UTILISATION OF DRIED CUTTLE FISH (*Sepia officialis*) WASTE SILAGE IN LAYER DUCK RATION

JAYANT GOVINDAN

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

2005

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 CUTTLE FISH (*Sepia officialis*) WASTE SILAGE IN LAYER DUCK 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,
01.09.05

JAYANT GOVINDAN

CERTIFICATE

Certified that this thesis, entitled "**UTILISATION OF DRIED CUTTLE FISH (*Sepia officialis*) WASTE SILAGE IN LAYER DUCK RATION**" is a record of research work done independently by **Jayant Govindan**, under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him.

1-9-05

Mannuthy
01.09.05

Dr P.A. Peethambaran,
Associate Professor,
Department of Poultry Science,
College of Veterinary and Animal Sciences,
Mannuthy.

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Jayant Govindan**, a candidate for the degree of Master of Veterinary Science in Poultry Science, agree that this thesis entitled **"UTILISATION OF DRIED CUTTLE FISH (*Sepia officialis*) WASTE SILAGE IN LAYER DUCK RATION"** may be submitted by Mr. Jayant Govindan, in partial fulfillment of the requirement for the degree.

Dr. P.A. Peethambaran,
(Chairman, Advisory Committee)
Associate Professor
Department of Poultry Science
College of Veterinary and Animal sciences
Mannuthy.

Dr. A. Jalaludeen
Director i/c and Head
Department of Poultry Science
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

Dr. K. Narayanankutty
Senior Scientist
AICRP on Poultry for Eggs
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

Dr. K. Ally
Assistant Professor
Department of Animal Nutrition
College of Veterinary and
Animal Sciences, Mannuthy
(Member)

External Examiner

ACKNOWLEDGEMENT

It is with immense pleasure that I record my sincere and heartfelt gratitude to the Chairman of the Advisory Committee ***Dr P.A. Peethambaran****, Associate Professor, Department of Poultry Science, for his meticulous guidance, personal attention, keen interest, affectionate encouragement, persuasion and incessant help offered to me from the initiation of work to the ship shaping of the manuscript. Without his strong support and co-operation the successful completion of this work would not have been possible.*

To the greatest degree, I am grateful to ***Dr. A. Jalaludeen,*** *Associate Professor and Head, Department of Poultry Science, Member of the Advisory Committee, for his generous encouragement, inspiration, kindness and personal guidance in the pursuit of this work.*

I am sincerely thankful to ***Dr. K. Narayanankutty,*** *Senior Scientist, AICRP on Poultry for Eggs and* ***Dr. K. Ally****, Assistant Professor, Department of Animal Nutrition for their whole-hearted co-operation, words of inspiration, incessant encouragement and affection rendered during the entire period of research work.*

I owe my sincere gratitude to ***Dr. A.D. Mercy****, Associate Professor, Department of Animal Nutrition,* ***Dr Amritha Viswanath, Dr. V.K. Elizabeth,*** *Associate Professors, Department of Poultry Science and* ***Dr P Anitha****, Assistant Professor AICRP on Poultry for Eggs for their valuable guidance, timely help and moral support.*

I gratefully acknowledge. ***Mr. Leo Joseph****, Associate Professor and Head, staff and labourers in University Poultry Farm for their lots of help rendered.*

I am thankful for the wholehearted help rendered for statistical analysis of data by ***Smt. Sujatha****, Assistant Professor and Head,* ***Smt. K.A. Mercy****, Assistant Professor, Department of Statistics.*

I am grateful to ***Dean****, College of Veterinary and Animal Sciences, Mannuthy and Kerala Agricultural University for the facilities provided for this research work.*

I wish to extend my thanks to ***Central Institute of Fisheries Technology (CIFT)****, Cochin for their timely supply of cuttle fish waste silage under the National Agricultural Technology Project (NATP).*

I am in short of words to express my deep sense of gratitude to my colleagues, ***Drs Sheena Grace Koshy, Lekshmy M. A****, without whose tireless help, unconditional support and constant encouragement the successful completion of this research work would not have been possible.*

The generous help, assistance, guidance and support rendered to me by my beloved seniors ***Drs. Giriraj K, Renjith P M and Anup Kollanur*** *is duly acknowledged. I am greatly thankful to* ***Drs. Sakthivel P.C.*** *and* ***Ravi S****, for their valuable help in literature collection. A bouquet of thanks to friends and junior colleagues* ***Drs. Rasina Karim, Preethymol Joseph and Lonkar Vijaysinh Dhansing*** *for their help and co-operation.*

Words possess no enough power to reflect my thankfulness for the invaluable help in various analysis work, moral support and affection rendered by my great friends ***Drs. Smita N F, Raja D, Sheena Joseph, Mary Juliet Francis and Smitha Wilson*** *in the Department of Animal Nutrition and Dr. Jega Veera Pandian, S. in the Department of Clinical Medicine.*

The help given by ***Ms. Dhanya,*** *Senior Research Fellow, Department of Animal Nutrition, Dr. Rajeshkumar, S., Hatchery Manager (RFH) and* ***Drs. Rajeesh M and Nishant S****, Senior Research Fellows, Department of Poultry Science is greatly acknowledged.*

I sincerely acknowledge the staff of our department ***Mrs. Vilasini*** *and* ***Mr. Paul*** *for their timely help.*

No phrase or words in any language can ever express my deep sense of love and gratitude to my beloved ***Acchan, Amma and my beloved sister.***

Above all, I bow my head before ***God The Almighty****, for the blessings showered on me... for all the things I have and I don't... for helping me to reach the shore safely... through the love and prayers of my family, friends and teachers.*

Jayant Govindan

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Introduction

1. INTRODUCTION

Poultry enterprise has transformed to a vibrant agri-based industry in the last three decades with annual growth rate of 10 per cent in layer production and 16-18 per cent in broiler production. These are the fast growing two segments in agriculture producing 35 billion eggs and 1.0 billion broilers annually in India occupying fourth and fifth positions in the world in egg and broiler production respectively Despite the spectacular growth rate, the per capita availability of eggs and poultry meat are very low in our country with 37 eggs and 1.2 kg of poultry meat respectively leaving a wide gap between availability and recommendation indicating great potential for further growth in poultry industry in India.

The poultry industry provides vast opportunities for employment and thus maintains a viable economy both in urban and rural sector. The intensive, semi-intensive and rural poultry production systems contribute substantially to the national economy. The rise in poultry population has been multi pronged incorporating all species of poultry in India. In spite of this, poultry production is mainly oriented in chicken to the extent of 90 per cent and ducks with 8.5 per cent of total poultry population occupy second position next to chicken in India.

Poultry population in Kerala include 10.99 million fowls, 0.66 million ducks and 2.76 million other poultry as per 2003 Livestock Census (Anon., 2005).

Duck production serve as a boon to the livelihood of the poor and marginal farmers in the backward strata of the society. The system of rearing foraging ducks is widely popular in the State, but the farmers are constraint by disease outbreaks, transportation of flock to neighbouring states and they strive hard to locate foraging fields under extensive system of rearing. Ducks being web footed aquatic species are being reared in paddy fields, riverside and in water bodies, traditionally. The studies conducted under the NATP proved that ducks also could be reared under cage system without adversely affecting the production performance.

India has very long coastal belt with eight large fish landings in the world and seafood export is the potential source of foreign exchange in our country. The processing of cephalopods in India is very high to the tune of 1.0 lakh MT annually and its export is second to shrimp in quantity and value. Processing plants generate huge quantity of fish wastes and more than 30000 MT of fish wastes are available from processing of cephalopods alone. The improper disposal of fish wastes pollutes water, air and environment and high quantum of animal protein present in wastes is being lost every year. Cuttle fish is considered to be superior over other fishes because of higher lysine and methionine content with added advantage of its fat rich in omega 3 fatty acids DHA and EPA.

Fish meal or dried fish is the major animal protein source in poultry rations but its high cost and poor quality led poultry nutritionists to search for alternate sources of protein in poultry rations. Attempts are being made to convert fish wastes into livestock feeds as a substitute for fish meal or dried fish but feeding experiments with fish wastes in ducks are scanty.

In most species of fishes, nearly 40-50 per cent waste is generated after separating edible portions. There are organised fish processing centers in Alappuzha and Ernakulam districts in Kerala State that generate large quantity of fish wastes. Because of its unpleasant appearance and high moisture content, storage and transportation are difficult without processing. The basic principle involved in the ensiling process of the waste is lowering the pH chemically by adding formic acid and thereafter allowing to liquefy by the action of proteolytic enzymes already present in fish wastes and such products will be free from pathogenic organisms. During liquefaction process, protein undergoes partial hydrolysis thereby increasing the digestibility of hydrolysed proteins. The liquefaction will be completed in 3 to 4 days and the resultant product will have a pleasant odour. In order to overcome the storage and transportation problems, the liquid silage can be mixed with deoiled rice bran and sun dried to reduce the moisture content to 10 per cent. The Cuttle fish waste silage (CFWS)-Rice bran mixture after sun drying contains 24 to 26 per cent protein and 3 to 4 per cent fat. The use of such fish wastes in feeds overcomes the animal protein deficit to certain extent and also solves the problem of waste disposal. Ducks utilize fish byproducts more efficiently than other species of poultry. Therefore, the present study was planned in layer ducks with the following objectives.

To assess the effect of incorporation of dried cuttle fish waste silage on production characteristics of layer ducks and to evaluate the economics of feeding dried CFWS in layer duck rations.

Review of Literature

2. REVIEW OF LITERATURE

2.1 FISH SILAGE

Johnsen and Skrede (1981) prepared fish viscera silage from gadoid species of cod and haddock fish using formic acid at 0.75 per cent and propionic acid at 0.75 per cent as preservatives. Dry matter (DM) content in this type of fish silage was 13 -15 per cent and Crude Protein (CP) content was 68-76 per cent. By vacuum drying, DM was increased by three fold to 43-46 per cent and CP increased to 72-74 per cent. There was 50 per cent loss of tryptophan in fish viscera silage and concluded that tryptophan is the first limiting amino acid followed by sulphur containing amino acids in fish viscera silage.

Strom and Eggum (1981) conducted experiments in rats with fish viscera silage from viscera of cod and siathe fishes. Formic and propionic acid were used as preservatives at 1:1 level. Protein content of cod viscera silage was 12-13 per cent and that in saithe viscera silage was 6-12 per cent .The Net Protein Utilization was 70 per cent.

Batterham *et al.* (1983) used 3.5 per cent formic acid to prepare silage from ocean perch and nannygai fishes to replace soybean meal as protein source in grower pig rations. This type of silage had a dry matter content of 23.9 per cent and CP was 68.6 per cent on dry matter basis. Growth ($P<0.05$) and feed conversion ratios ($P<0.01$) were improved compared to soybean meal or their combinations in pigs.

Johnson *et al.* (1985) used 3.5 per cent formic acid for preparing acid fish silage (AFS) from filleting waste. Fermented fish silage (FFS) was prepared by using 12 per cent molasses and 5 per cent *lactobacillus plantarum.* Mixing ensiled fish and wheat bran at the ratio of 85: 15 produced both types of silages. Dry matter and CP in acid silage meal was 93.6 and 37.1 and in FFS was 92.5

and 32.3 per cent respectively. AFS and FFS were added at 2.5, 5.0 and 10 per cent at the expense of soybean meal in broiler chick ration. No significant difference was obtained in feed intake, live weight gain, feed conversion and dressed carcass by feeding either silage at 5 or 10 per cent level.

Green *et al.* (1988) prepared fish silage from whole mackerel by adding formic acid at 3.5 per cent and the dry matter content was 33.8 per cent and CP content was 43.5 per cent. Fish silage was included at 5.0, 10 and 15 per cent in diets by replacing soybean meal and other plant based materials and inclusion of 10 per cent fish silage showed best performance in pigs.

Ologhobo *et al.* (1988) studied the replacement value of fish silage for fish meal in broiler rations. Acid and neutral fish silage was prepared by mixing cassava flour and maize as filler material. Diets having fish meal, neutral maize fish silage, acid maize fish silage, acidic cassava fish silage and all fish silage were studied. The weight gains in broilers fed five types of silage were 1.51, 1.06, 0.93, 1.03 and 0.89 kg respectively. The feed to gain ratio were better in the group fed fish meal and the FCR reported were 2.56, 3.5, 3.45, 3.31 and 3.43 respectively.

Strasdine *et al.* (1988) assessed the ensiled protein waste from dogfish to produce feed for monogastric animals and the fish silage produced by adding 1.5 per cent formic acid had moisture content of 74.4 per cent and CP of 18.8 per cent. These authors observed that fish silage could be used as supplement in barley based diet and suggested to combine with amino acids or other protein concentrates.

Machin *et al.* (1990) prepared dried fish silage by using cassava meal as filler material. Low oil fish silage (LOFS) was made using fresh whole Whiting fish and Mackerels with intact gut were utilized for preparing high oil fish silage

(HOFS). Cassava and fish were added in the ratio of 2:1 and the CP reported in LOFS was 22 per cent and that in HOFS was 24.7 per cent.

Myer *et al.* (1990) evaluated scallop viscera silage as high protein stuff with 3.5 per cent formic acid as preservative for growing finishing swine. Silage had a dry matter of 21 per cent and CP ranged between 83-87 per cent on dry matter basis. At 24 per cent level, average daily gain, average feed intake and feed to gain ratio were not effected.

Mahendrakar (1991) studied the influence of feeding fish and poultry viscera silages to broiler chicks and their replacement effects for fish meal on performance and meat quality. Viscera of fishes from carp variety mixed with deoiled rice bran as filler material was dried for the preparation of silage.

Espe *et al.* (1992) substituted fish meal protein in chicken diet with fish silage protein and free amino acid mixture. Fish silage was prepared using frozen saithe offal by adding 2.5 percent formic acid. Chickens were fed with basal diet of 55 per cent protein from fish meal. Growth and feed efficiency were same or better when some of the protein was from fish silage. Results showed that replacement of dietary fish meal with fish silage did not reduce the dietary quality of feed in growing chickens.

Syam Mohan and Sivaraman (1993) assessed the feeding value of dried prawn waste (DPW) by partial and complete replacement of animal protein from unsalted dried fish in rations of growing and finishing swine. Grower ration having crude protein of 18 per cent was fed upto 50 kg body weight and thereafter finisher ration having 14 per cent crude protein was given. When 50 and 100 per cent replacement of animal protein was done with DPW, there was significant reduction in growth rate and feed efficiency.

Rose *et al.* (1994) prepared acid silage by adding formic acid to cod filleting waste and fermented silage was prepared by adding bacterial culture of *Lactobacillus* and *Pediococcus sps*. On dry matter basis, protein content of fermented fish silage was 35.5 per cent and acid fish silage was 55.8 per cent. Production performance of young pigs weighing 6 kg was reduced than that of fish meal based diet and suggested that fish silage is not suitable for feeding in very young pigs.

Wohlt *et al.* (1994) used surf clam viscera having 88 per cent moisture and 71 per cent crude protein on dry matter basis as protein supplement for growing pigs. Growth was similar in pigs from 18 kg to market weight (92 kg) when either soybean meal or clam viscera were fed as protein supplements.

Ahmed and Mahendrakar (1996b) studied the effect of fermented fish viscera silage on the growth and meat quality of broiler chicken. In fermented fish viscera 10 per cent molasses and 0.5 per cent and 0.02 per cent ethoxyquin were added. Fish meal was replaced at 25 and 50 per cent level in the diets. Feed intake and growth rate were reduced in treatment diets than that of control and concluded that fish viscera silage can be included in the diets by replacing fish meal at less than or equal to 50 per cent level.

Raj *et al.* (1996) studied the effect of fermented fish and poultry offal inclusion in broiler chicken diets. Control diet had fish meal at 8 per cent and test diets had 50 per cent fish meal replaced by fermented fish viscera silage and poultry intestine silage.

Kjos *et al.* (1999) studied the effect of dietary fish silage and fish fat on growth and sensory quality in growing and finishing swine. Fish silage was prepared from the slaughter byproducts of salmon and crude protein content was 34.9 per cent. There was no significant difference in growth of pigs fed either control diet or one of three diets containing 50 per cent fish silage and different levels of fish fat.

Borin *et al.* (2000) conducted experiments with growing fattening pigs by feeding fermented fish waste silage prepared by mixing partly eviscerated fish with sugar palm syrup and rice bran in 50:10:40 ratio on fresh basis comprising 500 g rice bran, 400 g fermented fish waste silage and *ad lib* sugar palm juice. The average daily growth rate was superior to protein supplement from boiled whole soybean diets.

Ngoan *et al.* (2001) ensiled shrimp byproduct with sugarcane molasses in the ratio of 3:1 wet weight and with cassava root meal in 1:1 ratio of wet weight of shrimp meal to air dry weight of cassava root meal. Dry matter content was ranged between 20-30 per cent and crude protein was only 26.9 per cent and concluded that ensiled shrimp meal byproduct can replace fish meal at 50 per cent of crude protein in cassava root meal cum rice bran based diet.

Anon (2004) reported the moisture, crude protein in cuttle fish waste silage at less than 10 and 24-26 per cent respectively .It was prepared by adding 3.5 per cent formic acid to liquid cuttle fish waste to bring down pH and allow liquefaction. Silage was later mixed with rice bran and then sun dried.

2.2 BODY WEIGHT AND SEXUAL MATURITY

Vedhanayagam *et al.* (1976) conducted experiments by replacing fish meal at 7 and 10 per cent levels with fish silage prepared from trash fish in White Leghorn chick ration and observed higher body weight in fish silage fed groups.

McNaughton *et al.* (1978) conducted experiments in broiler chicks to study the utilization of hydrolyzed fish protein and observed no improvement in body weight compared to those fed corn-soya diet balanced with essential amino acid.

Andrews *et al.* (1984) compared the performance of desi ducks reared in two systems and reported that the body weight at 20 weeks of age was 1438 g under intensive system and 1443 g under semi-intensive system of management. These ducks were fed with a diet containing 17.3 per cent crude protein and 2650 Kcal ME/kg and the body weight at 44 weeks of age was 1311g under intensive system and 1281 g under semi-intensive system of management.

