NUTRITIVE EVALUATION OF PRAWN WASTE FOR GROWTH IN LARGE WHITE YORKSHIRE PIGS

By

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THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Veterinary Science

Faculty of Veterinary and Animal Sciences
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MANNUTHY, THRISSUR - 680651
KERALA, INDIA

2002

DECLARATION

I hereby declare that the thesis entitled "**Nutritive Evaluation of Prawn Waste for Growth in Large White Yorkshire Pigs**" 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
14·05·2002

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CERTIFICATE

Certified that the thesis entitled "**NUTRITIVE EVALUATION OF PRAWN WASTE FOR GROWTH IN LARGE WHITE YORKSHIRE PIGS**" is a record of research work done independently by **Shri. Madhukumar, U.,** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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ACKNOWLEDGEMENTS

*I wish to express my deep sense of gratitude to **Dr. T.V. Viswanathan,** Associate Professor and Head, Department of Animal Nutrition and Chairman, Advisory Committee for his invaluable guidance, critical supervision and wholehearted co-operation throughout the study.*

*My sincere indebtedness and gratitude are due to **Dr. A.D. Mercy,** Associate Professor, **Dr. P. Gangadevi,** Associate Professor, Department of Animal Nutrition and **Dr. P. Kuttinarayanan,** Associate Professor, Department of Livestock Products Technology, Members of the advisory committee for their support, critical supervision and guidance.*

*I sincerely thank **Dr. George Mathen,** professor and Head (Retd.), Department of Animal Nutrition, for the unstinted support, helpful suggestions and meticulous guidance during the study.*

*I owe my sincere gratitude to **Mr. M. Nandakumaran,** Professor, Department of Animal Nutrition for his valuable guidance and timely help in laboratory techniques.*

*I am grateful to **Dr. C.S. James,** Professor and Head (Retd.), **Dr. N. Kunjikutty,** Professor (Retd.), **Dr. K.M. Syam Mohan, Dr. K. Ally, Dr. K. Shyama,** Assistant Professors, Department of Animal Nutrition, **Dr. Joseph Mathew,** Associate Professor, Centre for Pig Production and Research for their inimitable help and keen interest in the work.*

I express my sincere gratitude to ***Dr. M. Sunil,*** *Assistant professor and the other staff of Meat Technology Unit for the help rendered to carry out the slaughter studies.*

I am short of words to express my deep sense of gratitude to my best friends, ***Dr. Sunil Wilson, Dr. T.V. Asitha*** *and* ***Dr. P. Rekha,*** *without whose tireless help, unconditional support and constant encouragement, the successful completion of this research work would not have been possible.*

I wish to place on record my sincere thanks to ***Dean,*** *College of Veterinary and Animal Sciences, Mannuthy for facilities provided and Indian Council for Agricultural Research, New Delhi for providing the Junior Research Fellowship for the period of study.*

Bouquets of special thanks are due to my friends ***Anil, Anwar, Muraly, Reddy, Vijayakumar, Yuvaraj, Paul*** *and* ***Swamy,*** *for their moral support and encouragement from across the miles.*

Camaraderie of ***Rajanna, Manjanna, Jeethendra Shetty, Natesh, Navid, Tejashanker, Sanjeev Gowda, Nanaiha, Prakesh Reddy, Vijay*** *and* ***Rane*** *made stay here comfortable and is sincerely acknowledged.*

I greatly appreciate ***Venugopal*** *and* ***Thomas,*** *for their timely help in the care and management of my experimental animals.*

I take this opportunity to express my thanks to all the non-teaching staff in the Department of Animal Nutrition who have helped me in my work.

I am thankful to the staff and labourers of Centre for Pig production and Research for their help and co-operation.

I am short of words to express my deep gratitude to my fellow ***PGs*** *of 99 and 2000 batches for their company and concern towards my study.*

I remember with gratitude the help rendered by my Assistant Director ***Dr. H.S. Dharanandra,*** *for successful completion of this degree programme.*

Great care and concern shown in giving good shape to its present form of this thesis by ***Mr. T.S. Sumesh,*** *M/s Delta Computers is sincerely acknowledged.*

Any amount of words is not sufficient to acknowledge due love, affection and moral support of my beloved ***Mother*** *and* ***Sister.***

Madhukumar, U.

