight showed significant ($P \leq 0.05$) difference between different periods. Quails fed with control diet (T1) recorded higher egg weight during fifth period but it was statistically comparable to egg weight of third and fourth periods. Lower egg weight (11.27g) was recorded during first period. Mean egg weight recorded during period II was 11.64g but it was statistically comparable to III and IV. Birds fed a diet supplemented with dried fish waste (T2) recorded significantly ($P<0.05$) higher egg weight during third, fourth and fifth periods. The mean egg weight recorded during 7 to 10 weeks of age and 11 to 14 weeks of age did not differ significantly for T2. Birds fed diet supplemented with fermented fish waste silage recorded significantly ($P \leq 0.05$) heavier eggs during third, fourth and fifth periods. Lowest egg weight was recorded during first period and it was comparable to that of second period.

Table 15. Mean egg weight (g) as influenced by experimental diets

Period	Age in weeks	Mean egg weight (g)		
		T_1	T_2	T_3
I	7-10	11.26^{C} ±0.18	11.32^{B} ±0.13	10.95^{B} ±0.13
II	11-14	11.64^{B} ±0.16	11.37^{B} ±0.29	11.10^{B} ±0.16
III	15-18	12.14^{AB} ±0.24	12.36^{A} ±0.14	12.29^{A} ±0.36
IV	19-22	12.23^{AB} ±0.23	12.34^{A} ±0.08	12.33^{A} ±0.11
V	23-26	12.29^{A} ±0.08	12.39^{A} ±0.06	12.34^{A} ±0.08
Overall mean^{ns} ± S.E	7-26	11.91 ±0.12	11.97 ±0.13	11.80 ±0.61

Note: Mean values bearing different superscript within a row or column differ significantly ($P<0.05$). ns: non significant

Fig.7. Mean egg weight (g) as influenced by experimental diets



4.8 EGG QUALITY CHARACTERISTICS

The data on egg quality parameters viz., shape index, albumen index, yolk index, internal quality unit and shell thickness as influenced by inclusion of different dietary treatments are given in Table 16, 17,18,19 and 20 respectively.

4.8.1 Shape index

The data on mean shape index is presented in Table 16. The overall mean shape index for treatments T1, T2 and T3 were 79.69, 79.46 and 80.02 respectively. Statistical analysis of data on mean shape index did not reveal significant difference between treatments. Significant difference between periods was noted only for T3. In T3 significantly ($P \leq 0.05$) higher shape index was recorded (82.53) during third period,but it was statistically comparable to second and fourth period.The mean shape index values of eggs obtained from fermented fish waste silage (T3) was significantly lower during first and fifth period but it was statistically comparable to second and fourth period.

4.8.2 Albumen Index

The data on mean albumen index is presented in Table 17. The overall mean albumen index of the eggs belonging to T1, T2 and T3 were 0.102, 0.102 and 0.099 respectively. Statistical analysis of data on mean albumen index did not reveal significant difference between treatments.

Mean albumen index revealed significant difference between periods. In control group (T1) higher albumen index was recorded during first period and it was statistically comparable to second and third period. Lower albumen index was recorded during fifth period (0.009) but it was statistically comparable to albumen index recorded during fourth period. In T2 significantly ($P \leq 0.05$) higher albumen index was recorded during first, second, third and fourth period. Significantly lower albumen index was recorded during fifth period but it was statistically comparable to fourth period. In fermented fish waste silage fed group (T3) significantly higher albumen index was recorded during first period and it was statistically comparable to second period. Significantly lower albumen index was recorded during fourth and fifth period but it was statistically comparable to third period.

4.8.3 Yolk Index

The data on mean yolk index among different treatment groups are presented in Table 18. The overall mean yolk index for T1, T2 and T3 were 0.45, 0.46 and 0.46. Statistical analysis of data on mean yolk index did not reveal significant difference between treatments, but it was influenced by periods. For control group (T1) significantly lower ($P \leq 0.05$) yolk index (0.43) was recorded during fifth period but it was statistically comparable to fourth period. Significantly higher yolk index was recorded during first period and then a decreasing trend in yolk index value was noticed in subsequent periods. In T2 significanlty higher yolk index was recorded during first and second periods than other periods. Yolk index value recorded during third and fourth period did not differ significantly, but during fifth period significantly lower yolk index was recorded. Quails fed with fermented fish waste silage (T3) recorded significantly higher yolk index during first period and lower yolk index during fifth period. Non significant difference in yolk index was recorded during second, third and fourth periods.

4.8.4 Internal Quality Unit (IQU)

The data on mean internal quality unit is presented in Table 19.The overall mean internal quality unit for T1, T2 and T3 were 57.10, 57.24 and 56.69 respectively. Statistical analysis of data on internal quality unit did not reveal significant difference between treatments except for periods.

Quails fed control diet T1 recorded significantly higher IQU during first and second period than third, fourth and fifth period. In T2 significantly higher IQU was recorded during first period but it was statistically comparable to second period. Significantly lower IQU was recorded during fifth period but it was comparable to third and fourth periods. In T3, significantly higher IQU was recorded during first period and lower IQU during third, fourth and fifth periods.

4.8.5 Shell thickness

The data on mean shell thickness is presented in Table 20. The cumulative mean shell thickness of T1, T2 and T3 were 0.20, 0.19 and 0.20mm. Statistical analysis of data on mean shell thickness revealed significant difference ($P \leq 0.05$) between treatments for the first and fourth periods only. During first period significantly higher shell thickness was recorded in control group (T1) but it was statistically comparable to T3. Quails fed with dried fish waste (T2) recorded significantly lower shell thickness at 10^{th} week of age but it was comparable to T3. During fourth period significantly higher shell thickness (0.22mm) was obtained for T3 but it was comparable to control group. Significantly lower shell thickness was reported in T2 during 22 week of age but it was statistically comparable to control group (T1). The mean shell thickness was affected during different periods in T2 and T3. In control group there was no difference between periods in shell thickness. For T2, significantly ($P \leq 0.05$) higher shell thickness was reported during second, third and fifth period but it was comparable to fourth period. During first period, significantly lower value (0.18 mm) was obtained for T2. Statistical analysis of data on shell thickness for different periods reveals significant difference between periods for fermented fish waste silage fed group. Significantly ($P \leq 0.05$) higher shell thickness was observed during fourth and fifth period but it was comparable to second period. Significantly lower shell thickness reported during first and third period, but it was comparable to shell thickness of second period.