Krogdahl (1985b) conducted experiment with meat type chicken and ducks. Fish silage was included at 0, 10, 20 or 40 per cent of dietary crude protein in chicken and 0, 20 or 40 per cent of dietary crude protein in ducks. A higher weight gain was observed in birds fed fish silage diets than those fed reference diet.

Gajendran *et al.* (1990) reported body weight of 1.402 kg in Khaki Campbell ducks and 1.465 kg in desi ducks at 20 weeks of age and the mean age at first egg recorded was 140.16 days in Khaki Campbell ducks and 145.21 days in desi ducks under deep litter system of rearing.

Machin *et al.* (1990) reported that the weight gain in broiler chicken fed balanced diets containing 4.7 and 9.4 per cent crude protein from high oil fish silage (9.8 and 19.6 per cent of dietary dry matter) were 99 and 85 g during first week. Those groups fed 5.2 and 10.4 per cent from low oil fish silage (6.8 and 13.5 per cent of dietary dry matter) were 98 and 91 g respectively.

Rodriguez *et al.* (1990) fed fish silage prepared from shrimp at 2.5 and 5 per cent levels in ration of broilers and observed better response at 5 per cent dietary inclusion.

Tanaka *et al.* (1990) conducted experiments in White Leghorn chicks at 4 weeks of age by feeding fermented Chub mackerel at 0, 0.2, 0.5, 1 and 2 per cent levels. Body weights were higher in Chub mackerel fed groups.

Baruah *et al.* (1991) reported that the age at first egg were 144.2, 150.4 and 146.4 days and the age at 30 per cent production were 167.2, 158.6 and 161.8 days in indigenous Pati ducks, Khaki Campbell ducks and their crosses respectively.

Ochetim (1992) fed locally produced fish waste meal to broilers and layers in Western Samoa. Fish waste meal replaced imported meat cum bone meal in the diet. The starter and finisher ration of broilers had meat cum bone meal and it was replaced at 15 and 12 per cent levels by local fish waste meal and reported final body weight of 1.98 kg with meat cum bone meal diet and 2.05 kg with local fish waste meal diet in broilers at seventh week of age.

Dutta *et al.* (1993) studied body weight pattern in Khaki Campbell ducks at different ages under open range, deep litter and semi intensive systems of management. Body weights reported at 20 weeks were 1347.33, 1351.33 and 1386.67 g in open, deep litter and semi intensive system respectively with overall mean of 1361.78 g.

Rosenfield *et al.* (1997) measured the effect of substitution of different levels of shrimp meal for soybean meal in broiler diets and significant difference was noticed in body weight when shrimp meal replaced soybean meal at 0,10, 20, 30, 40, 60, 80 and 100 per cent on crude protein basis. Significantly higher body weight ($P< 0.01$) was noticed only at 100 per cent replacement.

Hammoumi *et al.* (1998) prepared broiler diets with fermented fish waste silage and chopped pilchard waste incorporating bran and barley and reported net increase in broiler weight compared to that fed a control diet.

Magana *et al.* (1999) evaluated the nutritional quality of silage prepared from tuna fish wastes in the diets of broiler birds. Silage was mixed with sorghum at 70:30 ratio and after drying crude protein content was 28.3 per cent and crude fibre content was 1 per cent. He did not observed any significant difference in weight gain when fish silage mixed with sorghum was included in diets at 5, 10, 15 per cent levels.

Mohan (1999) included squilla meal protein at 0, 25, 50, 75 and 100 per cent levels replacing fish meal in ration of egg type chicks and reported statistically non significant weight gain of 511.3, 494.8, 509.5, 475.4 and 476.4 g in corresponding groups.

Das *et al.* (2000) compared the age at sexual maturity and egg production in Desi, Khaki Campbell and their crosses under field conditions. In Desi, Khaki Campbell and their crosses, mean age at sexual maturity was reported as 229.19, 169.16 and 220.24 days respectively showing highly significant ($P<0.01$) influence of genetic group on age at sexual maturity.

Kjos *et al.* (2000) prepared ration for broiler chicks using fish silage from slaughter byproducts of farmed salmon and reported higher weight gain.

Barroga *et al.* (2000) studied the growth performance of fattened paddy herded ducks, which were fed silage mixed diets. Cherry valley ducks achieved higher weight gain and growth rate than Aigamo crossbreds when fed a commercial grower ration and Lucerne meal mixture (90:10) and an experimental diet containing barley based feed, tofu cake, and fish silage in 70:20:10 ratio. The results showed that there was breed difference and better adaptability to tofu cake and fish silage.

2.3 EGG PRODUCTION

Avens *et al.* (1980) studied the egg production and efficiency of feed conversion in Khaki Campbell ducks under individual cage and in floor pens with

4 ducks per pen which were fed layer ration in pelleted form having 18 per cent CP and 11.4 MJ ME. The mean egg production reported was 95.3 in cage and 86.6 in floor rearing in 20 weeks study.

Reddy *et al.* (1981) studied the protein and energy requirements of Khaki Campbell layer ducks from 21-52 weeks age on feeding a layer diet containing 19 per cent crude protein and 2400 K Cal ME / kg diet and reported egg production of 69.1 per cent with 154.8 eggs per duck.

Andrews *et al.* (1984) reported duck day egg production of 14.9 per cent under intensive and 12.6 per cent under semi-intensive system of management in desi layer ducks.

Eswaran *et al.* (1985) studied the comparative performance of Khaki Campbell and Desi ducks and reported the egg production of 60.16 per cent in Khaki Campbell ducks and 51.66 per cent in Desi ducks up to 280 days of age.

Krogdahl (1985a) observed drop in egg production rate in layers in the ninth period, fed with 40 per cent fish viscera silage but laying rate as well as total egg production was similar at 20 percent levels of both silage fed and fish meal included reference diets in chicken.

Narahari and Sundararasu (1988) studied the relative performance of ducks fed wet and dry mash in desi and Khaki Campbell ducks. Wet mash was given by adding water at 3:1 ratio in dry mash from 21 to 40 weeks of age and reported no significant difference in production traits in ducks relating to two types of feeding system.

Baruah *et al.* (1991) studied the egg production performance of ducks with indigenous Pati, Khaki Campbell and their crosses under semi-intensive farm conditions of Assam and reported gradual increase in egg production from first to fourth period in the eight 28-day laying period with rate of egg production per duck ranging from 3.45 to 9.41 eggs per period.

Ochetim (1992) reported that the total egg production was 225 with meat cum bone meal diet and 226 with local fish waste meal diet in layer chicken.

Apllegate *et al.* (1998) reported peak egg production in Pekin ducks between 28 and 30 weeks of age.

Das *et al.* (2000) found that egg production in Desi, Khaki Campbell and their crosses were 19.45, 71.98 and 34.20 per cent respectively.

Kjos *et al.* (2001) reported that egg production was not affected by control diet or one of four diets containing 50 g / kg, fish silage and different levels of fish fat in laying hens. At 16.8 and 24.8 g / kg fish fat, there was decrease in egg production and hen day egg production.

Ravi (2002) registered duck housed number of 86.1 eggs with 4 and 0.6 Ca and AP and 64.8 eggs in 3.5 and 0.6 Ca and AP combinations from 21 to 40 weeks of age in indigenous layer ducks.

Anon (2004a) reported overall mean egg number of 80.64 and mean per cent production of 57.6 in Kuttanad ducks under cage system of rearing from 21 to 40 weeks of age.

2.4 FEED CONSUMPTION

Vedhanayagam *et al.* (1976) replaced fish meal at 0, 7 or 10 per cent level with fish silage in White Leghorn chick rations and increased feed consumption was reported in silage fed groups.

Andrews *et al.* (1984) observed average daily feed consumption of 191 g under intensive system and 185 g under semi-intensive system of management in indigenous ducks from 21 to 44 weeks of age.

Easwaran *et al.* (1985) reported feed consumption in six, 28 day laying period in Khaki Campbell (KC) ducks. The mean daily feed consumption in Khaki Campbell ducks was 177-179 g and in Desi ducks it was 181-184 g per day.

Gajendran *et al.* (1990) stated that the mean daily feed consumption was 155 g in desi ducks and 165 g in Khaki Campbell ducks from 21 to 40 weeks of age.

Baruah *et al.* (1991) reported that the average daily feed consumption for Indigenous ducks, Khaki Campbell ducks and their crosses were 190.06, 174.29 and 178.01 g respectively.

Ochetim (1992) reported that the feed intake in broilers up to 7 week of age was 4.35 kg with meat cum bone meal diet and 4.35 kg with local fish waste meal diet and the average daily feed consumption was 112 g in both meat and bone meal and local fish waste meal diets.

Raj *et al.* (1996) studied the effect of fermented fish and poultry offal inclusion in broiler chicken diets . Control diet had fish meal at 8 per cent and test diets had 50 per cent fish meal replaced by fermented fish viscera silage and poultry intestine silage. Feed consumption was 19.4 per cent and 16.7 per cent more than that of control in fermented fish viscera silage and poultry intestine silage respectively.

Kjos *et al.* (2000) prepared ration using fish silage from slaughter byproducts of farmed salmon and reported greater feed intake in broiler chicken fed fish silage.

Kjos *et al.* (2001) used concentrated defatted fish silage and fish fat to study the performance and egg quality of laying hens and reported that feed intake were not affected by control diet or one of four diets containing five percent and different levels of fish fat. They found that there was decrease in feed intake at 16.8 and 24.8 g / kg , fish fat.

Ravi (2002) reported mean daily feed consumption of 143.8 g per duck with 8 per cent fish meal and Ca and available Phosphorous (AP) at 4 and 0.6 per cent in the layer diet.

Reddy *et al.* (2004) reported that fish meal at 0, 4.45, 8.89 and 13.34 per cent levels with squilla meal did not affect the feed consumption in broilers.

2.5 FEED CONVERSION EFFICIENCY

Avens *et al.* (1980) observed mean FCR of 3.0 in either type of individual cage and floor system of management in Khaki Campbell layer ducks.

Reddy *et al.* (1981) reported feed conversion ratio of 2.23 at 17 per cent CP and 2700 Kcal ME per kg diet and 2.42 at 19 per cent CP and 2700 Kcal ME per kg diet in Khaki Campbell layer ducks from 21 to 52 weeks of age.

Andrews *et al.* (1984) recorded feed efficiency of 19.5 and 22.7 under intensive and semi-intensive system of management of desi ducks.

Eswaran *et al.* (1985) reported FCR as feed consumed for production of one kg eggs in Desi ducks was 13.54 ± 8.85 and for Khaki Campbell ducks it was 11.68 ± 4.77 from 21 to 44 weeks age.

Machin *et al.* (1990) reported that the feed conversion ratios in broilers were 97 and 103 per cent of the gain in the group fed high oil fish silage (HOFS) whereas the FCR was 101 and 99 per cent of the gain in the low oil fish silage (LOFS) fed group.

Gajendran *et al.* (1990) reported that the mean daily feed consumption was 155 g in desi ducks and 165 g in Khaki Campbell ducks. Feed required to produce one dozen egg was 4.883 kg in desi ducks and 10.049 kg in Khaki Campbell ducks under deep litter system of rearing on feeding a layer ration containing 13 per cent CP and 2475 K Cal ME / kg from 21-40 weeks of age.

Nwokola and Sim (1990) did a comparative evaluation of fermented fish waste, fermented whole herring and fish meal by incorporating them at 5-10 per cent levels into a balanced diet of broiler chicks. Feed to gain ratio reported was 2.05 for fermented herring fed group and was the highest among the three fish products tested.

Baruah *et al.* (1991) reported that feed conversion ratio of Indigenous ducks, Khaki Campbell ducks and their crosses were 10.87, 5.01 and 6.91 respectively during the study from 21 to 48 weeks of age.

Epse *et al.* (1992) observed no significant difference in weight gain when Herring offal silage replaced fish meal protein at 0, 5, 10, 20, 30 and 40 per cent levels in White Leghorn cockerel diets.

Ochetim (1992) reported that in layer chicken, feed to gain ratio was 2.25 and 2.16 in meat cum bone meal and local fish waste meal diet but did not differ significantly (P>0.05) and reported that the feed conversion ratio per kg eggs for meat cum bone meal basal diets was 1.99 kg and that for local fish waste meal was 1.91 but did not differ significantly (P>0.05).

Raj *et al.* (1996) reported feed conversion ratio was better in silage diets with 2.12 for fish viscera silage, 2.27 for poultry intestine silage and 2.65 for fish meal diet in broiler chicken.

Ravi (2002) recorded FCR per dozen eggs and FCR per kg egg mass at 2.4 and 3.6 respectively in indigenous layer ducks.

Anon (2004a) recorded mean value for feed conversion ratio per dozen eggs at 3.6±0.26 under intensive system in Kuttanad ducks.

2.6 EGG WEIGHT

Reddy *et al. (1981)* reported egg weight of *59.38*, *60.67* and *56.68* g when dietary CP was fixed at graded levels of 15, 17, and 19 per cent respectively in Khaki Campbell ducks.

Andrews *et al.* (1984) reported mean egg weight of 60.4 g under intensive and 60.7 g under semi-intensive system of management of desi layer ducks.

Eswaran *et al. (1985)* reported egg weight of *71.40 ± 0.95 g in Desi and* 62.41 ± 0.50g in Khaki Campbell ducks.

Krogdahl (1985a) replaced reference diets having fish meal at 0, 20 and 40 per cent levels with concentrate fish silage in White Leghorn layers and observed no significant difference in egg weight.

Mahanta *et al.* (1993) reported mean values for egg weight in indigenous Pati ducks at 60.55 ± 0.29 and 56.44 ± 0.38 g for Khaki Campbell duck eggs. Pati ducks had significantly higher egg weight (P< 0.01).

Mohan (1999) reported that replacing fish meal protein in layer chicken ration at 0, 25, 50, 75 and 100 per cent levels with squilla meal did not affect egg weight.

Ravi (2002) reported the overall mean egg weight of 57.3 g with 3.0 and 0.6 per cent Ca and AP whereas it was 61.5 g with 4 and 0.6 per cent Ca and AP combinations in layer duck diets.

Anon (2004a) recorded mean egg weight of 57.42±1.50 g from 21 to 40 weeks of age in Kuttanad ducks under intensive system of rearing.

2.7 EGG QUALITY

Reddy *et al.* (1981) reported significantly higher mean shell thickness (0.42 mm) and it was higher ($P < 0.01$) in group fed 2.75 per cent Ca and 0.54 per cent P with CP of 15 per cent.

Eswaran *et al.* (1985) reported shell thickness of 0.36 ± 0.004 mm in eggs of Desi ducks and 0.38 ± 0.007 in Khaki Campbell ducks.

Mahanta *et al.* (1993) studied the physical quality of indigenous and Khaki Campbell duck eggs. Mean values for albumen index, yolk index, shell thickness and percent shell for indigenous Pati ducks were 0.114 ± 0.002, 0.42 ± 0.004, 0.34 ± 0.004, 12.6 ± 0.10 and for Khaki Campbell were 0.115 ± 0.003, 0.391 ± 0.005, 0.328 ± 0.004, 12.01 ± 0.13 respectively. Significant differences were noticed in yolk index and shell thickness.

Mohan (1999) observed that except in yolk index and yolk colour egg quality parameters were not significantly affected when squilla meal protein was fed to layer chicken.

Kjos *et al.* (2001) concluded that fatty acid composition, yolk color and sensory quality of eggs were not effected by using concentrated defatted fish silage and fish fat in laying hens. There was increased yolk color index and the linear relationship between dietary fish fat level and increased off taste intensity in egg yolk was observed.

Reddy *et al.* (2004) reported that no specific trends were observed in egg quality parameters when White Leghorn layers were fed with squilla meal.

2.8 BIOCHEMICAL PARAMETERS

Surendranathan (1966) reported that serum Calcium level was 19.94 ± 0.940 mg/ dl and serum Phosphorus level was 8.47 ± 0.44 mg / dl in indigenous laying ducks. The plasma protein in adult males was 4.65 ± 0.19 mg / dl and in adult non laying female duck was 5.00 ± 0.14 mg / dl.

Peethambaran (1991) reported the serum protein in duckling fed with a diet having crude protein 17 per cent and energy 2600 ME Cal /kg at 3.090,3.860 and 2.416 mg / dl at 5,8 and 10 weeks of age respectively.

Ravi (2002) reported serum Calcium level at 15.4 mg / dl and serum Phosphorus level at 3.2 mg / dl in indigenous laying ducks.

2.9 LIVABILITY

Johnson *et al.* (1985) fed acid fish silage and fermented fish silage at 0, 2.5, 5 and 10 per cent levels and observed no significant difference in livability and was comparable with 5 per cent fish meal included group.

Ochetim (1992) reported that no significant difference in livability were observed in both broilers and layers fed with locally available fish waste meal that replaced meat cum bone meal.

Ahmed and Mahendrakar (1996b) included fish silage at 25 and 50 per cent levels as replacement for per cent fish meal on isocaloric and isonitrogenous basis in broiler ration. Mortality of 10 per cent with fish meal diet while 15 and 12.5 per cent mortality respectively in 25 and 50 per cent fish fed silage groups were noticed.

Ravi (2002) reported 100 per cent livability in chara and chemballi ducks under intensive system of management from 21 to 40 weeks of age

2.10 ECONOMICS

Vedhanayagam *et al.* (1996) included fish silage at 7 and 10 per cent levels in experimental diets replacing fish meal and control group had fish meal at 10 per cent level and reported that feed efficiency was better in fish silage fed groups in broiler chicken. They concluded that the feed cost per kg gain in body weight was lower in 7 and 10 per cent trash fish silage diets than 10 per cent fish meal diet.

Mohan (1999) replaced fish meal at 0, 25, 50 and 100 per cent levels with squilla meal in egg type chicken and observed that cost of feed per egg in fish meal and 25 per cent replacement groups was 79 paise. Economic loss was noticed at other inclusion levels.