Dedicated

To

My Mother and Sister

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Introduction

1. INTRODUCTION

In India, pig farming has a special significance as it can play an important role in improving the socio-economic status of a sizeable section of the rural community. The proper development of pig industry on specific and profitable lines as followed in other developed countries of the world will not only help to solve the country's food problem to a great extent, but also improves the nutritional standards of our growing population.

Profitable raising of pigs depends largely on careful planning and efficient feeding programme. Since more than 70 to 75 per cent of the cost of swine production is accounted for the feed, economic formulation of swine ration assumes paramount importance.

Pigs, because of their monogastric nature must be provided with an animal protein supplement in order to balance the essential *amino acids makeup* of the diet. Unsalted dried fish / fish meal is usually used for this purpose, but due to its escalating price and non-availability of good quality material, it has become necessary that alternative sources like prawn waste, hatchery waste, feather meal etc., has to be utilised to reduce the cost of production to a great extent.

Aquatic animal (prawn) waste is an unconventional feed source, which can be exploited to a large extent as a livestock feed ingredient. India ranks eight in total fish landing in the world (Sripathy, 1989). Global annual crustacean waste was estimated as 1.46×10^6 tonnes and substantial quantities of this valuable waste are discarded. About 600km of coastal line, 400 km of backwaters, rivers, lakes, reservoirs and with potential for inland aquaculture development, Kerala stands first among Indian states in production of sea foods. The export oriented shrimp based seafood industry is one of the organised fish processing industries in India. The annual availability of prawn waste in Kerala was estimated as 0.9 lakh tonnes (Fisheries Statistics, 1991). Handling of prawn waste poses problems of disposal due to their high moisture content, quick deterioration, offensive odour and polluting nature. The common practice in Kerala is to use the major portion of the fish processing waste including prawn waste as manure or to throw back to sea.

Prawn waste was subjected to series of feeding experiments in different species of animals in the Department of Animal Nutrition, College of Veterinary and Animal Sciences.

Prawn waste was found to be a potential source of nutrients such as protein and minerals for poultry (Menachery *et al.*, 1978). Prawn waste can be converted to satisfactory silage with proper additives (Ramachandran *et al.*, 1992 and James, 1993). Prawn waste was found to be inferior to fish meal as it lowered body weight gain and less feed conversion efficiency in pigs (Mohan, 1991).

The information about the nutritive value of cooked prawn waste and its effect on carcass characteristics are scanty. Hence, this study was under taken in order to assess the nutritive value of cooked prawn waste and to find out its effects on the carcass characteristics of Large White Yorkshire pigs.

Review of Literature

2. REVIEW OF LITERATURE

2.1 Utilisation of seafood byproducts for animals

Lubitz *et al.* (1945) reported that the mean chemical composition of commercial crab meal was as follows: moisture 6.3 per cent, crude protein 32.7 per cent, crude fat 0.8 per cent, crude fibre 12.9 per cent, ash 41.6 per cent, calcium 16.4 per cent, phosphorus 1.64 per cent, potassium 0.4 per cent, sodium chloride 2.9 per cent, manganese 180 ppm, iron 1063 ppm, riboflavin 2.9 γ/gm, less than one IU of Vitamin A and no measurable amount of Thiamine and Vitamin D.

Crude protein content of prawn waste ranged from 37.6 ~~per cent~~ (Varughese, 1997) to 46.7 per cent (Morrison, 1984).

Chemical composition of shrimp meal varies on the proportion of meal made from shrimp head to meal made from body and tail (Jarquin *et al.*, 1972).

Shahidi and Synoweicki (1991) reported that byproduct from shrimp and different parts of crab contained 17.0 to 32.2 per cent of chitin, 3.4 to 14.7 mg / 100 g of carotenoid pigment and ash content in both the cases did not exceed 0.11 per cent on dry basis.

Both fish and crab waste ensiled with wheat straw were acceptable to sheep, and the nutrients were used efficiently (Samuels *et al.*, 1991).