Table 16. Mean shape index of quail eggs as influenced by experimental diets

Period	Age in weeks	Mean shape index		
		T_1	T_2	T_3
I	10	80.07 ±0.76	77.83 ±0.98	78.38 ^{B} ±0.53
II	14	81.18 ±0.11	81.38 ±1.74	80.95^{AB} ±0.81
III	18	80.38 ±0.92	81.14 ±1.61	82.53 ^{A} ±1.01
IV	22	78.52 ±0.91	77.71 ±1.10	80.28 ^{AB} ±0.89
V	26	78.34 ±0.45	79.17 ±0.75	78.23 ^{B} ±0.74
Overall mean^{ns} ± S.E	10-26	79.69 ±0.52	79.46 ±0.56	80.02 ±0.50

Note: Mean values bearing different superscript within a column differ significantly (P<0.05). ns: non significant

Table 17. Mean albumen index of quail eggs as influenced by experimental diets

Period	Age in weeks	Mean albumen index		
		T_1	T_2	T_3
I	10	0.108^{A} ±0.01	0.105 ^{A} ±0.01	0.108 ^{A} ±0.01
II	14	0.105^{AB} ±0.01	0.105 ^{A} ±0.01	0.103 ^{AB} ±0.01
III	18	0.103 ^{AB} ±0.01	0.103 ^{A} ±0.01	0.100 ^{BC} ±0.00
IV	22	0.100^{BC} ±0.00	0.100 ^{AB} ±0.00	0.095 ^{C} ±0.01
V	26	0.096^{C} ±0.00	0.095^{B} ±0.00	0.094 ^{C} ±0.00
Overall mean^{ns} ± S.E	10-26	0.102 ±0.01	0.102 ±0.01	0.099 ±0.01

Note: Mean values bearing different superscript within a column differ significantly (P<0.05).

ns: non significant

Table 18. Mean yolk index of quail eggs as influenced by experimental diets

Period	Age in weeks	Mean yolk index		
		T_1	T_2	T_3
I	10	0.47^{A} ±0.01	0.48^{A} ±0.01	0.48^{A} ±0.01
II	14	0.46^{B} ±0.01	0.46^{A} ±0.01	0.46^{B} ±0.00
III	18	0.45^{BC} ±0.01	0.45^{B} ±0.01	0.46^{B} ±0.01
IV	22	0.44^{CD} ±0.01	0.45^{B} ±0.01	0.46^{B} ±0.00
V	26	0.43^{D} ±0.01	0.44^{C} ±0.01	0.44^{C} ±0.01
Overall mean^{ns} ± S.E	10-26	0.45 ±0.03	0.46 ±0.03	0.46 ±0.03

Note: Mean values bearing different superscript within a column differ significantly (P<0.05). ns: non significant

Table 19. Mean internal quality unit (IQU) of quail eggs as influenced by experimental diets

Period	Age in weeks	Mean internal quality unit		
		T_1	T_2	T_3
I	10	60.16^{A} ±0.19	60.07^{A} ±0.16	60.26^{A} ±0.09
II	14	59.56^{A} ±0.52	58.11^{AB} ±0.93	57.34^{B} ±0.91
III	18	57.07^{B} ±0.81	56.21^{BC} ±0.32	55.47^{C} ±0.68
IV	22	57.05^{B} ±0.73	56.17^{BC} ±0.37	55.30^{C} ±0.68
V	26	55.58^{B} ±0.38	55.68^{BC} ±1.0	55.10^{C} ±0.36
Overall mean^{n} ± S.E	10-26	57.10 ±0.40	57.24 ±0.46	56.69 ±0.51

Note: Mean values bearing different superscript within a column differ significantly (P<0.05). ns: non significant

Table 20. Mean shell thickness (mm) of quail eggs as influenced by experimental diets

Period	Age in weeks	Mean shell thickness		
		T_1	T_2	T_3
I	10	0.20^{a} ±0.002	0.18^{b} ±0.004	0.19^{ab} ±0.005
II	14	0.20 ±0.004	0.20^{A} ±0.004	0.20^{AB} ±0.002
III	18	0.20 ±0.003	0.20^{A} ±0.004	0.19^{B} ±0.002
IV	22	0.21^{ab} ±0.003	0.19^{Bb} ±0.008	0.22^{a} ±0.008
V	26	0.20 ±0.005	0.21^{A} ±0.009	0.22^{A} ±0.01
Overall $mean^{ns}$ ± S.E	10-26	0.20 ±0.002	0.19 ±0.003	0.20 ±0.003

Note: Mean values bearing differ superscript within a row or column differ significantly (P<0.05).

a, b, and c: superscript of mean values within row

A, B and C: superscript of mean values within column

4.9 SENSORY EVALUATION OF EGGS

The results of sensory evaluation of both control and treatment groups of hard boiled quail eggs as conducted by a eight member semitrained taste panel in terms of colour, flavour, juiciness, texture and overall acceptance on a nine point hedonic scale are given in Table 21. The overall mean panel score for T1, T2 and T3 was 7.32, 7.46 and 7.29 respectively.

Statistical analysis of data did not reveal significant difference between treatments for colour, flavour, texture and overall acceptance.

Table 21. Mean score of sensory evaluation of quail eggs as influenced by experimental diets

Parameter	T1	T2	T3
Colour	7.43 ±0.37	7.71 ±0.36	7.14 ±0.79
Flavour	7.29 ±0.42	7.43 ±0.29	7.14 ±0.40
Juiciness	6.86 ±0.51	7.00 ±0.49	7.00 ±0.49
Texture	7.71 ±0.29	7.14 ±0.59	7.57 ±0.43
Overall appearance	7.29 ±0.29	8.00 ±0.38	7.57 ±0.30
Overall mean score	7.32 ±0.45	7.46 ±0.46	7.29 ±0.50

4.10 LIVABILITY

Mortality of quails occurred in the different dietary treatments are presented in Table 22. A total of 27 birds died during the course of the study. Among the treatment groups, higher mortality number of 14 was recorded in group fed fermented fish waste silage (T3) . In T2, the number of birds died was 7 and in control group (T1) the number died was 6. Autopsy of all dead birds was conducted to detect the cause of death. The lesion did not show any sign attributable to treatment effect. The livability per cent in treatment groups T1, T2 and T3 were 87.5, 85.4 and 70.8 per cent respectively.