Sakthivel (2003) fed diets containing dried cuttle fish waste silage in growing and finishing swine replacing dried fish at 50 and 100 per cent levels on protein basis and found that there was no adverse effects. The cost of feed per kilogram gain was lower in cuttle fish waste silage fed groups.

3. MATERIALS AND METHODS

An experiment was conducted at the Department of Poultry Science, Kerala Agricultural University to examine the feasibility of incorporation of dried 'cuttle fish waste silage' (CFWS) in duck layer rations by partial and complete replacement of unsalted dried fish and to evaluate the economics of feeding dried CFWS in the diets of layer ducks. The experiment was carried out in Kuttanad ducks during the period from May through November 2004.

Ninety six (96) layer ducks, at 24 weeks of age, were housed in 48 cages at the rate of two ducks per cage in a well-ventilated poultry house. The dimensions of the cages were 60 x 45 x 40 cm. Floor area of 1350 cm^2 per duck was provided during the experiment. At 24 weeks of age, the body weight of ducks was recorded individually.

The dried 'cuttle fish waste silage' was procured from Central Institute of Fisheries Technology (CIFT) Kochi, Kerala. The chemical composition of dried CFWS is presented in Table 1 as described by AOAC(1990). The experimental rations were formulated as outlined in Table 2 by adding dried CFWS at the rate of 0, 11.45 and 22.9 per cent in diets T1, T2 and T3 respectively.

Table 1. Chemical composition of dried cuttle fish waste silage on dry matter basis, percentage

Components	Per cent
Dry matter	90.03
Crude protein	22.21
Ether extract	2.75
Crude fibre	16.44
Total ash	17.62
NFE	40.98
Acid insoluble ash	7.51
Calcium	0.43
Phosphorus	1.62

Table 2. Composition of experimental diets, per cent

Ingredients	T 1	T 2	T 3
Yellow maize	48.00	39.55	35.00
Wheat bran	14.00	14.00	10.00
Soybean meal	14.00	16.00	17.00
Gingelly oil cake	5.00	5.00	6.10
Dried fish	10.00	5.00	0.00
Cuttle fish waste silage (CFWS)	0.00	11.45	22.90
Shell grit	7.00	7.00	7.00
Mineral mixture	1.75	1.75	1.75
Salt	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated values			
1. ME kcal/kg	2647.90	2643.30	2642.60
2. Calcium, per cent	4.11	3.81	3.52
3. Phosphorus, per cent	0.51	0.62	0.70
Analysed values			
1.Crude Protein, per cent	18.14	18.16	18.13
2.Crude fibre, per cent	4.29	5.72	6.65
Supplements			
1.Indomix(A, B_2, D3),g *	20	20	20
2.Alusil Premix,g **	200	200	200
3.Niacin,g	6.0	6.0	6.0

* *Indomix A, B_2, D3 (Nicholas Primal India Ltd, Mumbai) containing Vit A 40000 IU, Vit B_2 20 mg, Vit D_3 5000 IU per gm was added to 100 kg diet*

** *Alusil Premix (Stallen South Asia Pvt. Ltd) containing SiO_2 400-500 g, Al_2O_3 320-400 g, Fe_2O_3 3-10 g, MgO 5-20 g, CaO 30-50 g, Na_2O 25-45 g K_2O 5-10 g and inert ingredients made up to 1000 g was added to 100 kg diet*

The ducks were divided into three treatment groups T1, T2 and T3 consisting of 32 ducks in each treatment group. Each treatment consisted of eight replicates with four ducks in each replicate. The group T1 was fed a control diet containing 10 per cent dried fish (DF) contributing 5.08 per cent crude protein from dried fish alone. The second group, T2 was fed with a ration containing 5 per cent dried fish plus 11.45 per cent of dried CFWS contributing 2.54 per cent crude protein each from dried fish and dried CFWS. The third group T3 was fed with a ration containing 22.9 per cent dried CFWS contributing 5.08 per cent crude protein from CFWS alone thereby dried fish was replaced completely. The feed ingredients used in the ration were analysed for proximate composition.

The experimental diets were formulated isocaloric and isonitrogenous with 18 per cent crude protein and 2650 ME kcal /kg. The experimental feed was given from 25 to 44 weeks of age as wet mash two times daily and water was provided *ad lib* .The routine management practices were followed throughout the experimental period.

The experiment consisted of five periods of 28 days from 25 to 44 week of age. Individual body weights were recorded at the end of experiment at 44 weeks of age to observe the changes in body weight under the different feeding regime.

Daily egg production under different treatment groups was recorded during the entire experimental period. From these data, duck-housed and duck-day egg production number and per cent were calculated for each period. Feed intake was measured replicatewise and treatmentwise at the end of each fortnight and was calculated as mean daily feed consumption per duck in each replicate and treatment, fortnightly. Feed conversion ratios (FCR) were calculated based on egg number as well as egg mass and represented as FCR per dozen eggs and per kilogram egg mass.

The mean egg weight in each treatment was arrived at based on the individual egg weight recorded daily. From these data, the mean egg weight and total egg mass per duck per fortnight and per period was determined in each treatment.

During the last three consecutive days of each 28 day period, five eggs from each replicate were selected at random for egg quality studies. The eggs were weighed and broken to study albumen and yolk indices, shell weight and shell thickness. Albumen and yolk indices were estimated using Ame's tripod stand micrometer and shell thickness was determined using Ame's shell thickness measuring gauge. The per cent shell was calculated based on the corresponding egg weight.

At the end of 44th week, eight ducks from each treatment group were selected at random for estimation of calcium (Ca) and phosphorus (P) and protein in the serum. The estimation of serum Ca was carried out using Atomic Absorption Spectrophotometer (AAS) after diluting with 0.1 per cent lanthanum and serum inorganic phosphorus was determined by using phosphomolybdate kit. The serum protein was estimated by Direct Biuret method using kit.

Economics of egg production using dried cuttle fish waste silage in layer duck ration replacing unsalted dried fish was calculated taking in to account the feed cost, egg production, egg mass and FCR.

The data collected were subjected to statistical analysis as per Snedecor and Cochran (1985).

4. RESULTS

4.1 BODY WEIGHT

The mean body weight at 24 and 44 weeks of age in indigenous layer ducks fed various levels of dried cuttle fish waste silage (CFWS) is presented in Table 3. The results indicated that mean body weight at 24 weeks of age in groups T1, T2 and T3 were 1476 ± 22.25, 1453 ± 25.44 and 1492 ± 20.64 g respectively and the mean values were statistically comparable with each other. The group T1 was fed the diet containing 10 per cent dried fish without the addition of dried CFWS. Hence, in Tables, the diet T1 is indicated as zero per cent inclusion of dried CFWS and diet T2 contained 5.0 per cent dried fish plus 11.45 per cent dried CFWS replacing 50 per cent protein from dried fish and this diet T2 was indicated by 11.45 per cent CFWS inclusion and diet T3 was indicated by 22.9 per cent CFWS inclusion completely replacing dried fish in the diet.

In groups fed 0, 11.45 and 22.9 per cent dried CFWS, the mean body weight at 44 weeks of age were 1406 ± 32.07, 1387 ± 23.72 and 1423 ± 18.10 g and the differences between the mean values did not differ significantly among each other. In all the groups fed dried fish and that fed dried CFWS by partial and complete replacement of dried fish, a reduction in body weight at 44 weeks of age was noticed to the tune of 70, 66 and 69 g in T1, T2 and T3 respectively in comparison with the body weight at 24 weeks of age.

4.2 AGE AT SEXUAL MATURITY

The results pertaining to sexual maturity traits such as average and absolute values of age at first egg (AFE) in the flock and absolute values of age at

10 and 50 per cent production are presented in Table 3 and and the absolute values are depicted in Fig.1.

4.2.1 Age at First Egg (AFE) in the Flock

The results revealed that the age at first egg in the flock in groups fed dried fish (T1) and that fed 5 per cent dried fish plus 11.45 per cent dried CFWS was 169 days while that fed 22.9 per cent dried CFWS was 180 days (Table 3) indicating very late sexual maturity in group T3. The mean age at first egg in T1, T2 and T3 were 184.87, 186.06 and 190.25 days respectively, showing delayed maturity in group T3 fed 22.9 per cent dried CFWS in the diet.

4.2.2 Age at 10 Per cent Production

The absolute value of age at 10 per cent production in the groups fed 0, 11.45, and 22.9 per cent dried CFWS were 180, 182 and 181 days respectively, lowest being in the control group.

4.2.3 Age at 50 Per cent Production

The absolute value of age at 50 per cent production in the groups fed 0, 11.45 and 22.9 per cent dried CFWS were 194, 197 and 198 days respectively and was early in the control group.

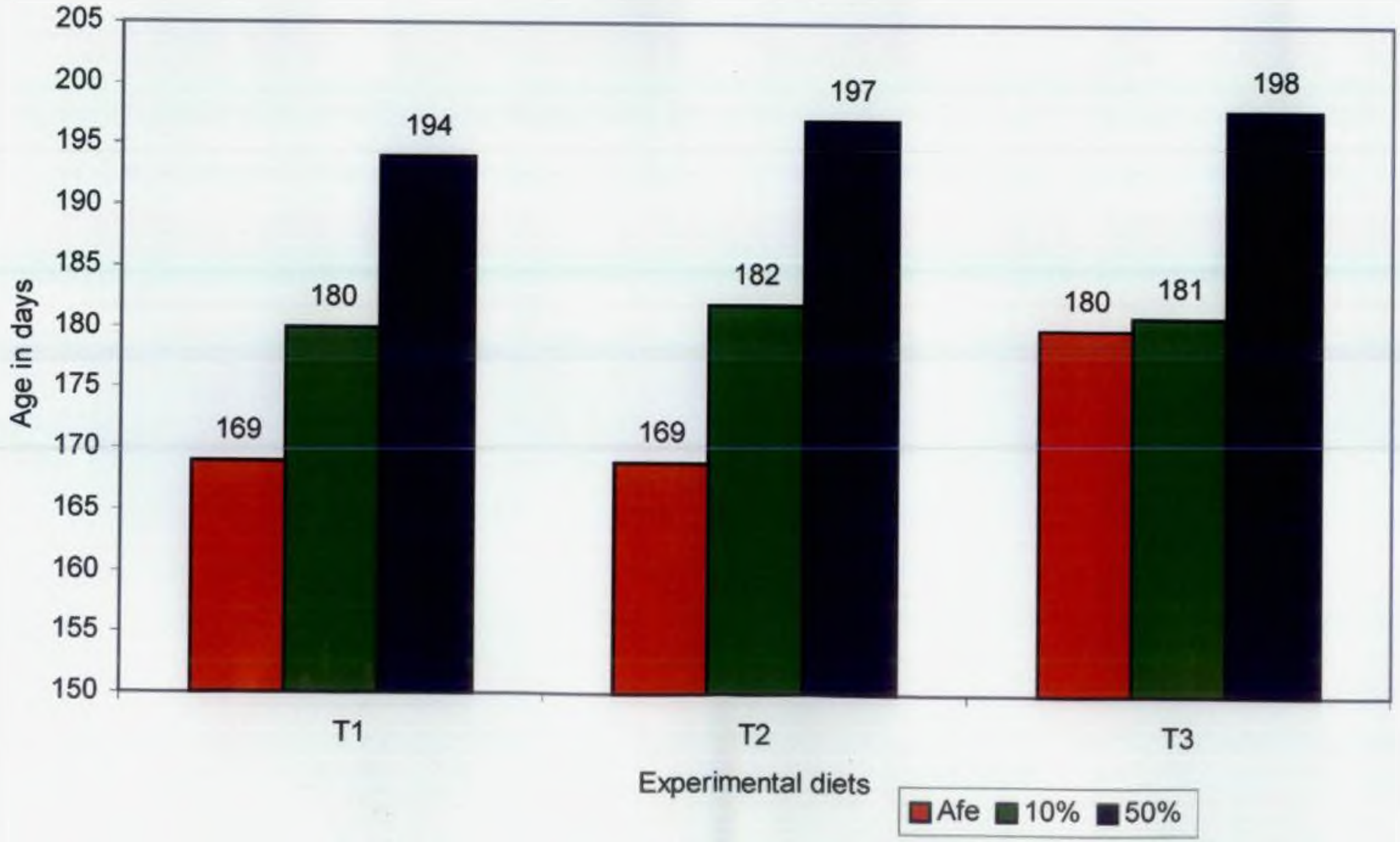
4.3 EGG PRODUCTION

The mean egg production per duck on duck housed basis is presented in Tables 4 and 5 and that on duck day basis is presented in Tables 6 and 7.

Table 3. Mean body weight (g), age at first egg and ages at 10 and 50 per cent production (in days) influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration.

Parameter	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
Mean BW at 24 weeks	1476 ± 22.25	1453 ± 25.44	1492 ± 20.64
Mean BW at 44 weeks	1406 ± 32.07	1387 ± 23.72	1423 ± 18.10
Age at first egg (days)	169	169	180
Mean age at first egg (days)	184.87	186.06	190.25
Age at 10 % prodn. (days)	180	182	181
Age at 50 % prodn. (days)	194	197	198

Fig. 1. Age at first egg ,ages at 10 and 50 per cent production influenced by dried cuttle fish waste silage in layer duck ration



4.3.1 Duck Housed Number (DHN)

The mean egg number per duck on duck housed basis represented as duck housed number (DHN) in various fortnights and the overall DHN per duck during the entire period from 25 to 44 weeks of age as influenced by incorporation of dried cuttle fish waste silage (CFWS) in the diets are presented in Table 4.

The mean DHN in the first fortnight at 25-26 weeks of age in groups T1, T2 and T3 were 1.03 ± 1.15, 1.09 ± 0.73 and 0.34 ± 0.16 eggs respectively. In the control group (T1), the DHN was increased from 1.03 ± 1.15 to 4.47 ± 0.73 eggs (second fortnight) at 27-28 weeks of age and further increased to 10.22 ± 0.54 and 10.22 ± 0.41 eggs in fortnights at 29-30 and 31-32 weeks of age.

The pattern of egg production in the CFWS fed groups in the second, third and fourth fortnights were 4.13 ± 0.90, 9.34 ± 0.64 and 8.84 ± 0.80 eggs in T2 and 3.28 ± 0.78, 9.06 ± 0.82 and 9.14 ± 0.67 eggs in T3 at 27-28, 29-30 and 31-32 weeks respectively.

The fortnightly egg production was the highest at 33-34 weeks of age with average DHN of 11.31 ± 0.26, 10.13 ± 0.95 and 10.06 ± 0.37 eggs per duck in groups T1, T2 and T3 respectively. Subsequently, a gradual decline in egg production was observed in all groups and the DHN were 8.87 ± 0.83, 6.81 ± 0.53 and 6.16 ± 0.70 eggs in T1, 9.16 ± 0.50, 7.03 ± 0.60 and 5.69 ± 0.83 eggs in T2 and 9.03 ± 0.43, 6.94 ± 0.56 and 5.44 ± 0.49 eggs in T3 at fortnights 35-36, 37-38 and 39-40 weeks respectively. The results also revealed that the fortnightly mean egg number did not differ significantly between control group and fish silage fed groups in any of the fortnights from 25 to 40 weeks of age.

Whereas, the fortnightly egg production showed significantly higher ($P<0.05$) DHN in the control group than those of CFWS fed groups in both fortnights at 41- 42 and 43-44 weeks of age. The depression in egg production

Table 4. Fortnightly and overall mean duck housed number (DHN) as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Age in weeks	Dried cuttle fish waste silage (%)in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	1.03±1.15	1.09±0.73	0.34±0.16
27-28	4.47±0.73	4.13±0.90	3.28±0.78
29-30	10.22±0.54	9.34±0.64	9.06±0.82
31-32	10.22±0.41	8.84±0.80	9.14±0.67
33-34	11.31±0.26	10.13±0.95	10.06±0.37
35-36	8.87±0.83	9.16±0.50	9.03±0.43
37-38	6.81±0.53	7.03±0.60	6.94±0.56
39-40	6.16±0.70	5.69±0.83	5.44±0.49
41-42	7.53± 0.58 [a]	5.03±0.60 [b]	5.06±0.46 [b]
43-44	8.44±0.44 [a]	6.81±0.48 [b]	5.37±0.61 [b]
Overall	75.06±0.97	67.25±0.89	63.72±0.97

Mean values bearing same superscripts within the row did not differ significantly (P<0.05)

after peak showed an increasing trend during the period 41-44 weeks in the control group. At these ages, the fortnightly mean DHN were 7.53 ± 0.58 and 8.44 ± 0.44 eggs in the control group fed diet containing 10 per cent dried fish (T1) showing slight increase in egg production compared to previous fortnight.

In the cuttle fish waste silage fed groups, the DHN were comparable between T2 and T3 and the mean DHN at 41- 42 and 43-44 weeks of age were 5.03 ± 0.60 and 6.81 ± 0.48 eggs in T2 and 5.06 ± 0.46 and 5.37 ± 0.61 eggs in T3 respectively, both were lower than those in control group. The increase in egg production in groups T2 and T3 was observed only at fortnight 43-44 weeks of age.

The overall egg production per duck during the entire period from 25 to 44 weeks of age was 75.06 ± 0.97, 67.25 ± 0.89 and 63.72 ± 0.97 eggs in the groups fed 0, 11.45 and 22.9 per cent CFWS respectively. However, the cumulative DHN did not differ significantly ($P<0.05$) between the groups fed diets containing dried fish and dried CFWS. But there was a numerical increase in egg production in the control group fed 10 per cent dried fish without the addition of dried CFWS. The overall mean production in groups T1, T2 and T3 is depicted in Fig. 2.

4.3.2 Duck Housed Per cent (DHP) Production

The per cent production on duck housed basis is presented as duck housed per cent (DHP) production in fortnightly periods in Table 5.