Abazinge *et al.* (1993) reported that crab waste and wheat straw mixture can be ensiled with the addition of molasses. They found that the addition of 20 per cent molasses appeared to be optimum level that is required to promote fermentation as well as for the development of low pH and the inhibition of offensive odour.

Ensiling of prawn waste with chopped paddy straw in equal proportion (1:1 wet basis) with 10 per cent tapioca flour as additive for 21 days produced satisfactory silage as evidenced from physical, chemical and fermentation characteristics (James, 1993). Nutritive evaluation of prawn waste paddy straw silage in cattle indicated that it has a DCP and TDN contents of 7.4 and 56.6 per cent, respectively on dry matter basis.

Abazinge *et al.* (1994) reported that ensiling crab processing waste, wheat straw and molasses, resulted in a feed with desirable fermentation characteristics and palatability. Dry matter digestibility indicated that the nutrients are largely recovered in the resultant silage, and that the silage could be fed to the ruminants at low levels of production without supplementation. They further reported that, for ruminants at high levels of production, crab waste-straw silage could form a part of the complete diet, supplying both protein and roughage in the diet.

Fresh prawn waste can be satisfactorily ensiled with rice bran (1:1 wet basis) along with additives such as tapioca flour or coconut cake at 10 or 20 per cent levels (Ramachandran *et al.*, 1992). They observed that the optimum period for producing satisfactory silage was 21 days and the silage was found to be safe for animal feeding as evidenced by a low total coliforms and aerobic spore count on microbial examination (Ramachandran *et al.*, 1997).

Angel (1935) observed that when four groups of pigs were fed on diets containing 5, 10, 15 and 20 parts of shrimps, along with basal ration, the rate of gain and feed consumed per unit weight gain were higher with ration containing 10 per cent shrimps during first period (70 days). In the second and third periods the ration containing five per cent shrimps gave the best result.

Brundage *et al.* (1981) conducted a trial in which King crab (*Paralithode camtschaitica*) meal was compared with soyabean meal at two per cent of concentrate supplementation for lactating cows. He concluded that, with certain qualification of King crab meal, it can be a potential source of supplemental protein in concentrates for lactating cows.

Three products derived from shrimp (*Pandalus jordani*) processing waste and protein concentrate extracted from King crab (*Paralithodes camschatica*) waste were evaluated as feed supplements for mink, replacing approximately 10 and / or 20 per cent of the protein in standard wet diet (Watkins *et al.*, 1982). Minks of both sexes and strains fed crustacean waste diets had lower final weight and greater feed consumption than control group fed standard diet.

Anderson and Lunen (1986) observed that the body weight gain of the growing pigs fed iso-caloric and iso-nitrogenous diets containing 0, 5, 10 or 15 per cent crab meal were not significantly different while feed consumed per day and feed / gain were higher for 10 per cent crab meal diet. Carcass index was significantly better with less back fat in pigs fed 15 per cent crab meal diet than those fed five per cent crab meal diets.

Chitin was incorporated at 0.25 and 0.50 per cent levels in commercial feed (control) and fed to broiler chicks (Ramachandran *et al.*, 1993). They observed that the birds fed on diet containing 0.5 per cent chitin showed significant increase in weight and decrease in feed conversion ratio. Weight gain with feed containing 0.25 per cent chitin was not significant and also not economically beneficial compared to the control.

Fifty and hundred per cent replacement of unsalted dried fish with dried prawn waste in the rations of growing and finishing pigs adversely affected body weight gain, feed conversion efficiency and carcass characteristics (Mohan and Sivaraman, 1993). They also reported that digestibility of dry matter and nitrogen free extract was increased when dried prawn waste replaced unsalted dried fish meal partially, but complete replacement decreased the digestibility of crude protein.

2.2 Nutrient requirement of pigs

2.2.1 Protein requirements

Aunan *et al.* (1961) reported that dietary protein levels of 14, 16 or 18 per cent did not have significant effect on daily gain and feed efficiency. While, the pigs fed at 10 per cent protein diet gained slower and were fatter than pigs fed 14 per cent protein diet (Cunningham *et al.*, 1973).