Table 22. Mortality number of Japanese quails as influenced by experimental diets

Period	T1	T2	T3	Total
I	1	3	1	5
II	3	1	8	12
III	0	1	0	1
IV	1	2	4	7
V	1	0	1	2
Total	6	7	14	27

4.10 ECONOMICS

The economics of egg production (Margin over feed cost) in Japanese quails in different dietary treatment groups are presented in the Table 23.

The cost of different diets used in the study was calculated based on the actual price of feed ingredients that prevailed at the time of experiment. The cost of feed for the different treatments T1, T2 and T3 was Rs.10 .00, 7.80 and 8.20 per kilogram respectively. Quail feed supplemented with dried fish waste (T2) was the cheapest (Rs. 7.80 per kg) and control ration (T1) was the costliest (Rs. 10.00 per kg).

The economics worked out for different dietary treatments indicated that feed cost for the production of one egg accounts to Rs. 0.54, 0.37 and 0.42 for the treatments viz., T1,T2 and T3 respectively.

This revealed that the cost of the feed per egg was lowest in the treatment group fed with dried fish waste (T2). The margin of return over feed cost per egg was found to be 16.34, 32.85 and 28.13 paise for the treatments viz., T1, T2 and T3 respectively. The corresponding values of returns over feed cost per quail housed were found to be12.62, 27.45 and 19.23 rupees respectively.

This indicated that inclusion of dried fish waste and fermented fish waste silage are beneficial from the economic point of view than control diet containing unsalted dried fish.

Table 23. Economics of quail rearing in cages from 7 to 26 weeks of age as influenced by experimental diets

Sl. No.	Particulars	Experimental diets		
		T1	T2	T3
1.	Total feed intake (kg)	189.35	191.04	173.59
2.	Feed cost per kg (Rs.)	10.00	7.80	8.20
3.	Total feed cost (Rs.)	1893.5	1490.11	1423.44
4.	Total number of eggs	3529.00	4011.00	3400.00
5.	Total returns by sale of eggs (Rs.)	2470.30	2807.70	2380.00
6.	Cumulative returns over feed cost (Rs.)	576.80	1317.59	956.56
7.	Feed cost per egg (Rs.)	0.54	0.37	0.42
8.	Margin of returns over feed cost per egg (Rs.)	0.16	0.33	0.28
9.	Margin of returns over feed cost /quail housed (Rs.)	12.02	27.45	19.93
10.	Margin of returns per quail housed per period (Rs.)	02.40	05.49	03.99

Table 24. Summary of performance of Japanese quail layers (7 to 26 week) as influenced by experimental diets

Sl. No.	Characteristics	Experimental diets		
		T_1	T_2	T_3
1.	BW 6th wk (g)	189.37	192.69	187.07
2.	BW 26th wk (g)	213.15	219.42	211.72
3.	Age at first egg in the flock (days)	42.5	43.30	42.00
4.	Age at 10% production (days) in the flock	44.50	45.25	43.50
5.	Age at 50 % production (days) in the flock	50.00	51.00	50.25
6.	Feed intake/day (g)/bird	30.89	31.42	31.33
7.	FCR / dozen egg	0.61	0.65	0.67
8.	QH egg number	77.96	91.74	82.51
10.	Egg weight (g)	11.91	11.97	11.80
11.	Shape index	79.69	79.46	80.02
12.	Albumen index	0.102	0.102	0.099
13.	Yolk index	0.45	0.46	0.46
14.	Internal quality unit	57.10	57.24	56.69
15.	Shell thickness (mm)	0.20	0.19	0.20
16.	Livability (%)	87.5	85.42	70.83
17.	Margin of return over feed cost/egg (Rs.)	0.16	0.33	0.28
18.	Feed cost per egg (Rs.)	0.54	0.37	0.42

Discussion

5. DISCUSSION

The results obtained from the study on utilisation of dried fish waste and fermented fish waste silage in Japanese quail layer ration are discussed in this chapter.

5.1 METEOROLOGICAL PARAMETERS

The data pertaining to microclimate inside the experimental house are presented in Table 6. During the course of the experiment from September 2006 to February 2007, the mean maximum temperature ranged from 31.51 to 33.43^{0}C within an average of 32.3^{0}C. The mean minimum temperature ranged from 21.70 to 24.00^{0}C with an average of 22.6^0 C. The mean per cent relative humidity ranged from 69.50 to 84.13 during forenoon with an average of 74.05 and during afternoon the relative humidity ranged from 34.00 to 62.5 with an average of 43.45 during the experimental period. This agrees with the findings of Somanathan (1980) who reported the highest mean maximum temperature of 31.14^{0}C to 35.14^{0}C and lowest of 21.15 to 25.80°C at Mannuthy. The daily average relative humidity ranged from 58.49 to 84.39 per cent during the period. Climatograph of this locality fall within the hot and humid standard.

5.2 BODY WEIGHT

Data on mean body weight recorded at sixth week and twenty sixth weeks of age are presented in Table 7. Statistical analysis of the data on sixth week body weight did not reveal any significant difference between treatments. Non significant difference in body weight at sixth week of age for the treatments T1, T2 and T3 indicates that the birds utilised for the study were of uniform body weight.

The mean body weight recorded at twenty six weeks of age were 213.15, 219.42 and 211.72g respectively for T1, T2 and T3. Statistical analysis of the data showed no significant difference among treatment groups. The results of the study revealed that feeding of dried fish waste (T2) or fermented fish waste silage (T3) did not have any adverse effect on body weight of Japanese quails. This agrees with the work of Johnson *et al.* (1985), who reported that there was no significant effect in the growth of broilers when acid or fermented fish silage was included in their ration. Similarly, Ochetim (1992) reported no significant difference in the body weight of broilers and layer birds when meat and bone meal was replaced by locally produced fish waste meal. The results of the present study agrees with that of Lekshmy (2005). She reported non significant effect in the body weight at twenty sixth weeks of age in Japanese quails when dried cuttle fish (*Sepia officialis*) waste silage was used to replace fish meal.

Contrary to the present findings Ponce and Gernat (2002) reported significant improvement in body weight of broilers when Tilapia by-product meal replaced soyabean meal in broiler ration. Periyasamy (2004) also reported better performance in broilers when sardine fish head meal was included at 7.5 per cent level. Hammoumi *et al.* (1998) reported increased body weight of broilers when fermented fish waste was included in their ration. Jayant (2005) observed reduction in body weight of layer ducks at 44 weeks of age by partial and complete replacement of dried fish with dried cuttle fish waste silage in duck layer ration.