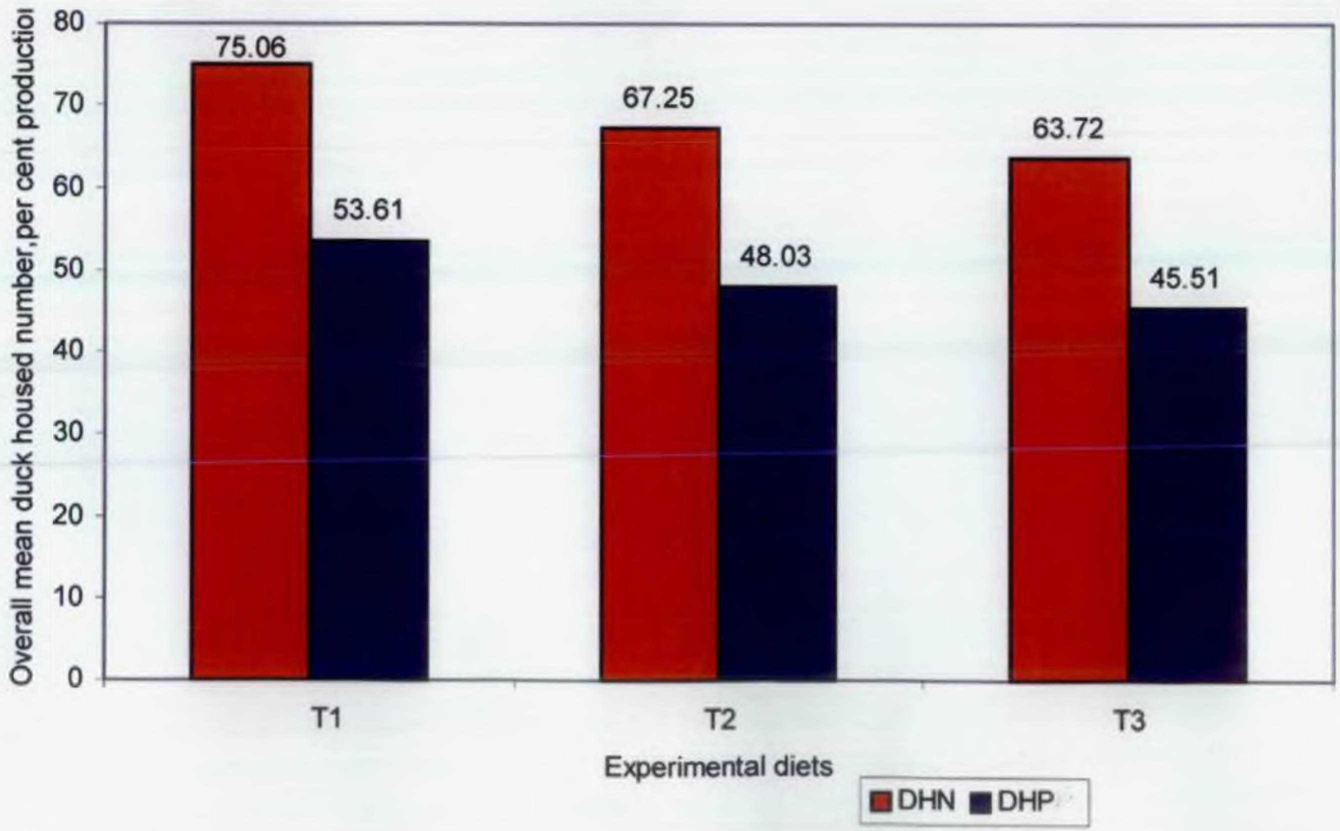
Results revealed that the initial egg production during the first fortnight at 25-26 weeks, the mean DHP in groups T1, T2 and T3 were 7.35 ± 8.22, 7.78 ± 5.23 and 2.43 ± 1.19 per cent respectively. In the control group (T1), the DHP was increased from 7.35 ± 8.22 to 31.92 ± 5.27 per cent (second fortnight) at 27-28 weeks of age and further increased to 72.99 per cent in both fortnights at

Table 5. Fortnightly and overall mean duck housed per cent (DHP) production as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Age in weeks	Dried cuttle fish waste silage (%)in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	7.35±8.22	7.78±5.23	2.43±1.19
27-28	31.92±5.27	29.46±6.41	23.44±5.60
29-30	72.99±3.92	66.74±4.60	64.73±5.89
31-32	72.99±2.93	63.17±5.71	65.18±4.82
33-34	80.80±1.90	72.32±6.78	71.88±2.67
35-36	63.39±5.93	65.40±3.60	64.51±3.08
37-38	48.66±3.78	50.22±4.33	49.55±4.02
39-40	43.97±4.94	40.63±5.94	38.84±3.51
41-42	53.79±4.12 ^{a}	35.94±4.27 ^{b}	36.16±3.34 ^{b}
43-44	60.27±3.14 ^{a}	48.66±3.40 ^{b}	38.39±4.36 ^{b}
Overall	53.61±6.95	48.03±6.36	45.51±6.95

Mean values bearing same superscripts within the row did not differ significantly ($P<0.05$)

Fig. 2 . Overall mean duck housed number (DHN) and per cent (DHP) production (25 to 44 weeks) influenced by dried cuttle fish waste silage in layer duck ration



29-30 and 31-32 weeks of age. From this level, the DHP was increased to 80.80 ± 1.90 per cent at 33 -34 weeks of age registering the peak production in the control group. Thereafter the DHP declined to 63.39 ± 5.93 per cent at 35-36 weeks of age. Afterwards, there was a drastic decline to 48.66 per cent at 37-38 weeks and 43.97 ± 4.94 per cent at 39-40 weeks of age.

The DHP was increased to 53.79 ± 4.12 per cent at 41-42 weeks and further increased to 60.27 ± 3.14 per cent during 43-44 weeks of age in the control group fed diet containing 10 per cent dried fish (T1).

In the CFWS group fed diet containing 5 percent DF plus 11.45 per cent CFWS, the initial production in the first fortnight was 7.78 ± 5.23 per cent at 25 to 26 weeks of age. This was increased gradually to 29.46 ± 6.41 and 66.74 ± 4.60 per cent which declined to 63.17 ± 5.71 per cent and reached a peak production of 72.32 ± 6.78 per cent at 33-34 weeks of age. Thereafter, there was decline in egg production to 65.40 ± 3.60, 50.22 ± 4.33, 40.63 ± 5.94 and 35.94 ± 4.27 per cent at 35-36, 37-38, 39-40 and 41-42 weeks of age respectively, lowest being at 41-42 weeks of age. This again registered an increase to 48.66 ± 3.40 per cent at 43- 44 weeks of age.

In the group (T3) fed diet containing 22.9 per cent CFWS, the initial egg production in the first fortnight was very low at 25-26 weeks of age (2.43 ± 1.19 per cent). This was increased gradually to 23.44 ± 5.60, 64.73 ± 5.89,65.18 ± 4.82 percent at 27-28, 29-30, 31-32 weeks respectively and recorded the peak production of 71.88 ± 2.67 per cent at 33-34 weeks of age. After peak production, there was a fall in DHP to 64.51 ± 3.08, 49.55 ± 4.02, 38.84 ± 3.51 and 36.16 ± 3.34 per cent at 35-36, 37-38, 39-40 and 41-42 weeks of age respectively which increased to 38.39 ± 4.36 per cent at 43- 44 weeks of age.

There was significantly higher egg production in the control group ($P<0.05$) in the last two fortnights (41-42 and 43- 44 weeks) in comparison with those recorded at the respective ages in the dried cuttle fish waste silage fed groups.

The overall egg production from 25 to 44 weeks of age was 53.61 ± 6.95, 48.03 ± 6.36 and 45.51 ± 6.95 per cent in T1, T2 and T3 respectively and the differences between the mean values did not differ significantly ($P<0.05$) between the treatment groups.

The overall mean duck housed per cent production is depicted in Fig.2.

4.3.3 Duck Day Number (DDN)

The egg number on duck day basis presented in Table 6 indicated that the mean values of DDN were the same as that presented in Table 4 since there was no mortality in groups T1 and T2 till 44 weeks of age. In the group T3, one duck died at 35 weeks of age and hence the values of DDN were the same as that presented in Table 4 upto the fortnight 33-34 weeks of age. Therefore, in group T3, the fortnightly DDN values were higher than the respective DHP values at 35-44 weeks of age.

The mean duck day number (DDN) in the group T3 was 9.28 ± 0.42, 7.16 ± 0.55, 5.61 ± 0.48, 5.22 ± 0.45 and 5.55 ± 0.60 eggs in the fortnights at 35-36, 37-38, 39-40, 41-42 and 43-44 weeks of age respectively. There was no significant difference in duck day egg production between T1, T2 and T3. The corresponding mean DHN in T3 were 9.03 ± 0.43,6.94 ± 0.56, 5.44 ± 0.49, 5.06 ± 0.46 and 5.37 ± 0.61 eggs per fortnight.

4.3.4 Duck Day Per cent (DDP) Production

The values on duck day per cent (DDP) production presented in Table 7 is same as that of duck housed per cent (DHP) production presented in Table 5

Table 6. Fortnightly and overall mean duck day number (DDN) as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	1.03±1.15	1.09±0.73	0.34±0.16
27-28	4.47±0.73	4.13±0.90	3.28±0.78
29-30	10.22±0.54	9.34±0.64	9.06±0.82
31-32	10.22±0.41	8.84±0.80	9.14±0.67
33-34	11.31±0.26	10.13±0.95	10.06±0.37
35-36	8.88±0.83	9.16±0.50	9.28±0.42
37-38	6.81±0.53	7.03±0.60	7.16±0.55
39-40	6.16±0.70	5.69±0.83	5.61±0.48
41-42	7.53± 0.58 [a]	5.03±0.60 [b]	5.22±0.45 [b]
43-44	8.44±0.44 [a]	6.81±0.48 [b]	5.55±0.60 [b]
Overall	75.06±0.97	67.25±0.89	64.70±0.98

Mean values bearing same superscripts within the row did not differ significantly (P<0.05)

Table 7. Fortnightly and overall mean duck day per cent (DDP production as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	7.35±8.22	7.78±5.23	2.43±1.19
27-28	31.92±5.27	29.46±6.41	23.44±5.60
29-30	72.99±3.92	66.74±4.60	64.73±5.89
31-32	72.99±2.93	63.17±5.71	65.18±4.82
33-34	80.80±1.90	72.32±6.78	71.88±2.67
35-36	63.39±5.93	65.40±3.60	66.28±2.98
37-38	48.66±3.78	50.22±4.33	51.14±3.89
39-40	43.97±4.94	40.63±5.94	40.07±2.76
41-42	53.79±4.12 [a]	35.94±4.27 [b]	37.28±2.92 [b]
43-44	60.27±3.14 [a]	48.66±3.40 [b]	39.64±3.87 [b]
Overall	53.61±6.95	48.03±6.36	46.21±6.97

Mean values bearing same superscripts within the row did not differ significantly (P<0.05)

except from 35 to 44 weeks of age in the groups fed 22.9 per cent dried CFWS since there was one mortality in this group at 35 weeks of age.

From 35 weeks onwards, in the group fed 22.9 per cent dried CFWS in fortnights at 35-36, 37-38, 39-40, 41-42 and 43-44 weeks of age, the DDP were 66.28 ± 2.98, 51.14 ± 3.89, 40.07 ± 2.76, 37.28 ± 2.92 and 39.64 ± 3.87 per cent respectively.

The overall duck day per cent (DDP) production in the group T3 was 46.21 and the overall DDP also did not differ significantly between T1, T2 and T3.

4.4 FEED CONSUMPTION

The fortnightly mean daily feed consumption (g) presented in Table 8 revealed that in the first fortnight at 25-26 weeks of age, the feed intake per duck in T1, T2 and T3 was 154.55 ± 0.25, 154.44 ± 0.22 and 154.29 ± 0.40 g respectively and was similar in all the three groups fed diet containing 10 per cent dried fish (T1), that fed 5 percent DF plus 11.45 per cent dried CFWS (T2) and the group fed diet containing 22.9 per cent dried CFWS (T3).

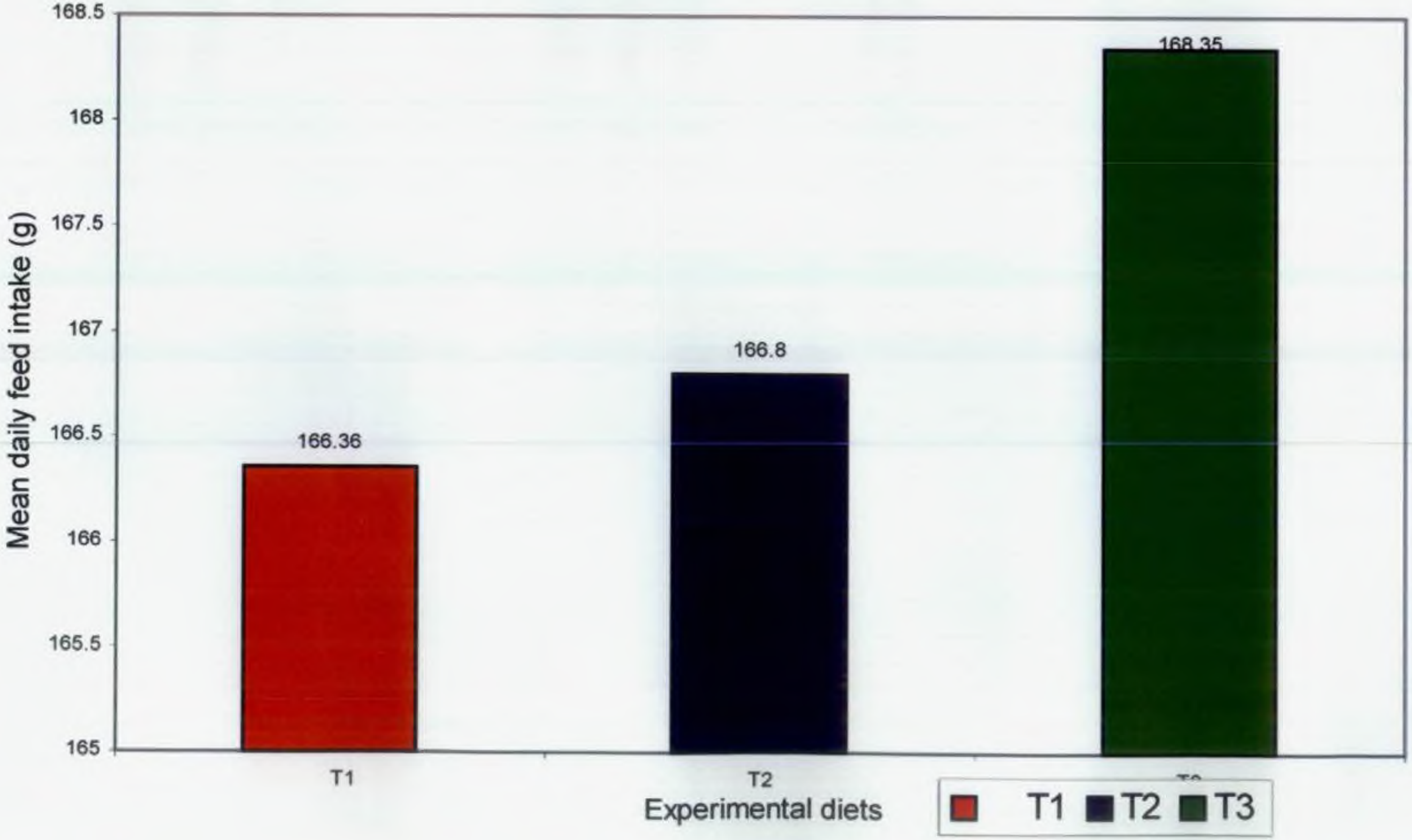
In the control group there was slight increase in feed consumption to 155.56 ± 0.42, 157.05 ± 0.50 and 157.52 ± 0.61 in the second, third and fourth fortnight respectively. It was increased to 169.84 ± 0.07 at 33 to 34 weeks of age. Subsequently the mean feed intake was 169.96 ± 0.05, 169.15 ± 0.06, and 169.78 ± 0.09 g at 35-36, 37-38 and 39-40 weeks of age respectively. Thus, the feed consumption was maintained at uniform level from 33 to 40 weeks of age. This was further increased to 179.87 ± 0.25 g and 180.27 ± 0.19 g during the end of experiment at 41to 42 and 43 to 44 weeks of age respectively.

In the dried CFWS fed groups, the feed consumption was ranged from 154.44 ± 0.22 to 180.25 ± 0.45 g in T2 and 154.29 ± 0.40 to 182.97 ± 1.43 g in

Table 8. Fortnightly and overall mean feed consumption per duck per day as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration, (g)

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	154.55±0.25	154.44±0.22	154.29±0.40
27-28	155.56±0.42	156.65±0.32	158.77±0.13
29-30	157.05±0.50	158.48±0.64	160.94±0.76
31-32	157.52±0.61	160.11±0.60	161.54±0.76
33-34	169.84±0.07	169.29±0.60	170.49±0.21
35-36	169.96±0.05	170.33±0.14	171.15±0.46
37-38	169.15±0.06	169.31±0.12	170.25±0.76
39-40	169.78±0.09	169.78±0.08	170.53±0.80
41-42	179.87±0.25	179.35±0.70	182.97±1.43
43-44	180.27±0.19	180.25±0.45	182.53±1.64
Overall	166.36±3.06	166.80±2.87	168.35±3.03

Fig .3. Overall mean daily feed intake (g) per duck per day influenced by dried cuttle fish waste silage in layer ration



T3. Almost similar trend was exhibited in groups T2 and T3 thereby the overall feed consumption and fortnightly feed consumption between the treatment groups did not differ significantly.

The overall feed consumption per duck per day during the period from 25 to 44 weeks of age was 166.36 ± 3.06, 166.80 ± 2.87 and 168.35 ± 3.03 g per day per duck in T1, T2 and T3 respectively. It is represented graphically in Fig.3.

4.5 FEED CONVERSION RATIO

The feed conversion ratio (FCR) per dozen egg is presented in Table 9 and FCR per kg egg mass is presented in Table 10.