Baird *et al.* (1975) observed greater efficiency of protein conversion on low protein diets in Poland China pigs. While the growth rate and feed gain ratio were improved when the protein levels were increased in the diet of pigs from 16 to 22 per cent (Fetuga *et al.*, 1975). Christian *et al.* (1980) reported that a 16 per cent protein diet decreased marbling scores and improved feed efficiency as compared to 12 per cent protein diet.

Approximate crude protein requirements of growing swine fed *ad libitum* were 22 per cent for 5 to 12 kg body weight, 18 per cent for 12 to 50 kg body weight and 14 per cent for 50 to 100 kg body weight (Ranjhan, 1981).

Campbell *et al.* (1984) showed that protein intake for the maximal rate of protein deposition was related to energy intake.

Campbell *et al.* (1985a) showed that in pigs of 45 to 70 kg body weight, protein deposition was found to increase up to an energy intake of 33 MJ DE / day. Above that energy level further increase of protein to maintain the constant energy - protein ratio was found to have little effect.

Indian Council of Agricultural Research (ICAR, 1985) recommended crude protein levels of 18, 16 and 14 per cents for pigs weighing 5 to 10, 10 to 40 and 40 to 60 kg, respectively.

Henry *et al.* (1992) reported that increasing the protein level from 13 to 15.6 per cent did not affect the feed intake, but growth rate was lower and feed / gain was increased in finishing pigs.

National Research Council (NRC, 1998) recommendation of protein for pigs of 3 to 5, 5 to 10, 10 to 20, 20 to 50, 50 to 80 and 80 to 120 kg body weights were 26.0, 23.7, 20.9, 18.0, 15.5 and 13.2 per cent, respectively.

2.2.2 Amino acid requirements

Baker *et al.* (1969) found that tryptophan was the first limiting and lysine the second limiting amino acid in corn protein and also that isoleucine, threonine and gluatmic acid-glycine mixture could be considered as a possible third limiting factors.

The tryptophan requirement of growing pigs for maximal weight gain was specified by Boomgaardt and Baker (1973) as 0.71, 0.67 and 0.66 per cent of the protein, respectively at 10, 14 and 18 per cent dietary protein.

An interaction between dietary leucine and isoleucine was demonstrated by Taylor *et al.* (1984). Increasing the dietary leucine concentration to 20.4 g / kg resulted in a deficiency of isoleucine in the basal diet. The daily gain, feed conversion efficiency and carcass quality were significantly improved by increasing the isoleucine concentration from 3.8 g to 4.5 g / kg diet. Dietary leucine concentration did not influence performance at the higher level of isoleucine supply.

Maximum daily gain was produced by feeding at least 10 g lysine per kg feed at 20 kg, about 8.0 g / kg at 80 kg body weight in male Large White Yorkshire pigs fed *ad libitum*. Similar results were obtained in females when fed at 9.9 g lysine per kg at 20 kg, less than 5-6 g / kg at 75 kg body weight (Batterham *et al.*, 1985). Carcass characteristic were largely unaffected by lysine concentration.

For pigs between 20 to 45 kg live weight, the dietary lysine requirement for maximal growth and rate of protein deposition were 0.78 and 0.81g / MJ digestible energy, respectively (Campbell *et al.*, 1985b).

Henry *et al.* (1992) reported that increasing dietary level of lysine from 0.55 to 0.65 per cent in finishing pigs with *ad libitum* access to feed improved average daily gain as well as muscle and fat. Feed / gain was decreased in relation to increased daily feed intake and there was a decrease in carcass length and an increase in muscle depth.

Bikker *et al.* (1994) found that approximately 0.60g of ileal digestible lysine / MJ of digestible energy was required to optimise performance of gilts with high genetic potential for lean growth irrespective of feed intake.

Friesen *et al.* (1994) observed that high-lean-growth gilts of 34 to 72 kg body weight required at least 22 g of total lysine intake per day to maximize crude protein accretion. Lawrence *et al.* (1994) found that a lysine: DE ratio of 3.0 to 3.5 g of lysine / Mcal of digestible energy was required to maximize lean and protein deposition.

Nam *et al.* (1995) suggested that pigs were unable to control their protein and lysine intakes to meet their requirement for growth when given a choice of two isoenergetic diets, which differed in protein and lysine contents.