The mean body weight gain for T1, T2 and T3 were 23.78, 25.53 and 24.65g respectively. Statistical analysis of the data on mean body weight gain did not reveal any significant difference between treatments but numerical increase in body weight gain in quails fed dried fish waste and fermented fish waste silage was noticed than control diet. Quails fed with dried fish waste (T2) recorded numerically higher body weight gain than T3. The better body weight gain in T2 may be due to higher protein content of dried fish waste and hence increased availability of essential amino acids in their ration. Hammoumi *et al.* (1999) observed increased weight gain when fermented fish waste was incorporated in poultry diet. In contrary to the present findings, Lekshmy (2005) reported decreased body weight gain in Japanese quail with increasing level of dried cuttle fish waste silage in their ration. The present study disagrees with Krogdahl (1985b) who could not observe any significant difference in weight gain when fish viscera silage was included in broiler ration. Espe *et al.* (1992) also reported no significant difference in weight gain when herring fish silage was used instead of fish meal in broiler ration. Magana *et al.* (1999) also observed no significant difference in the weight gain when fish silage mixed with soyabean was included in broiler ration.

The results of the present study reveals that inclusion of dried fish waste and fermented fish waste silage has positive effect on body weight gain in Japanese quails.

5.3 AGE AT SEXUAL MATURITY

The data on mean age at sexual maturity presented in Table 8 indicated as 42.50, 43.30 and 42.00 for T1, T2 and T3 respectively. Since the experiment was started at 42 days the treatment might not have affected the age at sexual maturity significantly. T3 was the first to reach age at sexual maturity and 10 per cent production. Quails fed with dried fish waste (T2) had delayed sexual maturity and age at 10 per cent and 50 per cent production. Statistical analysis of the data showed no significant effect on age at sexual maturity and 10 and 50 per cent production by the inclusion of dried fish waste and fermented fish waste silage. Jayant (2005) reported delayed age at 50 per cent production in ducks fed with dried cuttle fish waste silage. Preethymol (2006) and Raseena (2006) also observed age at first egg as 42 days in Japanese quails. Contrary to the present findings Sheena (2005) reported age at first egg in Japanese quails on 47 days and age at 50 per cent production on 58 days in quails fed control ration. Based on the study it could be stated that dried fish waste and fermented fish waste silage did not impart any adverse effect on the age at 10 per cent and 50 per cent production.

5.4 EGG PRODUCTION

The mean quail housed and quail day egg production and their per cent from seven to twenty six weeks of age are presented in Tables , 9, 11, 10 and 12 respectively. The overall mean quail housed egg number for T1, T2 and T3 were 77.96, 91.74, and 82.51 respectively and per cent quail housed egg number were 55.72, 65.53 and 58.94 for T1, T2 and T3 respectively. Statistical analysis of the data indicated that magnitude of differences in quail housed egg number and per cent quail housed egg production among the various treatments were non significant.

Though there was no significant difference in quail housed number of eggs due to different dietary treatments, the birds fed with dried fish waste (T2) recorded numerically higher egg production (91.74) than T1 and T3. Quails fed with fermented fish waste silage (T3) also recorded numerically higher egg production (82.52) than control group (77.96). This possibly suggests that feeding of dried fish waste and fermented fish waste silage improved egg production in Japanese quails. Krogdahl (1985a) also reported higher total egg production when fish viscera silage was fed to layer chicken replacing fish meal.

The overall mean per cent quail housed egg production for T1, T2 and T3 were 55.72, 65.53 and 58.94 respectively. Statistical analysis of the data did not reveal any significant difference between treatments except for the first and fifth period. Results of the present study agrees with that of Kjos *et al.* (2001) who reported non significant difference in egg production in White leghorn layers by replacing fish meal with fish silage.

Mean quail day egg number for T1, T2 and T3 were 80.57, 92.79 and 85.64 respectively. Quails fed dried fish waste and fermented fish waste silage recorded numerically higher quail day number than control group (T1). Statistical analysis of the data did not reveal any significant difference between treatments except for periods I, II and IV. The overall mean per cent quail day egg production for T1, T2 and T3 were 57.55, 66.28 and 61.17 respectively. Statistical analysis of data did not reveal significant difference between treatments except for first, second and fourth periods

Better egg production in quails fed with dried fish waste may be due to higher amino acid content of dried fish waste (Zynudin, 2007). Increased egg production due to increase in methionine was also reported by Ravikiran and Devegowda (1998). Decreased egg production in T3 than T2 might be due to lower availability of amino acids in fermented fish waste silage than dried fish waste. This agrees with the findings of Johnson *et al.* (1985).He reported that the recovery of amino acids relative to total crude protein content from fermented fish silage meal was only 78.7 per cent due to Mallaird reaction during drying of silage.

Lekshmy (2005) reported quail day production of 91.98 when 50 per cent unsalted dried fish was replaced with dried cuttle fish waste silage. Preethymol (2006) reported average quail day egg production of 80.50 per cent in quails when fed standard quail layer ration with 10 per cent unsalted dried fish. The present study agrees with them. Higher quail day egg production of 92.79 was obtained in the present study in T2. This might be due to better amino acid availability from dried fish waste.

Contrary to the present findings Shrivastav *et al.* (1993) reported lower quail day egg production of 65.02 when fed with 7 per cent fish meal.

5.5 FEED CONSUMPTION

The mean daily feed intake of quails of different dietary treatment groups are presented in Table 13 . The overall mean daily feed consumption for T1, T2 and T3 were 30.89g, 31.42g and 31.33g respectively. Statistical analysis of data revealed significant difference between treatments. Quails fed control diet revealed significantly lower feed consumption than T2 and T3. Significantly higher feed consumption in T2 and T3 might be due to higher quail housed egg production for these groups. Present findings agree with the findings of Vedhanayagam *et al.* (1976). They incorporated fish silage at 7 or 10 per cent levels in chick ration replacing fish meal and observed an increase in feed consumption. Similarly, Raj *et al.* (1996) replaced 50 per cent fish meal in broiler diet with fermented fish silage and observed higher feed consumption in fish silage fed groups. Hammoumi *et al.* (1999) and Maigualema and Gernat (2003) also reported increased feed consumption when Tilapia by-product meal was added to broiler diet. Jayant (2005) reported higher feed consumption in layer ducks when dried cuttle fish waste silage was included in duck ration.

On the other hand Johnson *et al.* (1985), Krogdahl (1985a), Espe *et al.* (1992), Ahmed and Mahendrakar (1996), Magana *et al.* (1999), Kjos *et al.* (2001), Ponce and Gernat (2002) and Reddy *et al.* (2004) reported non significant difference in feed consumption as a result of supplementation of fermented fish silage in broilers, herring fish silage in poultry, fish silage in layers, fish silage in broilers, Tilapia by-product meal in broilers, fish waste silage in broilers respectively.