4.5.1 Feed Conversion Ratio (FCR) per Dozen Eggs

Fortnightly feed conversion ratio per dozen eggs presented in Table 9 revealed that the ratios were very high during the 25 to 26 weeks of age since the rate of egg production was very low during this period in all treatment groups. The initial FCR recorded was 25.18 ± 22.78, 23.72 ± 10.00 and 75.14 ± 4.65 at 25-26 weeks and 7.55 ± 1.63, 10.41 ± 3.65 and 18.79 ± 7.60 at 27-28 weeks in groups fed diets containing 0, 11.45 and 22.9 per cent dried CFWS respectively.

These values during the period from 25 to 28 weeks were not used for statistical analysis.

In the control group, FCR gradually improved to 2.65 ± 0.17, 2.62 ± 0.11 and 2.53 ± 0.05 at 29-30, 31-32 and 33 to 34 weeks of age respectively, and the best FCR synchronized with the peak production was 2.53. Whereas, the best FCR of 2.96 ± 0.22 was noticed at 29-30 weeks in T2 and 2.87 ± 0.10 at 33-34 weeks in T3, the latter synchronized with its peak production. The fortnightly mean FCR values from 29 to 44 week of age were ranged from 2.96 ± 0.22 to 6.47 ± 0.60 in T2 and 2.87 ± 0.10 to 6.37 ± 0.80 in T3.

Table 9. Fortnightly and overall mean feed conversion ratio (FCR) per dozen eggs as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	25.18±22.78	23.72±10.00	75.14±4.65
27-28	7.55±1.63	10.41±3.65	18.79±7.60
29-30	2.65±0.17	2.96±0.22	3.27±0.47
31-32	2.62±0.11	3.34±0.49	3.09±0.22
33-34	2.53±0.05	3.14±0.52	2.87±0.10
35-36	3.51±0.45	3.20±0.18	3.15±0.17
37-38	4.43±0.48	4.27±0.38	4.16±0.32
39-40	5.05±0.53	5.82±0.84	5.59±0.78
41-42	4.22±0.40 [b]	6.47±0.60 [a]	6.37±0.80 [a]
43-44	3.66±0.19 [b]	4.60±0.32 [b]	6.02±0.67 [a]
Overall (29-44)	3.58±0.33	4.23±0.47	4.32±0.51

Mean values bearing same superscripts within the row did not differ significantly ($P<0.05$)

Significantly better ratios were recorded only in the fortnights at 41-42 and 43-44 weeks of age wherein the mean values at 41 to 42 weeks were significantly better in control group compared to the other two groups (4.22 ± 0.40, 6.47 ± 0.60 and 6.37 ± 0.80). At 43 to 44 weeks of age, the FCR in control group was comparable with that fed 11.45 per cent dried CFWS (3.66 ± 0.19 and 4.60 ± 0.32) and it was significantly inferior ($P<0.05$) with 22.9 per cent dried CFWS fed group (6.02 ± 0.67) in comparison with the former groups.

The overall values of FCR during the period from 29 to 44 weeks of age were 3.58 ± 0.33, 4.23 ± 0.47 and 4.32 ± 0.51 in T1, T2 and T3 respectively. The overall values did not differ each other significantly ($P<0.05$).

4.5.2 FCR per kg Egg Mass

The FCR per kg egg mass calculated in various fortnights and the overall mean FCR from 29 to 44 weeks is presented in Table 10.

In the control group, the FCR per kg egg mass was 3.56 ± 0.21, 3.38 ± 0.13 and 3.15 ± 0.10 at 29-30, 31-32 and 33-34 weeks respectively. The best FCR of 3.15 ± 0.10 synchronized with its peak production at 33-34 weeks. Significantly better FCR recorded in the control group at 41 to 42 weeks showed similar trend as that observed with per dozen eggs, but the mean FCR per kg eggs were 5.62 ± 0.46, 7.93 ± 0.76 and 7.58 ± 0.89 in T1, T2 and T3 respectively.

At 43-44 weeks of age, the FCR recorded with group (T3) fed 22.9 per cent dried CFWS (7.17 ± 0.83) was significantly inferior ($P<0.05$) in comparison with the control group. But FCR recorded with 11.45 per cent dried CFWS (T2) was intermediary (5.50 ± 0.40) and was comparable statistically with the other two groups T1 and T3.

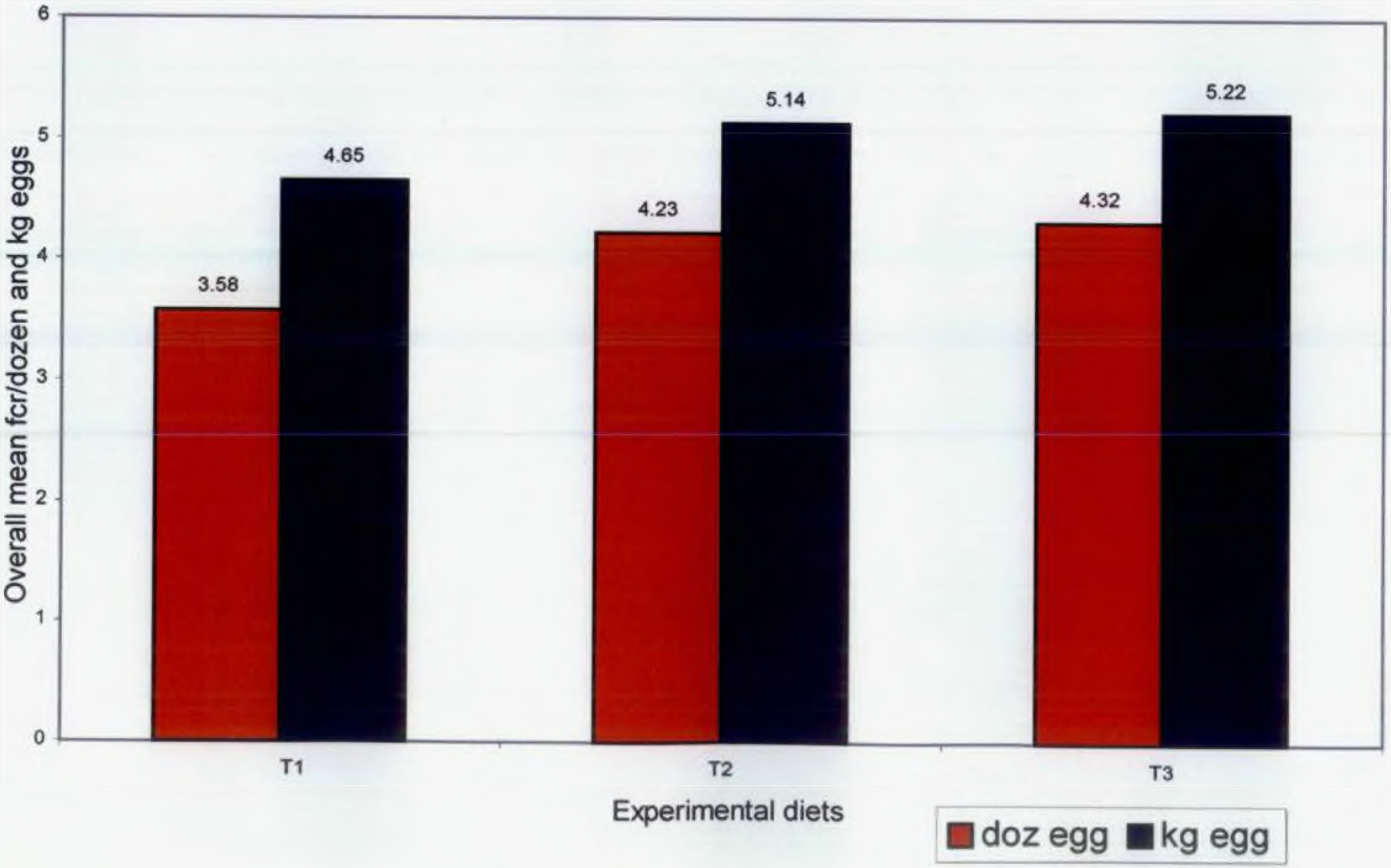
The overall values of FCR during the period from 29 to 44 weeks of age were 4.65 ± 0.44, 5.14 ± 0.56 and 5.22 ± 0.50 in T1, T2 and T3 respectively

Table 10. Fortnightly and overall mean feed conversion ratio (FCR) per kg egg mass as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	35.02±29.67	30.52±13.52	105.93±06.48
27-28	10.09±2.15	13.43±4.71	26.06±11.01
29-30	3.56±0.21	3.70±0.27	4.21±0.60
31-32	3.38±0.13	4.14±0.62	3.87±0.27
33-34	3.15±0.10	3.76±0.65	3.45±0.12
35-36	4.42±0.57	3.89±0.23	3.81±0.20
37-38	5.69±0.60	5.19±0.44	4.96±0.34
39-40	6.62±0.64	6.97±1.00	6.72±0.95
41-42	5.62±0.46 ^{b}	7.93±0.76 ^{a}	7.58±0.89 ^{a}
43-44	4.72±0.22 ^{b}	5.50±0.40 ^{ab}	7.17±0.83 ^{a}
Overall (29-44)	4.65±0.44	5.14±0.56	5.22±0.50

Mean values bearing same superscripts within the row did not differ significantly ($P<0.05$)

Fig .4 . Overall mean feed conversion ratio per dozen and kg eggs (29 to 44 weeks) influenced by dried cuttle fish waste silage in layer duck ration



(Table 10) and the mean values did not differ significantly ($P<0.05$) among each other. The corresponding values of overall FCR per dozen eggs were 3.58 ± 0.33, 4.23 ± 0.47 and 4.32 ± 0.51 (Table 9).

A comparison between overall mean FCR per dozen eggs and per kg eggs is given in Fig.4.

4.6 MEAN EGG WEIGHT (EW)

The fortnightly mean egg weights are presented in Table 11. The mean egg weight in each treatment was arrived based on the individual egg weight recorded daily.

The overall mean egg weight was significantly lower in control group (T1) compared to silage fed groups T2 and T3. However, the fortnightly mean egg weight in group T2 and T3 was significantly higher in all fortnights except in 25-28 and 33-36 weeks of age. The overall mean egg weight is represented graphically in Fig.5.

The initial mean egg weight at 25-26 weeks of age in T1, T2 and T3 were 61.56 ± 1.14, 64.50 ± 1.96 and 59.35 ± 0.50 g respectively but did not differ significantly each other.

In the group T2, the egg weight increased gradually and registered the peak egg weight of 69.86 ± 0.61 at 43-44 weeks of age. In the group T3, egg weight increased from 59.35 ± 0.50 g after fluctuations and reached 70.17 ± 0.93 g at 43-44 weeks of age recording highest egg weight in this group.

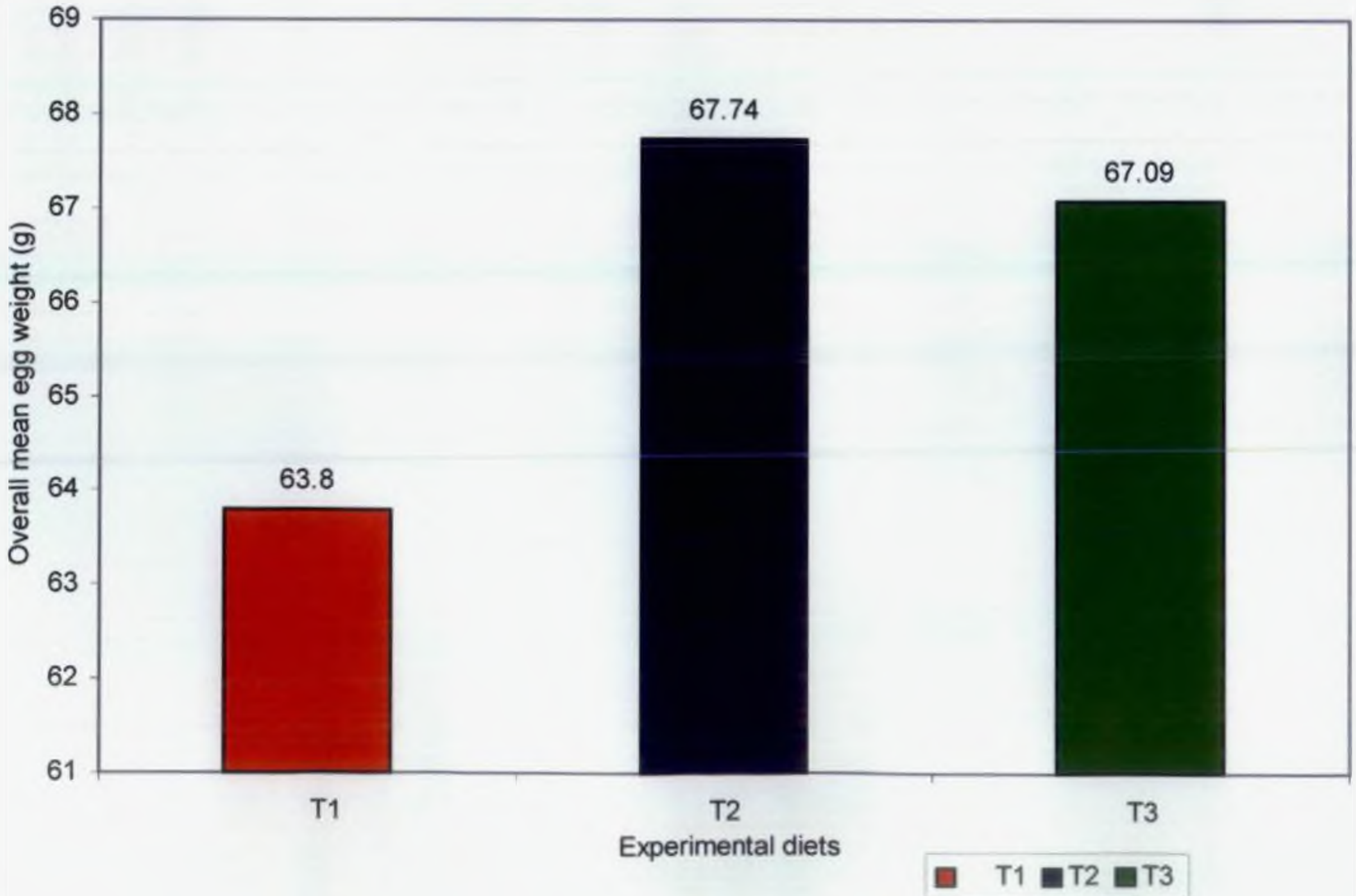
The mean egg weight at 33-34 and 35-36 weeks of age did not differ significantly among dietary groups. From 37-38 weeks onwards, the mean egg weight was significantly lower in the control group compared to silage fed

Table 11. Fortnightly and overall mean egg weight as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration, (g)

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	61.56±1.14	64.49±1.96	59.35±0.50
27-28	61.83±0.76	64.62±1.15	63.27±1.32
29-30	61.91±1.06 [a]	66.48±0.41 [b]	64.80±0.54 [b]
31-32	64.66±0.85 [a]	67.40±0.58 [b]	66.46±0.50 [ab]
33-34	67.23±1.01	69.82±0.48	69.41±0.80
35-36	66.09±1.18	68.58±0.51	68.85±0.68
37-38	64.85±1.11 [a]	68.44±0.64 [b]	69.58±0.89 [b]
39-40	63.07±0.94 [a]	69.62±0.64 [b]	69.41±0.88 [b]
41-42	62.38±1.30 [a]	68.13±0.50 [b]	69.64±1.21 [b]
43-44	64.47±0.79 [a]	69.86±0.61 [b]	70.16±0.93 [b]
Overall	63.80±0.62 [a]	67.74±0.63 [b]	67.09±1.14 [b]

Mean values bearing same superscripts within the row did not differ significantly (P<0.05)

Fig. 5. Overall mean egg weight(g) from 25 to 44 weeks influenced by dried cuttle fish waste silage in layer duck ration



groups. The mean egg weight between T2 and T3 was comparable during all periods.

Thus, the overall mean egg weight of 63.80 ± 0.62 g in T1 was significantly lower than T2 and T3. The overall mean egg weight in T2 was 67.74 ± 0.63 g and in T3 was 67.09 ± 1.14 g,

4.7 EGG MASS (EM)

The mean egg mass per duck is arrived based on the total eggs obtained from 32 ducks. The fortnightly and overall mean is presented in Table 12. The results showed that the egg mass did not differ significantly in any of the fortnights from 25 to 40 weeks of age but showed significant difference ($P<0.05$) in fortnights at 41-42 and 43-44 weeks of age.

The highest mean egg mass is recorded in the fortnight at 33-34 weeks in all the groups T1, T2 and T3 with mean value of 0.762 ± 0.026, 0.708 ± 0.066 and 0.698 ± 0.025 kg respectively.

The mean egg mass in the fortnight at 41-42 weeks in T1, T2 and T3 was 0.468 ± 0.035, 0.343 ± 0.041 and 0.385 ± 0.030 kg respectively and was significantly higher in the control group ($P<0.05$) compared to silage fed groups. However, in the fortnight 43 to 44 weeks, T2 recorded intermediary egg mass (0.477 ± 0.035 kg) and it was comparable with mean values of both T1 (0.543 ± 0.025 kg) and T3 (0.377 ± 0.042 kg) such that egg mass is significantly higher than T3 ($P<0.05$).

The overall mean egg mass per duck during the entire period from 25 to 44 weeks of age was 4.81 ± 0.081, 4.59 ± 0.076 and 4.40 ± 0.069 kg in T1, T2 and T3 respectively and did not differ significantly ($P<0.05$) each other.

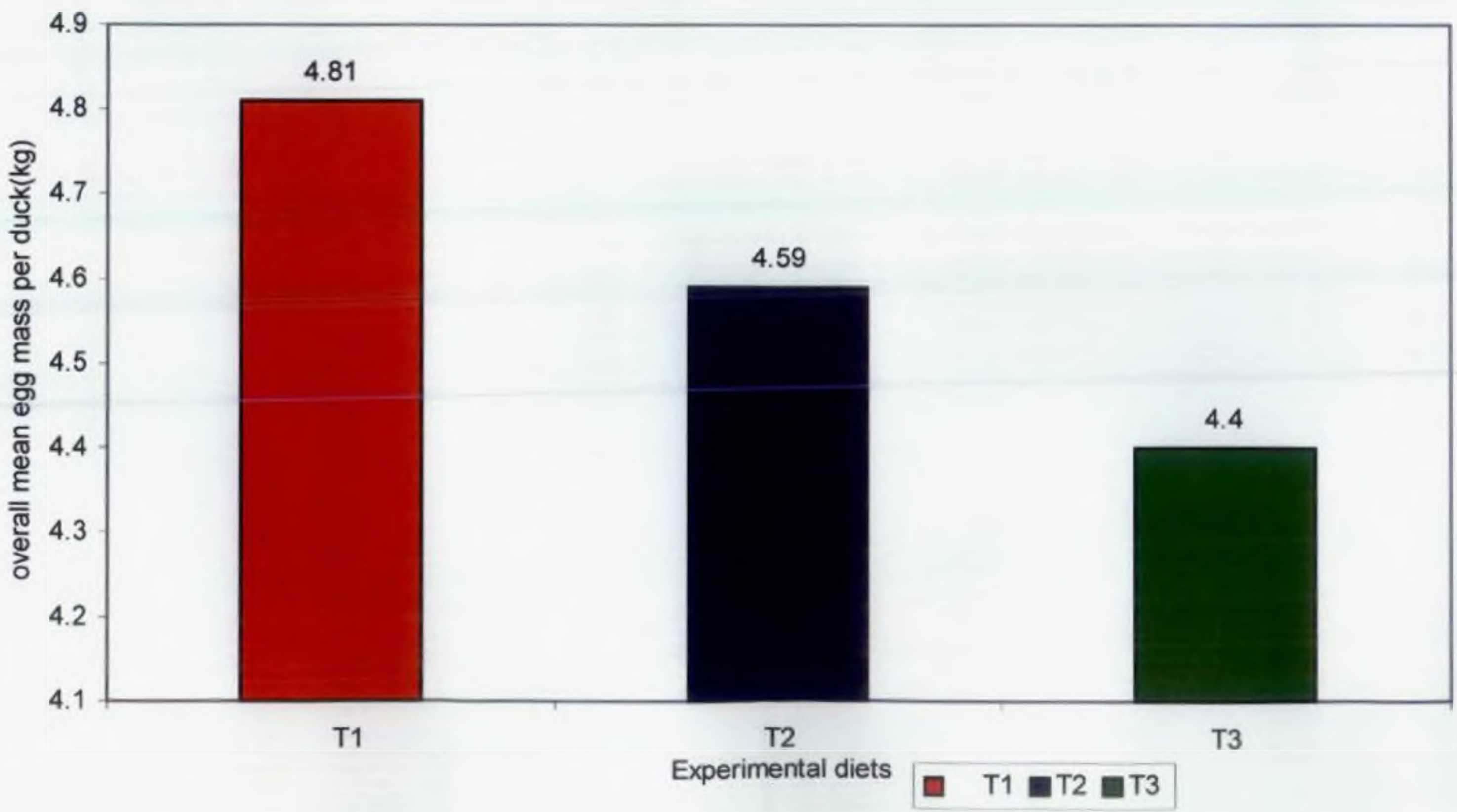
The overall mean egg mass per duck is depicted in Fig.6.

Table 12. Fortnightly and overall mean egg mass as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration, (kg / duck)

Age in weeks	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
25-26	0.062±0.039	0.070±0.034	0.020±0.010
27-28	0.274±0.042	0.266±0.057	0.212±0.051
29-30	0.631±0.033	0.621±0.042	0.587±0.052
31-32	0.660±0.026	0.598±0.056	0.607±0.046
33-34	0.762±0.026	0.708±0.066	0.698±0.025
35-36	0.584±0.052	0.629±0.065	0.621±0.027
37-38	0.442±0.035	0.481±0.041	0.481±0.035
39-40	0.385±0.040	0.396±0.058	0.378±0.035
41-42	0.468±0.035 [a]	0.343±0.041 [b]	0.385±0.030 [b]
43-44	0.543±0.025 [a]	0.477±0.035 [ab]	0.377±0.042 [b]
Overall in kg	4.81±0.081	4.59±0.076	4.40±0.069

Mean values bearing same superscripts within the row did not differ significantly ($P<0.05$)

Fig. 6. Overall mean egg mass per duck (25 to 44 weeks) influenced by dried cuttle fish waste silage in layer ration .



4.8 INTERNAL EGG QUALITY TRAITS

The overall mean value of albumen index, yolk index, shell weight percentage and shell thickness in the groups fed 0,11.45 and 22.9 per cent dried CFWS is presented in Table 13. Results indicated that the mean values of albumen index were 0.087 ± 0.027, 0.094 ± 0.011 and 0.105 ± 0.011 in group T1, T2 and T3 respectively were statistically non significant. Yolk index were 0.41 ± 0.005, 0.42 ± 0.005 and 0.42 ± 0.006, per cent shell were 10.2 ± 0.08,10.1 ± 0.72, and 9.9 ± 0.70 and shell thickness (mm) were 0.54 ± 0.002, 0.53 ± 0.002and 0.53 ± 0.003 in T1, T2 and T3 respectively did not differ significantly ($P<0.05$) each other.

4.9 SERUM PROTEIN, CALCIUM AND PHOSPHOROUS

The serum profile of ducks was examined at 44 weeks of age and the results pertaining to serum protein, serum Ca and P are presented in Table 14.

The mean values of serum protein were 4.5 ± 0.21,4.4 ± 0.18 and 4.3 ± 0.20 mg/dl in the groups fed 0, 11.45 and 22.9 per cent dried CFWS respectively, which did not differ significantly each other.

The serum Ca in the group fed 10 per cent DF was 17.3 ±0.72 mg / dl was significantly higher than that fed 22.9 per cent dried CFWS (14.8 ± 0.64 per cent) replacing DF completely. In the group T2 fed diet containing DF plus dried CFWS, the mean serum Ca was 16.4 ± 0.69 mg/dl. It was intermediary and statistically comparable between T1 and T3.

The mean values of serum phosphorus (Table 13) revealed that it was significantly higher in T1 and T2 than in T3. The mean values were 3.5, 3.4 and 2.7 mg / dl in T1, T2 and T3 respectively.

Table 13. Mean value of Albumen index, Yolk index, Shell weight (g) and Shell thickness (mm) as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration.

	Dried cuttle fish waste silage (%) in experimental diets		
Overall Mean	0 (T1)	11.45 (T2)	22.90 (T3)
Albumen index	0.087±0.027	0.094±0.011	0.105±0.011
Yolk index	0.41±0.005	0.42±0.005	0.42±0.006
Per cent shell	10.2±0.08	10.1±0.72	9.9±0.70
Shell thickness (mm)	0.54±0.002	0.53±0.002	0.53±0.003

Table 14. Mean serum profile at 44 weeks of age and livability of ducks as influenced by incorporation of varying levels of dried cuttle fish waste silage in layer duck ration.

	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
Serum Protein (mg / dl)	4.5±0.21	4.4±0.18	4.3±0.20
Serum Calcium (mg/ dl)	17.3±0.72 [a]	16.4±0.69 [a b]	14.8±0.64 [b]
Serum Phosphorus (mg/dl)	3.5±0.21 [a]	3.4±0.23 [a]	2.7±0.13 [b]
Livability (%)	100	100	96.88

Mean values bearing same superscripts within the row did not differ significantly (P<0.05)

4.10 LIVABILITY

The livability obtained in the present study in the groups fed 0, 11.45 and 22.9 per cent dried CFWS were 100, 100 and 96.87 per cent (Table 13) respectively from 25 to 44 weeks of age. There was only one mortality in group fed 22.9 per cent dried CFWS (T3) at 35 weeks of age (sixth fortnight). The post mortem conducted on the carcass did not suggest any adverse effects due to feeding of dried cuttle fish waste silage and the reason attributed for the death was non specific.

4.11 ECONOMICS

The economics was worked out on the basis of feeding cost alone and the feed cost of experimental diets per kg were Rs.8.83, 8.52 and 7.87 in groups T1, T2 and T3 respectively. The feed cost for the production of per dozen eggs and per kilogram egg mass, feed cost per egg, the margin of return over feed cost per egg and per kg egg mass are presented in Table 15.

The results revealed that the feed cost per kg egg mass in groups fed 0, 11.45 and 22.9 per cent dried CFWS were Rs.42.74, 43.36 and 42.14 respectively by taking Rs. 50 as cost per kg eggs. The higher cost of production in group T2 owes to the intermediary egg mass and high feed intake from 25 to 44 weeks of age.

Production cost on the basis of per dozen eggs were Rs. 32.88, 35.50 and 34.38 in T1, T2 and T3 respectively denoting higher cost of feed per dozen eggs in group fed 11.45 per cent dried CFWS. The cost of feed per egg in T1, T2 and T3 were Rs. 2.74, 2.96 and 2.86 respectively and the cost of production was higher in group T2. The economics of feeding dried CFWS in layer duck rations was evaluated and the salient features are presented in Fig. 7

Table 15. Results from 32 ducks during the period from 25 to 44 weeks of age and economics of incorporation of varying levels of dried cuttle fish waste silage in layer duck ration

Parameters	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
Total feed intake (kg)	745.27	747.26	742.25
Total eggs produced	2402	2152	2039
Total eggs mass (kg)	153.96	146.83	138.63
Feed cost / per kg diet (Rs)	8.83	8.52	7.87
Feed cost / kg egg mass (Rs)	42.74	43.36	42.14
Feed cost / dozen egg (Rs)	32.88	35.50	34.38
Feed cost / egg (Rs)	2.74	2.96	2.86
Margin of return over feed cost / egg (Rs.)	0.26	0.04	0.14
Margin of return over feed cost/ kg egg (Rs)	7.26	6.64	7.80

The results obtained in present study are summarised in Table 16

The overall mean EW was significantly higher in T3 ($P<0.05$). Serum Ca and P were significantly lower in the group T3 ($P<0.05$).

Fig .7 Economics of feeding dried cuttle fish waste silage in layer duck ration

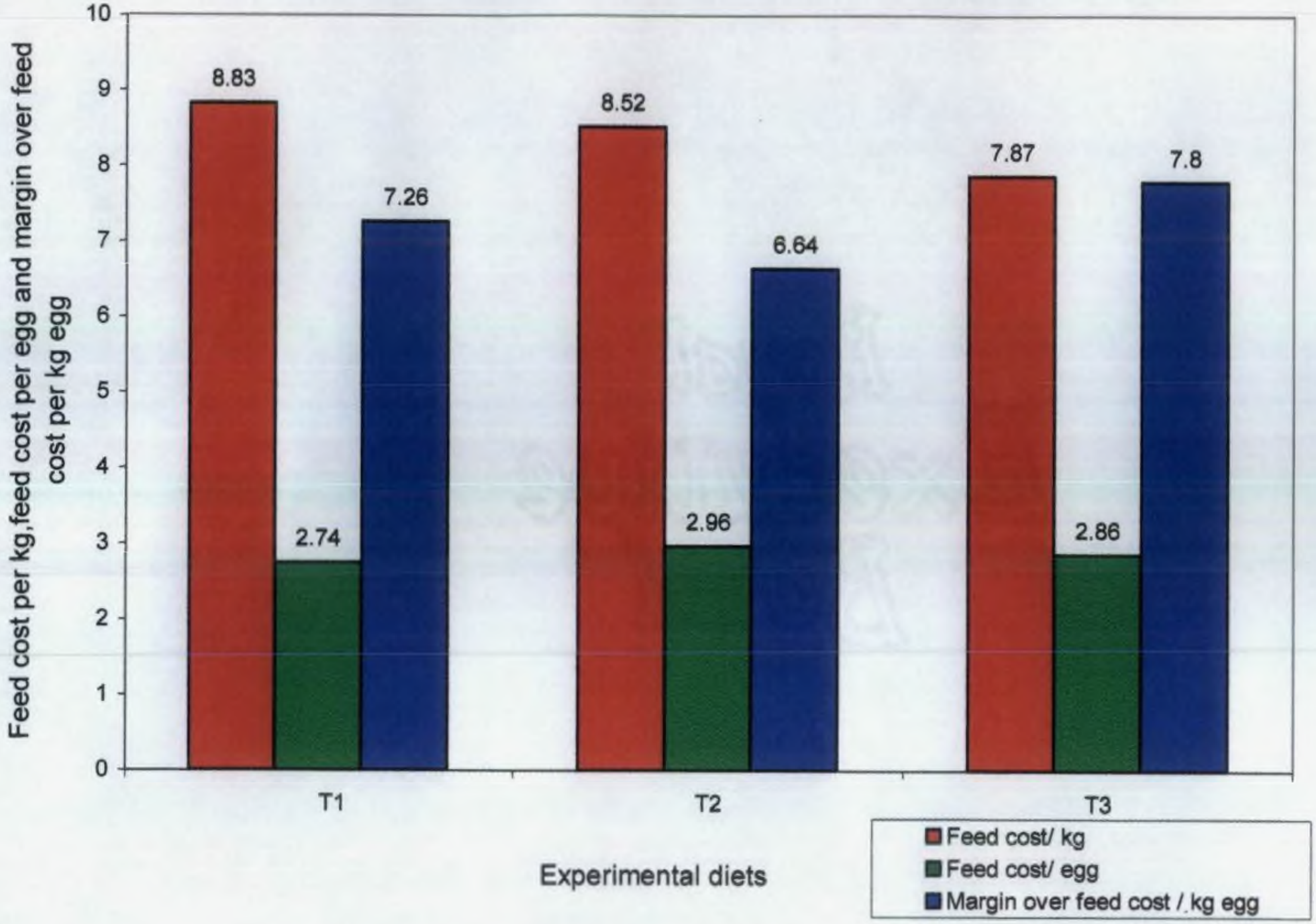


Table 16. Summary of production performance and economics in indigenous layer ducks influenced by incorporation of varying levels of dried cuttle fish waste silage replacing dried fish in duck layer ration.

Parameter	Dried cuttle fish waste silage (%) in experimental diets		
	0 (T1)	11.45 (T2)	22.90 (T3)
Overall mean from 25 to 44 weeks			
1. Duck housed number	75.06	67.25	63.72
2. Duck housed per cent production	53.61	48.03	45.51
3. Duck day number	75.06	67.25	64.70
4. Duck day per cent production	53.61	48.03	46.21
5. Daily feed intake (g)	166.36	166.80	168.35
6. FCR/doz eggs (29 -44 weeks)	3.58	4.23	4.32
7. FCR/ kg eggs (29 - 44 weeks)	4.65	5.14	5.22
8. EW (g)	63.80 [a]	67.74 [b]	67.09 [b]
9. Egg mass (kg/duck)	4.81	4.59	4.40
10. Albumen index	0.087	0.105	0.094
11. Yolk index	0.41	0.42	0.42
12. per cent shell	10.2	10.1	9.9
13. Shell thickness (mm)	0.54	0.53	0.53
At 44th week			
14. Serum Ca (mg/dl)	17.3 [a]	16.4 [ab]	14.8 [b]
15. Serum P (mg/dl)	3.5 [a]	3.4 [a]	2.7 [b]
16. Serum Protein (mg/dl)	4.5	4.4	4.3
Economics			
17. Feed cost / kg diet (Rs)	8.83	8.52	7.87
18. Feed cost / kg egg mass (Rs)	42.74	43.36	42.14
19. Feed cost / dozen eggs (Rs)	32.88	35.50	34.38
20. Feed cost / egg (Rs)	2.74	2.96	2.86
21. Margin of return over feed cost/egg (Rs)	0.26	0.04	0.14
22. Margin of return over feed cost/ kg egg mass (Rs)	7.26	6.64	7.80

Discussion

5. DISCUSSION

5.1 BODY WEIGHT

The results presented in Table 3 indicated that the mean body weight (BW) in ducks at 24 weeks of age was comparable between groups T1, T2 and T3 (1476 ± 22.25, 1453 ± 22.54 and 1492 ± 20.64 g) showing uniformity in the flock at the beginning of the experiment. These results agree with the body weights in indigenous ducks (1465, 1438 and 1443 g) reported by Gajendran *et al.* (1999) and Andrews *et al.* (1984).

The BW at 44 weeks of age averaged 1406 ± 32.07, 1387 ± 23.72 and 1423 ± 18.1 g in T1, T2 and T3 respectively in ducks fed dried fish (DF) and dried cuttle fish waste silage (CFWS) from 25 to 44 weeks of age. The mean values did not differ significantly with each other (Table 3) and proved that the inclusion of dried CFWS at levels 11.45 per cent (T2) and 22.9 per cent (T3) replacing 5 and 10 per cent dried fish, by partial and complete replacement of fish protein in duck layer rations, did not affect the 44th week body weight in indigenous layer ducks.

A decline in body weight to the tune of 70, 66 and 69 g in groups T1, T2 and T3 respectively was observed in ducks at 44 weeks of age in comparison with their respective body weights at 24 weeks of age. The decline was almost similar in all groups fed dried fish and dried CFWS. These results obtained in the present study indicated that indigenous ducks did not accumulate weight during laying period and this can be considered as a favorable characteristic for egg type ducks. In an earlier work, the phenomenon of reduction in BW was reported advantageously by Ravi (2002) in indigenous layer ducks.

Johnson (1985) reported no significant effect in growth on feeding acid or fermented fish silage in broilers which confirms with the results of present study.

Similarly, Krogdahl (1985b) did not observe any significant difference in weight gain when broilers were fed fish viscera silage.

5.2 SEXUAL MATURITY

The age at sexual maturity (ASM) presented in Table 3 and Fig.1 and showed that the first egg in the flock was laid at the same age (169 days) in both groups fed diet containing 10 per cent dried fish (T1) and that fed 5 per cent dried fish plus 11.45 per cent dried CFWS (T2) indicating early sexual maturity in these groups. The mean age at first egg was intermediary in group T2 (186.06 days). The average age at first egg (190.25 days) and the age at 50 per cent production (198 days) were delayed in ducks fed 22.9 per cent dried CFWS (T3) by the complete replacement of dried fish protein.