Contrary to the present findings Lekshmy (2005) reported reduced feed intake in Japanese quail layers with increased levels of dried cuttle fish waste silage.

Period wise daily feed intake between treatments reveals significant difference during first, third and fourth periods only. During first period significantly lower feed consumption in T3 was recorded. This might be due to low quail housed production during that period where as during third period significantly lower feed consumption was recorded in control group (T1) but it was statistically similar to T2. Quails fed with fermented fish waste silage in T3 recorded significantly higher feed consumption. Higher feed consumption in T3 might be due to higher quail housed number (18.75) during that period. During fourth period significantly lower feed consumption was recorded in T1 but it was statistically similar to T3. Lower feed consumption might be due to lower egg production in T1 and T3 than T2 during that period.

5.6 FEED CONVERSION RATIO

The feed conversion ratio calculated based on kilograms of feed consumed per dozen eggs in the three dietary treatments are presented in Table14. The overall mean values for feed efficiency were 0.61, 0.65 and 0.67 respectively for T1, T2 and T3. Statistical analysis of the data did not revealed significant difference between treatments but numerically better feed efficiency was noted in T1. This finding agrees with the findings of Espe *et al.* (1992) and Magana *et al.* (1999). They reported non significant difference in feed efficiency in broilers fed with fish silage and tuna fish waste silage.

Contrary to the present findings better feed efficiency in broilers was reported by Ochetim (1992) when broilers are fed with locally available fish waste than those on meat and bone meal. Contrary to the present findings Raj *et al.* (1996) also observed better feed efficiency in broilers fed with fermented fish silage replacing 50 per cent fish meal. Lekshmy (2005) also reported better feed efficiency when 50 per cent fish meal protein replaced with dried cuttle fish waste silage in Japanese quail layers.

Based on beneficial effect on feed efficiency it can be concluded that dried fish waste and fermented fish waste silage could replace unsalted dried fish in quail layer ration.

Period wise feed conversion efficiency between treatments revealed significant difference between treatments during second period only. Lower feed efficiency in T2 might be due to lower egg production during second period.

5.7 EGG WEIGHT

The data on mean egg weight for the different dietary treatment groups were presented in Table 15. The mean egg weight for the treatments T1, T2, and T3 were 11.91, 11.97 and 11.80g respectively. Statistical analysis of data on mean egg weight did not reveal significant difference between treatments. This finding agrees with the findings of Krogdahl (1985a), Kjos *et al.* (2001) and Lekshmy (2005). Average egg weight of 11.60g, 11.14g, 11.17g and 11.27g was reported in Japanese quails fed with unsalted dried fish by Elangovan *et al.* (2002) Sheena (2005) Preethymol (2006) Raseena (2006) respectively. The egg weight recorded in the present study is numerically higher than those reported by above authors.

The period wise data on mean egg weight recorded significant ($P<0.05$) difference between periods. But significantly higher egg weight was recorded during third, fourth and fifth period than first and second period, following normal pattern of egg weight. This is in agreement with the reports of Romanoff and Romanoff (1949).The mean egg weight was significantly low at initial periods and increased progressively as period advances.

Contrary to the present findings Jayant (2005) reported decreased egg weight in ducks when dried cuttle fish waste silage was included in their ration.

The result of the present study indicates that inclusion of dried fish waste or fermented fish waste silage does not have any adverse effect on egg weight.

5.8 EGG QUALITY CHARACTERS

Mean values of egg quality parameters viz., shape index, albumen index, yolk index, internal quality unit and shell thickness as influenced by inclusion of experimental diets presented in Tables 16, 17, 18, 19 and 20 did not reveal significant difference between treatments.

The mean shape index of Japanese quail eggs for T1, T2 and T3 were 79.69, 79.46 and 80.02 respectively. Shrivastav *et al.* (1993) and Elangovan *et al.* (2002) reported mean shape index of Japanese quail eggs as 77.79 and 77.90 respectively when fish meal was included at seven per cent and five per cent levels. Lekshmy (2005) reported shape index of 78.89, 78.61 and 78.55 in quails fed fish meal, 50 per cent replacement and 100 per cent replacement with dried cuttle fish waste silage respectively. The present finding agrees with those reported by the above authors.

The mean albumen index values for treatments T1, T2 and T3 were 0.102, 0.102 and 0.09 respectively. Statistical analysis of the data on albumen index did not reveal significant difference between treatments. The results of the present findings agree with those reported by Elangovan *et al* (2002), Sheena (2005) and Raseena (2006).

The overall mean yolk index value for treatments T1, T2 and T3 were 0.45, 0.46 and 0.46 respectively. Non significant difference in yolk index by feeding dried cuttle fish waste silage in Japanese quails was reported by Lekshmy (2005) and in ducks by Jayant (2005). Yolk index of 0.469 was reported by Lekshmy (2005). Elangovan *et al.* (2002) reported yolk index of 0.478. Present finding agrees with those reported by above authors.

The mean shell thickness for treatments T1, T2 and T3 were 0.20, 0.19 and 0.20 respectively. Statistical analysis of data did not reveal significant difference between treatments for 10 to 26 weeks of age .The mean values agrees with those reported by Elangovan *et al.* (2002) and Erener *et al* (2003). Lekshmy (2005) reported shell thickness of 0.183mm.

The mean internal quality units observed among dietary treatments T1, T2 and T3 were 57.88, 57.24 and 56.69 respectively. Nonsignificant difference in internal quality in Japanese quails fed with dried cuttle fish waste silage was reported by Lekshmy (2005). The present finding agrees with the above findings. Raseena (2006) also reported lower internal quality unit of 60.81 in Japanese quail eggs.

5.9 LIVABILITY

The data on mortality pattern of birds under the different dietary treatment groups are presented in Table 22. Among the treatment groups, quails fed with fermented fish waste silage (T3) had highest mortality (14 number). Necropsy findings revealed that birds died due to egg bound condition (5 number), enteritis(5 number), pecking (8 number), hepatitis (6 number) and cage layer fatigue (3 number) . The lesion did not show any signs attributable to treatment effect. Thus it is evident that feeding of dried fish waste or fermented fish waste silage did not have any detrimental effect on the physiological well being of laying quails. This agree with the finding of Johnson *et al.* (1985) and Ochetim (1992) . The overall mortality of 27 birds among the experimental birds accounted to livability of 81.25 per cent.