5.3 EGG PRODUCTION

5.3.1 Duck Housed Number (DHN)

The egg production on duck housed basis presented in Table 4 revealed fortnightly variations in duck housed number (DHN) and magnitude and duration of peak production in ducks fed diets containing dried fish, dried CFWS and its combination.

The fortnightly DHN was comparable between groups T1, T2 and T3 in all fortnights up to 40 weeks of age. Thereafter, a shift in the egg production pattern was observed at fortnight 41- 42 and 43-44 weeks of age. At these ages, the DHN in T2 and T3 was comparable statistically but was very low. Moreover, significantly higher DHN was recorded in the control group ($P<0.05$). This significant variation as such was not reflected in cumulative egg number from 25 to 44 weeks of age. Thus, the overall mean DHN was comparable among each other in DF and dried CFWS fed groups with numerically higher DHN in T1, T2 and T3 in that order (75.06, 67.25 and 63.72 eggs). The significantly higher DHN *in the control group at the age of 41-42 and 43-44 weeks was due to significantly* lower mean egg weight as evidenced by the data on mean EW (Table 11).

The inclusion of 5 per cent dried fish (DF) plus substitution of 50 per cent DF protein by 11.45 per cent dried CFWS protein resulted in a reduction of 7.81 eggs in overall DHN. Of this, a reduction of 4.13 eggs occurred during 41-44 weeks. The complete replacement of fish protein by 22.9 per cent dried CFWS in comparison with control diet resulted in reduction of overall DHN by 11.34 eggs. Of this, the reduction of 5.54 eggs, that is; about half of the overall difference was occurred during 41-44 weeks showing variation in egg number was inconsistent in early ages leading to statistically non significant differences in cumulative DHN between T1, T2 and T3. The dried CFWS fed groups (T2 and T3) showed that the complete replacement of 10 per cent DF resulted in a decrease of 3.53 eggs only, in comparison with diet containing 5 per cent DF plus 11.45 per cent CFWS.

Similar results in layer chicken were reported by Krogdahl (1985a) and Kjos *et al.* (2001) that feeding of fish silage did not affect egg production.

5.3.2 Duck Housed Per cent (DHP) Production

In the control group, the duck housed per cent production (DHP) which was 7.35 per cent in the first fortnight at 25-26 weeks showed increase to 31.92 per cent at 27-28 weeks and 72.99 per cent in both fortnight at 29-32 weeks and 31-32 weeks (Table 5). The DHP was further increased to 80.80 per cent and registered the highest production percentage at 33-34 weeks in the control group fed 10 per cent dried fish. After peak production, the DHP was decreased to 63.39 at 34-35 weeks of age. The fall in egg production after peak production observed in all groups followed the normal trend.

The decline was continued and DHP in T1 was 48.66 per cent at 37-38 weeks and 43.97 per cent at 39-40 weeks of age. From this stage, there was an abrupt increase to 53.79 per cent at 41-42 weeks and 60.27 per cent at 43-44 weeks of age showing significantly higher out put in control group ($P<0.05$) in comparison with other groups where no similar increase was observed. Thus, the egg production was more than 70 per cent in fortnights during 29-34 weeks and fairly high in other fortnights in control group fed dried fish, but the DHP was comparable between groups T1, T2 and T3 in all fortnights, up to 40 weeks of age.

In the group T2, ducks fed with 5 per cent DF plus 11.45 per cent dried CFWS, the initial egg production which was 7.78 per cent at 25-26 weeks reached the peak production of 72.32 per cent at 33-34 weeks and decreased to 65.40 per cent at 35-36 weeks and the declining trend continued to 35.94 per cent at 41-42 weeks and increased to 48.66 per cent at 43-44 weeks of age. In this group, the magnitude of peak was low and decline was sharp and severe thereby registered very low percentages at 41-42 weeks in the group fed combination of DF and dried CFWS.

In the group T3, ducks fed 22.9 per cent dried CFWS replacing dried fish completely showed very low duck housed per cent (2.43 per cent) at 25-26 weeks due late sexual maturity. DHP was further increased to the peak level of 71.88 per cent at 33-34 weeks and decreased to 64.51 per cent at 35-36 weeks of age. The DHP declined to 36.16 per cent at 41-42 weeks following almost similar trend as in T2. The production registered at 43-44 weeks of age was 38.39 per cent in T3 and the increase in production during this period was only 2.23 per cent.

Thus, the peak production was recorded at 33-34 weeks of age in all groups and it was high in T1 (80.80 per cent), low in T2 and T3 which was almost similar (72.32 and 71.88 per cent). The significantly higher DHP during

41-42 and 43-44 weeks of age was due to the peculiarity of abrupt increase in production linked with significantly lower EW in the control group, in comparison with T2 and T3 where severe drop in egg number associated with significantly higher EW was contributory to the above situation.

The egg production in fish silage fed groups T2 and T3 was statistically comparable in all fortnights consistently from 25 to 44 weeks of age and the cumulative percentages of 48.03 and 45.51 was also comparable suggesting that dried CFWS can be included in duck layer rations up to 22.9 per cent either partially or completely replacing dried fish, without any adverse effects on egg production.

5.3.3 Duck Day Number (DDN)

The overall egg number on duck day basis presented in Table 6 was 75.06, 67.25 and 64.70 eggs and the duck day number (DDN) was comparable between T1, T2 and T3 and the fortnightly variations were similar to that observed with DHN. Increase in overall DDN by 0.98 than DHP in T3 was noticed due to mortality of one duck at 35 weeks of age. In T1 and T2, DHN and DDN were same in all fortnights.

5.3.4 Duck Day Per cent (DDP) Production

The overall duck day per cent (DDP) production of 53.61, 48.03 and 46.21 per cent did not differ significantly between T1, T2 and T3. Numerically higher percentage in control group can be linked with early sexual maturity and significantly lower egg weight compared to T2 and T3 wherein, the numerically lower duck day percentage was coupled with significantly higher egg weight and late ASM. The overall duck day per cent production in T3 was higher than DHP as one duck died during sixth fortnight.

5.4 FEED CONSUMPTION

The mean daily feed consumption presented in Table 8 indicated that feed intake in groups fed DF and dried CFWS was almost similar at 25-26 weeks of age (154.55 ± 0.25, 154.44 ± 0.22 and 154.29 ± 0.40 g). In the control group, the mean daily feed intake did not show much variation up to 32 weeks of age but it was increased to 169.84 g per day during 33-34 weeks of age and the daily mean feed intake till 40 weeks of age was almost same as that registered at the time of peak egg production. As age advanced, there was an increase in daily feed intake to the tune of 179.87 g at 41-42 weeks and 180.27 g at 43-44 weeks of age, with control diet containing dried fish. The mean daily feed consumption in this study is higher than that reported by Ravi (2002).

More or less the same trend was exhibited in groups T2 and T3 and the results proved that the incorporation of dried CFWS by partial and complete replacement of dried fish did not affect the feed intake pattern significantly in any of the fortnights. Thus, the overall feed intake from 25 to 44 weeks of age being similar (166.36, 166.8 and 168.35g) with groups T1, T2 and T3, it can be surmised that the mean daily feed intake did not influence any of the traits markedly.

These findings were in agreement with results of Johnson *et al.* (1985), Epse *et al.* (1999), Magana *et al.* (1999) and Kjos *et al.* (2000) who did not observe any significant difference in feed intake when included fish silage in broiler chicken diets. Similarly, Ahmed and Mahendrakar (1996b) replaced 50 per cent fish meal protein with fish silage protein and did not report reduction in feed intake in broilers.

5.5 FEED CONVERSION RATIO

5.5.1 FCR per Dozen Eggs

The Feed Conversion Ratio (FCR) per dozen eggs and per kg egg mass (Tables 9 and 10) were poor at 25-26 and 27-28 weeks due to very low egg production in all groups fed dried fish and dried CFWS. Improvements in FCR per dozen eggs were observed in the control group from 29-30 weeks of age onwards but the fortnightly FCR was statistically comparable between T1, T2 and T3 up to 40 weeks of age and indicated that the utilisation of nutrients was uniformly good in all groups.

The FCR in the control group were 2.65, 2.62 and 2.53 and those in T2 were 2.96, 3.34 and 3.14 while those in T3 were 3.27, 3.09 and 2.87 during 29-30, 31-32 and 33-34 weeks respectively. Compared to previous fortnights, a numerical increase in daily feed intake was also appreciated in all groups at 33-34 weeks of age when peak egg production was recorded. Within the groups, the poorest ratio of 5.05 was recorded at fortnight 39-40 weeks in T1 and 6.47 in T2 and 6.37 in T3 both being at 41-42 weeks of age. These results indicated that, as age advanced, the conversion efficiency with respect to egg number was declined in ducks fed dried CFWS with significantly inferior FCR in T2 and T3.

In the control group, the poorest ratio in T1 was registered inspite of similar feed intake during the period from 33 to 40 weeks of age. Improvement in FCR was noticed at 41-42 and 43-44 weeks of age (4.22 and 3.66) with numerical increase in feed intake and higher egg out put during these periods. With similar feed intake, the groups T2 and T3 could not produce well. Therefore, the fortnightly FCR in T1 was significantly better than other groups at 41-42 weeks of age. But at 43- 44 weeks of age, FCR in T1 and T2 was comparable (3.66 and 4.60). At both these ages, the FCR was significantly inferior ($P<0.05$) with 22.9 per cent dried CFWS fed group in comparison with other groups. These variations as such were not carried over to the overall values of FCR.

The overall FCR during the entire period from 29 to 44 weeks of age were 3.58, 4.23 and 4.32 in T1, T2 and T3 respectively and did not differ significantly ($P<0.05$) with each other. These results are indicative of similar conversion rates by the dried CFWS and dried fish except at 41-44 weeks. The nutrients present in cuttle fish waste have been utilised efficiently and the overall FCR with dried CFWS can be considered equally good as that of dried fish in duck layer rations.

These findings are in line with the results of Epse *et al.* (1992) Magana *et al.* (1999) who did not report any difference in FCR in broilers when fish silage was included 30 and 15 per cent levels respectively.

5.5.2 FCR per kg Egg Mass

The fortnightly and overall FCR per kg egg mass exhibited the similar trend as that observed with FCR per dozen eggs except the fact the FCR in ducks fed 11.45 per cent dried CFWS (T2) was intermediary and statistically comparable with T1 and T3 at 43-44 weeks of age.

The overall FCR per kg egg mass from 29 to 44 weeks of age were 4.65, 5.14 and 5.22 in T1, T2 and T3 respectively (Table 10) and the mean values did not differ significantly ($P<0.05$) with each other. The corresponding values per dozen eggs were 3.58, 4.23 and 4.32 (Table 9). The overall results proved that the efficiency of conversion to egg number as well as egg mass is favourable with partial and full replacement of dried fish with ensiled cuttle fish wastes.

5.6 MEAN EGG WEIGHT (EW)

The results pertaining to the mean egg weight from 25 to 44 weeks presented in Table 11 revealed that it was significant in all fortnights except the initial fortnights at 25-26 and 27-28 weeks and in the middle of experiment at 33-34 and 35-36 weeks. At these ages, the mean EW in T1, T2 and T3 was comparable with each other.

The overall mean egg weight from 25 to 44 weeks in T1, T2 and T3 was 63.80, 67.74 and 67.09 g and it was significantly lower in control group than the silage fed groups. This finding showed that both levels of cuttle fish waste silage (11.45 and 22.9 per cent) resulted in substantial increase in mean EW.

The variations in mean egg weight have to be perceived with egg number and can be examined along with egg mass data presented in Table 12. One reason that can be attributed to the variations in egg number as evidenced by the data presented in Table 4 to 6 has to be interpreted with the negative correlations that existed between the egg number and egg weight. The significantly lower mean egg weight registered in the control group also has nutritional dimensions beyond the genetic correlations. This was confirmed by the significantly higher EW consistently during the periods from 29 to 32 and 37 to 44 weeks of age in fish silage fed groups T2 and T3 with numerical advantage at other periods. The EW at 25-26 weeks was poor and that at 31-32 weeks was comparable with other groups and showed fortnightly fluctuations like 69.41, 68.85, 69.58, 69.41, 69.64 which in turn reached 70.17 g at 43-44 weeks of age recording highest egg weight in this group. Interestingly the mean egg weight 33-34 and 35-36 weeks did not differ significantly each other because it was synchronized with peak production and fall in egg production after peak in all groups.

From 37-38 weeks onwards the mean egg weight was significantly lower in the control compared to silage fed groups and the mean egg weight between

T2 and T3 was statistically comparable during these periods. These differences might be contributed by the varied availability of nutrients in the ration. The results pertaining to the mean EW in T1 and T2 presented in Table 11 clearly indicated that that there was a definite increase of 3.34 g in overall mean egg weight in the group fed diet containing 11.45 per cent dried CFWS by replacing 50 per cent of protein in dried fish. It is also not clear about nutritional factors favoured higher egg weight of 3.19 g in T3 compared to control diet. It was imperative that the mean egg weight in groups fed diets containing 11.45 and 22.9 per cent dried CFWS was differed only by 0.65 g higher in the group T2 .

The results also indicated that there was a slight decline in egg weight by complete replacement of dried CFWS in relation with its partial replacement of 50 per cent of crude protein of dried fish. The mean egg weight was increased from 61.56 to 67.23 g in the group fed diet containing 10 per cent dried fish. Whereas, in the diet containing 11.45 per cent dried CFWS, the mean EW were raised from 64.50 to 69.86 g and in T3 from 59.35 to 70.16 g. The consistently higher egg weight in the fish waste silage fed groups might be due to the differences in the amino acids and fatty acid profile of dried CFWS which has to be confirmed by further studies. The increment in fortnightly and overall mean egg weight perceived in the study showed considerable increase in EW contributed by nutrients in dried CFWS.

The mean egg weight obtained in present study in three treatment groups are higher than those reported by Ravi (2002).

5.7 EGG MASS (EM)

The fortnightly mean egg mass (kg) per duck presented in Table 12 showed that the egg mass during the period from 25 to 44 weeks of age was comparable up to 40 weeks of age and it differed significantly at 41-42 and 43-44 weeks of age. The overall mean egg mass per duck during the entire period from

25 to 44 weeks of age was 4.81, 4.59 and 4.40 kg in T1, T2 and T3 respectively and did not differ significantly (P<0.05) with each other following the trend similar to that observed with DHN.

At 41-42 weeks, the EM was significantly higher (P<0.05) with significantly higher egg number in the control group showing significant depression in egg mass as well as egg number in both groups fed cuttle fish waste silage. The mean egg mass in the fortnight at 41-42 weeks in T1, T2 and T3 was 0.468, 0.343 and 0.385 kg respectively and was significantly higher in the control group (P<0.05) compared to silage fed groups. At 43-44 weeks of age, the significant depression in egg mass was observed with T3 only. However, in the fortnight 43 to 44 weeks, T2 recorded intermediary egg mass (0.477 kg) and it was comparable with mean values of both T1 (0.543 kg) and T3 (0.377 kg). Significantly higher egg number was observed at both these ages in T1.

Since the overall egg number and egg mass were comparable between T1, T2 and T3, it was concluded that the variations in mean EW was due to certain nutrients present in dried CFWS .

5.8 INTERNAL EGG QUALITY TRAITS

The overall egg quality traits namely albumen index, yolk index, per cent shell and shell thickness in the groups fed 0,11.45 and 22.9 per cent in dried CFWS are presented in Table 13 and it was comparable in T1, T2 and T3.

The numerically lower values of albumen index can be attributed to the low mean egg weights in the group fed 10 per cent dried fish. As discussed earlier, the low mean egg weight was due to the higher egg number in control group. The comparable values of albumen index in group T2 and T3 is indicative of the fact that dried CFWS did not effect egg quality traits.

Kjos *et al.* (2001) also could not observe significant difference in egg quality traits when fish meal was replaced by fish silage in laying hens.

The values of yolk index, per cent shell and shell thickness were comparable between the three treatment groups in all periods. The results are comparable with the finding of Mohan (1999) and Reddy *et al.* (2004) who reported no significant difference in egg quality traits in layer birds when squilla meal replaced fish meal in diets.

It can be concluded that replacement of dried fish with dried CFWS did not make any significant change in egg quality. Numerically higher egg output with significantly lower mean EW was due to negative correlation between these traits in control diet.

5.9 SERUM PROTEIN, CALCIUM AND PHOSPHORUS

The serum profile of ducks was examined at 44 weeks of age and the results pertaining to serum protein, serum Ca and P are presented in Table 14.

Serum protein is almost similar in all groups and is within the normal range of 4.65 to 5.0 mg / dl in ducks reported by Surendranathan (1966). The serum Ca content is significantly higher in ducks fed dried fish than that fed 22.9 per cent dried CFWS might be due to the variations in Ca content in experimental diets used in the present study. Serum P values were significantly higher in both groups fed DF and DF plus dried CFWS than that of T3 in which DF was replaced completely. This might be due to variations in Ca: P ratio in diets. The serum Ca values obtained in the present study are lower than the value of 19.94 mg / dl reported by Surendranathan (1966).

5.10 LIVABILITY

The livability obtained in the present study for the groups fed 0, 11.45 and 22.9 per cent dried CFWS were 100, 100 and 96.87 per cent respectively from 25 to 44 weeks of age. There was only one mortality in group fed 22.9 per cent dried CFWS (T3) at 35 weeks of age (sixth fortnight). The post mortem conducted on the carcass did not suggest any adverse effects due to feeding of dried cuttle fish waste silage and the reason attributed for the death was non specific.

Johnson *et al.* (1985) also did not observe significant difference in mortality when groups fed with fish meal, fish silage and fermented fish silage in broilers.

5.11 ECONOMICS

The economics of feeding dried CFWS in layer duck rations was evaluated and the results are presented in Table 15. The cost of experimental diets per kg were Rs.8.83, 8.52 and 7.87 in groups T1, T2 and T3 respectively. The economics based on feeding cost alone was worked out and the feed cost per dozen eggs and kilogram egg mass, feed cost per egg and the margin of profit over feed cost are presented in Table 15.