5.10 ECONOMICS

The cost of three experimental diets isonitrogenous and isocaloric was Rs.10.00, 7.80 and 8.20 per kg for treatment groups T1, T2 and T3, respectively. The low cost of T2 and T3 rations were due to the inclusion of low price of dried fish waste and fermented fish waste silage respectively. The cost of dried fish waste and fermented fish waste silage per kg was Rs. 5 and 6 respectively. The feed intake for the period from 7 to 26 weeks of age was higher in T2 (191.04 kg) and lower in T3 (173.59 kg) and it was lower when compared to 189.35 kg of the control group. The feed required per egg was highest in T1group. The cost of feed per egg was Rs. 0.54, 0.37 and 0.42 for T1, T2 and T3, respectively. The crude protein of fermented fish waste silage was lower and that of dried fish waste was higher as compared to unsalted dried fish. The unsalted dried fish, dried fish waste and fermented fish waste silage were used in experimental rations at the rate of 8, 8.5 and 10 per cent respectively to maintain the diet isonitrogenous but there was better egg production in dried fish waste fed group (T2) and fermented fish waste (T3) groups.

The above findings are in line with the findings of Vedhanayagam *et al.* (1976) who observed that the cost of feed per kilogram weight gain was lower in broilers fed fish silage and Lekshmy (2005) observed low cost of feed per egg by replacing unsalted dried fish with 50 and 100 per cent dried cuttle fish waste silage in Japanese quail layer ration.

From the critical evaluation of the result obtained in the present study, it was inferred that dried fish waste and fermented fish waste silage can replace unsalted dried fish protein completely in Japanese quail layer diet without any adverse effect on egg production. Feed cost can be reduced considerably by replacement of unsalted dried fish with dried fish waste and fermented fish waste silage. As feed cost per egg was lowest and egg production was highest in dried fish waste fed group it can be used more advantageously than that of fermented fish waste silage.

Summary

6. SUMMARY

An experiment was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy, to evaluate the production and economics of replacement of unsalted dried fish with dried fish waste and fermented fish waste silage in Japanese quail layer rations. The study was conducted from 7 to 26 weeks of age. One hundred and forty four, Japanese quail pullets were weighed individually and distributed randomly to three treatment groups with four replicates of twelve birds each. The quail layer ration containing 22 per cent crude protein with 2650 kcal ME per kg, 3.26 per cent calcium and 0.63 per cent phosphorus formed the basal diet (T1). This diet contained 8 per cent unsalted dried fish. The 100 per cent unsalted dried fish protein in basal diet was replaced completely by adding 8.5 per cent dried fish waste in diet T2 and 10 per cent fermented fish waste silage in diet T3. All the rations were made isocaloric and isonitrogenous.

The experimental birds were housed replicate wise in separate cages and standard management conditions were maintained uniformly. The maximum and minimum temperature (^{0}C) and per cent relative humidity inside the experimental house were recorded daily in the forenoon and afternoon. The mean body weight at 6 and 26 weeks of age representing the initial and final body weight were recorded. Data were collected for five periods of 28 days, each from 7 to 26 weeks of age. Egg production was recorded daily replicate wise and expressed as quail housed and quail day egg number on per cent basis. Replicate wise data on feed intake was recorded throughout the experimental period and the feed conversion ratios based on kilograms of feed per dozen eggs were calculated. At the end of each period, all the eggs collected for three consecutive days were weighed to calculate the mean egg weight. Five eggs picked at random from each replicate in the last three days of each period were utilised for egg quality studies. The shape index, albumen index, yolk index, internal quality unit and shell thickness were recorded. At 26 weeks of age, eight eggs from each treatment

were collected and boiled at equal temperature for equal time and sensory evaluation was carried out. Economics over feed cost during the period was calculated based on the prevailing cost of feed ingredients and sale price of quail eggs.

The results obtained in this study are summarised hereunder.

1. The overall mean maximum temperature was 32.30°C and minimum temperature was 22.60°C and relative humidity (%) in the forenoon was 74.08 and in the afternoon was 71.67 inside the experimental house, during the period from 7 to 26 weeks of age, from September 2006 to February 2007.

2. The mean body weight of quails at 6 weeks of age were 189.37, 192.69 and 187.07g, and 26 weeks of age were 213.15, 219.42 and 211.72g for the treatments T1, T2 and T3 respectively. The mean body weight gain for the treatments T1, T2, and T3, during the period from six to twenty six weeks of age were 23.78, 25.53 and 24.65g respectively. There was no significant difference between the treatments in body weight as well as body weight gain.

3. The age at sexual maturity for treatments T1, T2 and T3 were 42.5, 43.30 and 42 days respectively.

4. The cumulative mean quail housed egg number for the period from 7 to 26 weeks of age were 77.96, 91.74 and 82.51 and per cent quail housed number were 55.72, 65.53 and 60.00 for the treatment groups T1, T2 and T3, respectively.

5. The mean cumulative quail day egg number were 80.57, 92.79 and 85.64 and the corresponding per cent quail day egg production were 57.55, 56.28 and 61.17, respectively for T1, T2 and T3. Quail day egg

number and per cent of the treatments during the five periods were statistically similar.

6. The cumulative mean daily feed intake of Japanese quails from 7 to 26 weeks of age were 30.89, 31.42 and 31.33g for the groups T1, T2 and T3, respectively. Statistical analysis revealed significant difference between treatments. Quails fed with control diet (T1) had significantly ($P<0.05$) lower feed consumption than quail fed dried fish waste (T2) and fermented fish waste silage (T3).

7. The mean cumulative feed conversion ratio calculated based on per dozen eggs for the groups T1, T2, and T3 were 0.61, 0.65 and 0.67, respectively , There was no significant difference between treatments.

8. The cumulative mean egg weight from 7 to 26 weeks of age for T1, T2 and T3 were 11.91, 11.97 and 11.80g respectively and statistically non significant among each other.

9. The egg quality characteristics studied, did not show any significant difference between treatments at 10, 14,18, 22 and 26 weeks of age and the overall mean values were comparable

10. Livability was comparatively better in control and dried fish waste groups compared with the group fed fermented fish waste silage (T3).The number of birds died in treatments T1,T2 and T3 were 6, 7 and 14 respectively.

11. The feed cost per kg for treatments T1,T2 and T3 were Rs.10.00, 7.80 and 8.20 respectively.

12. The feed cost for the production of one egg accounted to Rs. 0.54, 0.37 and 0.42 for the treatments T1, T2 and T3, respectively.

13. The margin of return over feed cost per egg was found to be Rs. 0.16, 0.33 and 0.28 for the treatments T1, T2 and T3, respectively.

14. The margin of return over feed cost per quail housed were Rs. 12.02 , 27.45 and 19.93, respectively.

From the critical evaluation of the results obtained in the present study, it was inferred that dried fish waste and fermented fish waste silage can replace unsalted dried fish protein completely in Japanese quail layer diet without any adverse effect on egg production. Feed cost can be reduced considerably by replacement of unsalted dried fish with dried fish waste and fermented fish waste silage. As feed cost per egg was lowest and egg production was highest in dried fish waste fed group it can be used more advantageously than that of fermented fish waste silage.

References

REFERENCES

Ahmed, J. and Mahendrakar, N.S. 1996. Growth and meat quality of broiler chicks fed with fermented fish viscera silage. *Int. J. Anim. Sci.* 11: 1-5

Anon. 2004. *Bulletin on Livestock Feed From Cephalopod Processing Waste.* Central Institute of Fisheries Technology. p.11

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

Babu, M., Prabakaran, R. and Sundararasu, V. 1987. Energy requirements of Japanese quails. *Indian J. Poult. Sci.* 22(1): 6-8

Dale, N. 2001. Nutrient composition of catfish meal. *J. Applied Poult. Res. Abstract.* 10(3): 252-254

Elangovan, A.V., Verma, S.V.S., Sastry, V.R.B. and Singh, S.D. 2002. Laying performance of Japanese quail fed on different seed meals in diet. *Indian J. Anim. Nutr.* 19: 244-250

Erener, G., Ozer, A. and Oeak, A. 2003. Growth and laying performance of Japanese quails fed graded levels of hazel-nut oil meal incorporated into diets. *Asian-Aust. J. Anim. Sci.* 16(12): 1789-1794

Espe, M., Haaland, H. and Njaa, L.R. 1992. Digestability and utilization in young growing rats given saithe fish offal silage stored for different length of time as the sole protein source. *Fiskeridirektoratets-Skrifter-Serie-Ernaering.* 3: 37-42

Faid, M.1997. Biotransformation of fish waste into a stable feed ingredient. *Food chemistry.* 60: 13-18

Gernat, A., and Dale., N. 2006. Tilapia by-product meal. *Feed International* 26: 22-23

Hammoumi, A., Faid, M., Yachioui, E.M. and Amarouch, H. 1998. Characterization of fermented fish waste used in feeding trials with broilers. *Process Biochem.* 33(4): 423-427

•Hammoumi, A., Faid, M., Yachioui, E.M. and Amarouch, H. 1999. Use of fermented fish waste as a poultry feed ingredient. *Cahiers Agricultures* 8(3): 207-209

Jayant, G. 2005. Utilisation of dried cuttle fish *(Sepia officialis)* waste silage in layer duck ration. M.V.Sc thesis, Kerala Agricultural University, Thrissur, India, 75 p.

•Johnsen, F. and Skrede, A. 1981. Evaluation of fish viscera silage as a feed resource. 1. Chemical characteristics. *Acta. Agric. Scand.* 31: 21-28

Johnson, R.J., Brown, N., Eason, P. and Sumner, J. 1985. The nutritional quality of two types of fish silages for broiler chickens. *J. Sci. Fd. Agric.* 36: 1051-1056

Kjos, N.P., Herstad, O., Skrede, A. and Overland, M. 2001. Effects of dietary fish silage and fish fat on performance and egg quality of laying hens. *Can. J. Anim. Sci.* 81: 245-251

Kondaiah, N., Panda, B and Singhal, R.A. 1981. Internal egg quality measures of Japanese quail eggs. *Indian J. Anim. Sci.* 53: 1261-1264

•Krogdahl, A. 1985a. Fish viscera silage as a protein source for poultry. I. Experiments with layer type chicks and hens. *Acta Agric. Scand.* 35: 3-23

Krogdahl, A. 1985b. Fish viscera silage as a protein source for poultry. II. Experiments with meat type of chickens and ducks. *Acta. Agric. Scand.* 35: 24-32

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

Machin, D.H., Panigrahi, S., Bainton, J. and Morris, T.R. 1990. Performance of broiler chicks fed on low and high oil fish silages in relation to changes taking place in lipid and protein components. *Anim. Feed Sci. Technol.* 28: 199-223

Magana, L.A.V., Avila, E. and Sotelo, A. 1999. Silage preparation from tuna fish wastes and it's nutritional evaluation in broilers. *J. Sci. Fd. Agric.* 79:1915-1922

Mohan, B. 1999. Feeding value of squilla meal as a replacement for fish meal in chicken ration. Ph.D. thesis, Tamil Nadu Veterinary And Animal Sciences University, Chennai, India, 147 p.

Mohan, B. 2002. The value addition of eggs through dietary manipulation. Compendium on Recent developments in value addition poultry products and marketing from July 10- 30, 2002. Tamil Nadu Veterinary and Animal Science University, Veterinary College Research Institute , Namakkal, Tamil Nadu pp 28-29

Maigualema, M.A. and Gernat, A.G. 2003. The effect of feeding elevated levels of Tilapia *(Oreochromus nitoticus)* by-product meal on broiler performance and characteristics. *Int. Anim. Sci.* 2(3):195-199

•Mundheim, H. and Opstvedt, J.1982. The value of Nowergian herring type fish meal and soyabean meal as protein supplements to poultry diets based on different type of cereals. *Acta. Agric. Scand.* 32(3): 273-281

Ngoan, L.D., Ogle, B. and Lindberg, J.E. 2001. Effects of replacing fishmeal with ensiled shrimp byproduct on the performance and carcass characteristics of growing pigs. *Asian-Aust. J. Anim. Sci.* 14(1): 82-87

Ochetim, S., 1992. Performance of broilers and layers fed locally produced fish waste meal in Western Samoa. *Asian-Aust. J. Anim. Sci.* 5(1): 91-95

Pearson, A.W., Greenwood, N.M., Buttler, E.J., Curl, C.L., Fenwick, G.R.1983. The involvement of trimethylamine oxide in fish meal in the production of egg taint. *Anim. Feed Sci. Technol.* 8(2): 119-127

Periyasamy, P. 2004. Feeding value of sardine fish head meal for broilers. M.V.Sc. thesis. Tamil Nadu Veterinary and Animal Sciences University, Chennai, India, 74p.