The results revealed that the feed cost per dozen eggs were Rs. 32.88, 35.50 and 34.38 in T1, T2 and T3 respectively denoting high feed cost in group T2 fed 11.45 per cent dried CFWS followed by T3 and T1 in that order. The reason for this can be attributed to the lesser number of eggs produced in T2 than the control group T1. The feed cost per egg was considered in T1, T2 and T3 and were Rs. 2.74, 2.96 and 2.86 respectively with higher cost of production in group T2 due to the variation in cost of experimental diets with uniform cumulative mean feed intake. The feed cost per kg egg mass in groups fed 0, 11.45 and 22.9 per cent dried CFWS were Rs.42.74, 43.36 and 42.14 respectively when sale price per kg egg mass was taken at Rs. 50 per kg eggs. The higher cost of production in group T2 owes to the intermediary egg mass with higher feed intake from 25 to 44 weeks of age.

The feed cost per egg was Rs. 2.74, 2.96 and 2.86 in T1, T2 and T3 respectively. Thus, the net margin over feed cost per egg in the above groups was Rs.0.26, 0.04 and 0.14. in T1, T2 and T3 respectively registering higher returns in the control group. Even though, the cost of feed in the control group was the highest of Rs. 8.83, the numerical increase in egg production brings favourable results for group T1 in respect of margin of returns over feed cost. The feed cost was Rs.8.52 per kg diet containing 11.45 per cent dried CFWS and it was only Rs. 7.87 for diet containing 22.9 per cent dried CFWS. Vedhanayagam (1976) observed similar findings in broilers wherein cost of feed was lower for fish silage fed groups when replaced fish meal in diets.

Based on feed cost per kg egg mass, it was beneficial in T3 since the feed cost per egg mass in the above groups was Rs. 42.74, 43.36 and 42.14 in T1, T2 and T3 respectively. The margin of returns over feed cost per kg egg mass were Rs. 7.26, 6.64 and 7.86 in T1, T2 and T3 respectively registering higher returns in the T3 group.

Based on the economic considerations, it can be surmised that the addition of dried CFWS can reduce the feed cost by partial and complete replacement of dried fish in layer duck rations. The net margin of return over feed cost per egg in the above groups indicated that it was Rs.0.26, 0.04 and 0.14 respectively and is beneficial in the order of T1, T3 and T2, if the eggs are sold on number basis. If the eggs are sold on egg weight basis, the returns will be higher with T3, T1 and T2 in that order. The results summarized in table 16 confirmed the above findings.

Summary

6. SUMMARY

An experiment was conducted at Department of Poultry Science, Kerala Agricultural University during the period form May through November, 2004 to examine the utilization of dried cuttle fish waste silage (CFWS) in duck layer rations by partial and complete replacement of dried fish (DF) and to evaluate the economics of feeding dried CFWS in duck layer ration.

At 24 weeks, ninety six (96) indigenous layer ducks were housed in 48 cages at the rate of two ducks per cage. They were divided into three groups T1, T2 and T3, consisting of 32 ducks in each treatment group having eight replicates with four ducks in each replicate. The diet T1 contained 10 per cent dried fish (DF) and zero per cent dried CFWS. Dietary group T2 had a combination of 5 per cent DF and 11.45 per cent dried CFWS while diet T3 was having 22.9 per cent dried CFWS replacing DF completely. All diets were made iso-caloric and iso-nitrogenous

The production performance of ducks was recorded from 25 to 44 weeks of age. Egg production was recorded on daily basis while the feed consumption was recorded fortnightly and the feed conversion ratio was arrived per dozen and per kg egg mass basis. All eggs were weighed individually throughout the experimental period and egg mass was calculated per duck basis. Egg quality parameters in respect of albumen index, yolk index per cent shell and shell thickness were recorded in five eggs from each replicate during the last three consecutive days of each 28-day periods. Serum protein, serum Calcium and Phosphorous were analyzed in 8 ducks per group at 44 weeks of age. The economics of utilization of dried CFWS in layer duck ration were assessed.

The fortnightly and overall effect due to incorporation of dried CFWS by partial and complete replacement of dried fish was presented in Tables 3 to 15 and the overall performance of ducks in dietary treatments T1, T2 and T3 is summarized in Table 15.

The following results were obtained in the present study.

1. Age at first egg in the flock was 169 days in T1 and T2 while the mean age at first egg (184.87 days) and the age 50 per cent production (194 days) were also early in T1.

2. The duck housed number (DHN) averaged between 0.34 to 11.31 eggs in various fortnights from 25 to 44 weeks but it was differed significantly only during fortnights 41-44 weeks of age. While the overall DHN was 75.06 , 67.25 and 63.72 eggs in T1, T2 and T3 respectively and the differences between mean values were non significant ($P<0.05$).

3. The overall mean DHP from 25 to 44 weeks of age was 53.61, 48.03 and 46.21 in T1, T2 and T3 respectively were statistically non significant ($P<0.05$) each other.

4. The overall mean daily feed consumption were 166.36, 166.80 and 168.35 in T1, T2 and T3 respectively were statistically comparable each other. The fortnightly mean daily feed consumption also was not influenced by incorporation of varying levels of dried CFWS.

5. The overall feed conversion ratio per dozen eggs was 3.58, 4.23 and 4.32, while that per kg egg mass was 4.65, 5.14 and 5.22 in T1, T2 and T3 respectively. Although better in T1, the varying levels of dried CFWS replacing DF in diets, FCR did not show significant difference in overall mean EW between groups. However, the FCR per dozen eggs and per kg egg mass were significantly better in the control group during fortnights at 41-44 weeks of age.

6. Overall mean egg weight (EW) was 63.80, 67.74 and 67.09 g in T1, T2 and T3 respectively resulting significantly lower EW in T1 than that of T2 and T3. The EW was comparable by feeding dried CFWS at levels 11.45 and 22.90 per cent, by partial and complete replacement of DF.

7. The overall mean egg mass (kg) per duck was 4.81, 4.40 and 4.49 in T1, T2 and T3 respectively having comparable mean egg mass between dietary groups.

8. The serum profile of ducks at 44 weeks of age revealed almost similar serum protein levels (4.5, 4.4 and 4.3 mg/dl). While, the serum Ca per cent (17.3, 16.4 and 14.8 mg/dl) was significantly higher in T1 and intermediary in T2 and lower in T3. Conversely, the serum phosphorous was significantly lower in T3 (2.7 mg/dl) than that of T1 and T2 (3.5 and 3.4 mg/dl).

9. Overall mean values of internal egg quality traits revealed non significant variations in albumen index (0.087, 0.105 and 0.094), yolk index (0.41, 0.42 and 0.42), shell thickness (0.54, 0.53, 0.53mm) and per cent shell (10.2,10.1 and 9.9) in T1, T2 and T3.

10. Livability from 25 to 44 weeks of age was 100 per cent in T1 and T2 and 96.88 per cent in T3.

11. The feed cost of experimental diets was Rs. 8.83, 8.52 and 7.87 in T1, T2 and T3 respectively, the highest being in T1 and the lowest in T3 and intermediary in T2. The feed cost per egg was Rs. 2.74, 2.96 and 2.86 and the return over feed cost per egg was Rs. 0.26, 0.04 and 0.14 in T1, T2 ands T3 respectively.

Considering the above findings, it was concluded that dried CFWS can be included in duck layer rations with significant improvement in mean EW by partial and complete replacement of dried fish on crude protein basis without affecting production traits DHN, feed consumption, FCR and egg mass, under cage system of rearing. It can be surmised that the return over feed cost per egg was high with T1, T3 and T2 in that order and that per kg egg mass was with T3, T1 and T2 in that order.

References

REFERENCES

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

Andrews, C. V., Venugopalan, C.K., Unni, A.K.K. and Ramakrishnan, A. 1984. Comparative performance of Desi ducks reared under two systems of housing. *Kerala J. Vet. Sci.* 15: 140-145

Anon. 2004a. Final report (1999-2004) NATP on "Productivity Enhancement of Ducks" Kerala Agricultural University. pp.12-81

Anon. 2004b. Livestock feed from Cephalopod processing waste. NATP on "Development of Value added products and by-products from Low cost Fish and processing waste from Fish and Shellfish" p. 11

Anon. 2005. *Farm Guide.* Farm Information Bureau, Govt. of Kerala, p.124

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

Applegate, T.J., Harper, D. and Lilburn, M.S. 1998. Effect of hen production on egg composition and embryo development in commercial Pekin ducks. *Poult. Sci.* 77: 1608-1612

Avens, J.S., Athearn, R.M., and McNeal, J.H. 1980 Egg production and efficiency of food conversion of Khaki Campbell ducks under different Management systems. *Brit. Poult. Sci.* 21: 333-337

Barroga, A.J., Barroga, R.M., Tobioka, H. and Pradhan, R. 2000. Growth performance and meat production of fattened paddy herded ducks fed fish silage mixed diets. *Philipp. Agric. Scientist* 87: 140-147

Baruah, R.K., Sharma, P.K. and Bora, N.N. 1991. Egg production of indigenous, Khaki Campbell ducks and their crosses. *Indian J. Poult. Sci.* 26: 193-197

Batterham, E.S., Gorman, T.B.S. and Chvojka, R. 1983. Nutritional value and mercury content of fish silage for growing pigs. *Anim. Feed Sci. Technol.* 9: 169-179

Borin, K., Chou, S. and Preston, T.R. 2000. Fresh water fish silage as protein source for growing fattening pigs fed sugar palm juice. *Liv. Res. Rural Dev.* 12: 35-40

Das, G.C., Goswami, N., Das, D. and Goswami, R.N. 2000. Comparative studies on age at sexual maturity and egg production at different ages of Kahaki Campbell, Desi ducks and their crosses under field condition. *Indian J. Poult. Sci.* 35: 240-242

Dutta, K.K., Pathak, J. N., Dutta, K.K. and Goswami, R. N. 1993. Body weight of Khaki Campbell at different ages under three managemental systems. *Indian Poult. Rev.* 24: 41-43

Espe, M., Haaland, H. and Njaa, L.R. 1992. Substitution of fish silage protein and a free amino acid mixture for fish meal protein in a chicken diet. *J. Sci. Fd. Agri.* 58: 315-319

Eswaran, K.R., Ramakrishnan, A., Venugopalan, C.K. and Nair, G.R. 1985. Comparative performance of Khaki Campbell and Desi ducks, egg production, feed efficiency and egg quality. *Indian J. Poult. Sci.* 20: 42-45

Gajendran, K., Kothandaraman, P. and Sheriff, F. R. 1990. Performance of Khaki Campbell and Desi ducks under intensive system of rearing in maritime monsoon type of climate. *Cheiron* 19: 213-219

Green, S., Wiseman, J. and Cole, D.J.A. 1988. Examination of stability and its effect on the nutritive value of fish silage in diets for growing pigs. *Anim. Feed Sci. Technol.* 21: 43-56

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: 423-427

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., Overland, M. and Skrede, A. 2000. Effects of dietary fish silage and fish fat on growth performance and meat quality of broiler chicks. *Can. J. Anim. Sci.* 80: 625-632

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

Kjos, N.P., Skrede, A. and Overland, M. 1999. Effect of dietary fish silage and fish fat on growth performance and sensory quality of growing-finishing pigs. *Can. J. Anim. Sci.* 79: 139-147

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

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 its nutritional evaluation in broilers. *J. Sci. Fd. Agric.* 79: 1915-1922

Mahanta, J. D. Dutta, D.J. and Rahman, H. 1993. Physical quality characteristics of indigenous and Khaki Campbell duck eggs. *Indian J. Poult. Sci.* 28: 147-149

Mahendrakar, N.S., Khabade, V.S., Rao, R.J., Latha, R. and Dani, N.P. 1991. Influence of feeding fish and poultry viscera silages to broiler chicks on their performance and meat quality. *Int. J. Anim. Sci.* 6: 19-26

McNaughton, J.L., May, J.D., Reece, F.N. and Deaton, J.W. 1978. Broiler chick utilization of hydrolysed fish protein. *Poult. Sci.* 57: 1157

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, p. 147

Myer, R.O., Johnson, D.D., Otwell, W.S., Walker, W.R., and Combs, G.E. 1990. Evaluation of scallop viscera silage as a high protein feedstuff for growing-finishing swine. *Anim. Feed Sci. Technol.* 31: 43-53

Narahari, D. and Sundararasu, V. 1988. Relative performance of ducks on wet and dry mash feeding. *Indian Poult. Rev.* 19: 49

Ngoan, L.D., An, L.V., Ogle, B and Lindberg, J.E. 2000. Ensiling techniques for shrimp byproducts and their nutritive value for pigs. *Asian-Aust. J. Anim. Sci.* 13: 1278-1284

Nwokola, E. and Sim, J. 1990. Comparative evaluation of fermented fish waste, fermented whole herring and fishmeal. *Poult. Sci.* 69: 270-275

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

*Ologhobo, A.D., Balogun, A.M. and Bolarinwa, B.B. 1988. The replacement value of fish silage for fish meal in practical broiler rations. *Biol. wastes* 25: 17-125

Peethambaran, P.A., 1991. Dietary protein and energy requirements of ducks for growth. Ph.D thesis. Kerala Agricultural University, Thrissur, India p. 138

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: 277-282

Ravi, S. 2002. Calcium and Phosphorus requirements of indigenous layer ducks. M.V.Sc. thesis. Kerala Agricultural University, Thrissur, India. p. 98.

Reddy, M.K., Rao, P.V. and Reddy, V.R. 1981. A study on the protein and energy requirements of Khaki Campbell layer ducks. *Indian J. Poult. Sci.* 16: 132-137

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: 68

*Rodriguez, T., Montilla, J.J. and Bello, R.A. 1990. Fish silage prepared from species of shrimp by-catch. 2. Performance trials in fattening chickens. *Archivos-Latinoamericanos de Nutriction* 40: 548-559

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

Rosenfield, D.J., Gernat, A.G., Marcano, J.D., Murillo, J.D., Lopez, G.H. and Flores, J.A. 1997. The effect of using different levels of shrimp meal in broiler diets. *Poult. Sci.* 76: 581-587

Sakthivel, P.C. 2003. Utilization of dried cuttle fish (*Sepia officials*) waste silage for growth in cross bred (Large White Yorkshire x Desi) pigs. M.V.Sc. thesis, Kerala Agricultural University, Thrissur, India, p. 88

Snedecor, G.W. and Cochran, W.G. 1985. *Statistical Methods.* Eighth edition. The Iowa State University Press, Ames, p. 313

Strasdine, G.A., Beames, R.M., Fisher, L.J. and Jones, Y.M. 1988. An assessment of ensiling the processing wastes from dogfish to produce a protein feed for monogastric animals. *Can. J. Anim. Sci.* 68 : 873-880

Strom, T. and Eggum, B.O. 1981. Nutritional value of fish viscera silage. *J. Sci. Fd. Agric.* 32: 115-20

Surendranathan, K.P., 1966. Studies on haematological constituents of duck. MVSc thesis. Kerala Agricultural University, Thrissur, India. p. 101.

172452

Syam Mohan, K.M. and Sivaraman, E. 1993. The feeding value of dried prawn waste in rations for swine. *J. Vet. Anim. Sci.* 24 : 103-108

Tanaka, K., Youn, B.S., Ohtani, S. and Sakaida, M. 1990. Effects of fermented products from the chub mackerel on growth and on lipogenisis and contents of various lipids in liver of growing chicks. *Japanese J. Zootech. 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

Wohlt, J.E., Petro, J., Horton, G.M.J., Gilbreath, R.L. and Tweed, S.M. 1994. Composition, preservation and use of sea clam viscera as a protein supplement for growing pigs. *J. Anim. Sci.* 72: 548-553

* Originals not consulted.

UTILISATION OF DRIED CUTTLE FISH (*Sepia officialis*) WASTE SILAGE IN LAYER DUCK RATION

JAYANT GOVINDAN

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

2005

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

ABSTRACT

An experiment was conducted in Department of Poultry Science, Kerala Agricultural University during the period from June to November, 2004 to assess the utilization of dried cuttle fish waste silage (CFWS) on replacement of dried fish (DF) in indigenous layer duck ration. At the age of 24 weeks, 96 layer ducks were housed under cage system of rearing with two ducks per cage. They were divided into three groups T1, T2 and T3 comprising 32 ducks per group with 8 replicates having four ducks per replicate. The three groups of ducks were fed with dietary combinations of 10 per cent DF and zero per cent dried CFWS (T1), 5 per cent DF and 11.45 per cent dried CFWS (T2) and 22.9 per cent dried CFWS replacing DF completely (T3) and the diets were made isocaloric and isonitrogenous.

The first egg in the flock was laid in groups T1 and T2 at 169 days of age and ages at 10 and 50 per cent production were also early in T1. The overall duck housed number and duck housed per cent production during 25-44 weeks of age were 75.06 and 53.61 in T1 which was though numerically superior was statistically non significant compared with T2 and T3. The overall mean daily feed consumption was 166.36,166.80 and 168.35 g per duck which were statistically comparable between various treatment groups. The overall feed conversion ratio per dozen eggs was 3.58, 4.23 and 4.32 and per kg egg mass was 4.65, 5.14 and 5.22 in T1, T2 and T3 respectively which was non-significant ($P<0.05$). The overall mean egg weight (EW) was 63.80, 67.74 and 67.09 g in T1, T2 and T3 having significantly lower EW in T1, whereas it was comparable between T2 and T3.

The lower DHN in groups fed dried CFWS was compensated by higher mean egg weight and thereby total egg mass in the study periodwas maintained in the cuttle fish waste silage fed groups. All the internal egg quality traits namely, albumen index, yolk index, percent shell and shell thickness did not differ

between treatment groups during five, 28-day periods. Livability was excellent in all groups. Economically, though control group showed higher feeding cost, due to higher egg number it returned higher margin of return over feed cost of rupees 0.26 per egg, whereas it was Rs. 0.04 in T2 and Rs.0.14 in T3.

Thus, it was concluded that dried cuttle fish waste silage can be included at 11.5 and 22.9 per cent levels in duck layer rations with significantly higher mean egg weight as 50 and 100 per cent replacement for dried fish protein under cage system of rearing of ducks.