Ponce, L., and Gernat, A.G. 2002. The effect of using different levels of Tilapia by-product meal in broiler diets. *Poult. Sci.* 81: 1045-1049

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

Raj, K.R., Rao, R.J. and Mahendrakar, N.S. 1996. Effect of feeding extruded diets containing fermented fish and poultry offals on growth and meat quality of broiler chickens. *Int. J. Anim. Sci.* 11(2): 277-282

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

Ravikiran , D. and Devegowda, G. 1998. Effects of DL-methionine supplementation in the ration of commercial layers during summer. *Indian J. Poult. Sci.* 33:279-283

Reddy, V.R., Reddy, V.R. and Quadratullah, S. 2004. Chemical composition and nutritive value of squilla (*Orastosquilla nepa*) meal for White Leghorn layers. *Indian J. Anim. Sci.* 74:1071-1074. Cited in *Poult. Abstr.* 2005 31(2): 68

Romanoff, A.L. and Romanoff, A.J. 1949. *The Avian Egg.* John Wiley and Sons, INC Newyork Chapman and Hall Ltd. London, p.721.

Rose, S.P., Anderson, D.M. and White, M.B. 1994. The growth of pig from 6 to 10 kg when fed fish silages that were preserved either by formic acid or by fermentation. *Anim. Feed Sci. Technol.* 49: 163-169

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, India, 92 p.

Shrivastav, A.K., Raja, M.V.L.N. and Johri, J.S. 1993. Effect of varied dietary protein in certain production and reproduction traits in breeding Japanese quail. *Indian J. Poult. Sci.* 28(1): 20-25

Singh, V.K., Shukla, P.K. and Srivastava, R.K. 1999. Dried poultry droppings as a replacement of fish meal for quail layers. *Indian J. Poult. Sci.* 34: 398-399

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods.* Eighth edition. The Iowa State University Press, America, p. 313

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

Tanaka, K., Youn, B.S., Ohtani, S. and Sakaida, M. 1990. Effect of fermented products from the chub mackeral on growth and on lipogenesis and contents of various lipids in liver of growing chicks. *Japanese J. Zootechnical Sci.* 61: 1102-1106.Cited in *CABI Abstr.* 1990-1991

Vedhanayagam, K., Jaganathan, V. and Venkatakrishnan, R.1976. Use of fish silage in chick rations. *Cheiron* 5: 122-125

White, M.B., Anderson, D.M, and Rouvinen, K.I. 1999. Apparent digestibility coefficients of raw ground, acid and fermented silver hake (*Merluccius bilinearis*) feedstuffs for mink and an evaluation of the storage stability of the silages. *Can. J. Anim. Sci.* 79: 375-381

Whittemore, C.T. and Taylor, A.G. 1976a. Nutritional properties of liquified herring offal. *Proceedings, Torry Research Station Symposium on Fish Silage*, Aberdeen, II, pp. 1-4

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

Zahar, M. 2002. Biological ensiling of sardine wastes in sugarcane molasses for their valorization in animal feeding: Microbiological study. *Proceedings of International Symposium on Environmental Pollution Control and Waste Management*. p.305

Zynudin, A. 2007. Personal communication, Scientist, CIFT, Cochin

▪ Originals not consulted.

UTILISATION OF DRIED FISH WASTE AND FERMENTED FISH WASTE SILAGE IN JAPANESE QUAIL (*Coturnix coturnix japonica*) LAYER RATION

PREETA RAGHAVAN

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

2007

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

ABSTRACT

An experiment was conducted in Japanese quail layers from 7 to 26 weeks of age by 100 per cent replacement of unsalted dried fish with dried fish waste and fermented fish waste silage on protein basis. The objective of the study was to assess the production performance as well as the economics of feed cost over production. One hundred and forty four Japanese quail (*Coturnix coturnix japonica)* pullets of 6 weeks of age were randomly allotted to three treatment groups with four replicates of 12 quails each. Quail layer ration containing 10 per cent unsalted dried fish formed control ration (T1). The other two diets were formulated by 100 per cent replacement of unsalted dried fish by dried fish waste (T2) and fermented fish waste silage (T3). The experiment was conducted for five 28- day periods from 7 to 26 weeks of age.

Data on meteorological parameters, body weight, body weight gain, egg production, egg quality characteristics, sensory evaluation, livability and economics were the criteria used for evaluation. The body weights in groups T1, T2 and T3 were 189.37, 192.69 and 187.07g at 6 weeks and 213.15, 219.42 and 211.72g at 26 weeks of age respectively. The body weight and body weight gain during observation period for different dietary treatments did not differ significantly (P<0.05). All the birds in treatments viz., T1, T2 and T3 attained sexual maturity at the age of 42.5, 43.3 and 42 days. The age at sexual maturity, the age at 10 and 50 per cent production did not differ significantly (P<0.05) between treatments. The quail housed egg production and quail day egg production were statistically comparable among the treatment groups. The cumulative quail housed number of eggs in the different dietary groups were 77.96, 91.74 and 82.51 respectively. The cumulative quail day number of eggs were 80.57, 92.79 and 85.64 respectively. The overall mean feed consumption per bird per day were 30.89, 31.42 and 31.33g for T1, T2 and T3 respectively. Significantly lower feed consumption was noted in control group (T1). Overall mean feed efficiency were 0.61, 0.65 and 0.67 for treatment groups T1, T2 and

T3 respectively. The overall mean egg weight of three dietary treatment groups T1, T2 and T3 were 11.91, 11.97 and 11.80g respectively and did not differ significantly (P<0.05). The cumulative mean egg quality traits such as shape index, albumen index, yolk index, internal quality unit and shell thickness did not differ significantly among the treatment groups. The mean score of sensory evaluation of quail eggs did not differ significantly among different dietary treatment groups. The livability per cent in treatment groups T1, T2 and T3 were 87.5, 85.4 and 70.8 per cent respectively. The cost of feed per egg was Rs.0.54, 0.37 and 0.42 for treatment groups T1, T2 and T3 respectively. Marked reduction in the feed cost was noticed in the diet containing dried fish waste (T2) followed by fermented fish waste silage included diet (T3)

The overall evaluation of the study reveals that dried fish waste and fermented fish waste silage could be used economically to replace unsalted dried fish protein completely in Japanese quail layer rations, without any adverse effect on overall performance.

-172681-

KERALA AGRICULTURAL UNIVERSITY LIBRARY
THRISSUR