Owen *et al.* (1995) suggested that early-weaned pigs require approximately 0.48 to 0.52 per cent dietary methionine to maximize growth performance from day 0 to 14 post weaning.

National Research Council (NRC, 1998) recommendations of lysine for pigs of 3 to 5, 5 to 10, 10 to 20, 20 to 50, 50 to 80 and 80 to 120 kg body weight are 1.50, 1.35, 1.15, 0.95, 0.75 and 0.60 per cent respectively, while the methionine requirements are 0.40, 0.35, 0.30, 0.25, 0.20 and 0.16 per cent respectively.

2.2.3 Energy Requirements

Baird *et al.* (1970) proved that levels of crude fibre had no effect on growth rate and feed efficiency, provided energy density was adequate.

There was reduction in growth rate and feed efficiency when energy was restricted in the diet of pigs weighing more than 50kg body weight as shown by Ranjhan *et al.* (1972).

Seerley *et al.* (1978) found that the utilisation of calories for growth was equal for low and high energy diets during cool season, but high energy diets were more efficient in warm season for pigs.

Decrease in daily energy intake by 20 per cent caused a 15 per cent lower live weight gain, 12 per cent lower nitrogen retention, eight per cent lower protein deposition and 20 per cent lower fat deposition in swine (Metz *et al.*, 1980).

The study conducted by Devi (1981) showed that dried tapioca chips could be safely and profitably incorporated in swine ration at a level of 40 per cent in place of conventional feed grains like maize.

Ranjhan (1981) reported digestible energy requirements of 3800, 3500 and 3300 Mcal / kg for weaning (5 to 12 kg), growing (12 to 50 kg) and finishing (50 to 100 kg) categories of swine, respectively.

Thomas and Singh (1984a) observed a reduction in average daily gain, and digestibilities of dry matter, organic matter, ether extract, crude carbohydrate and crude protein when digestible energy content of grower pig ration was lowered by 15 per cent from NRC standards. Campbell *et al.* (1985a) found that protein deposition was linearly related to energy intake.

Indian Council of Agricultural Research (ICAR, 1985) recommends digestible energy levels of 3100 and 3000 kcal / kg feed for pigs weighing 5 to 10 and 10 to 60 kg respectively. Akita *et al.* (1991) reported that the average daily gain increased with increase in TDN intake.

When pigs were given increasing levels of energy (13.3, 14.0 and 14.7 MJ of DE / kg) the average daily gain, gain to feed ratio and back fat thickness increased linearly with increase in digestible energy level (Nam and Aherne, 1993). The maximum average daily gain was with 14.7 MJ digestible energy / kg.

Lawrence *et al.* (1994) found that when pigs were fed rations containing 3.50 and 3.78 Mcal of DE / kg, there was a reduction in feed intake and an improvement in the feed efficiency as digestible energy level was increased.

Smith *et al.* (1996) were of the opinion that energy density of the growing phase diet can be increased to improve gain: feed. However, during the finishing phase, increased energy density decreased average daily gain.

The National Research Council (NRC, 1998) recommended 3400 Kcal of digestible energy or 3265 Kcal of metabolisable energy per kg diet for pigs of all age groups.

2.2.4 Energy-protein interrelationship

Baird *et al.* (1975) opined that more of protein was used efficiently at lower level of intake and that high energy diet had a protein saving effect by improving feed efficiency.

Reddy *et al.* (1982) found that a diet with 18 per cent protein and 3.1 or 3.3 Mcal of DE / kg was superior in promoting better average daily gain and feed efficiency in growing Large White Yorkshire pigs.

Sivaraman and Mercy (1986) observed non significant difference in the average daily gain and feed conversion efficiency of pigs fed rations containing three levels of protein *viz.*, 14, 17 and 20 per cent and three levels of energy *viz.*, 2900, 3100 and 3300 kcal of digestible energy per kg. However, the cost per kg live weight was the least for the animals maintained on 20 per cent crude protein and 3300 kcal of digestible energy per kg feed.

Kyriazakis and Emmans (1992) showed that efficiency of protein utilization increased with an increase in starch intake in pigs.

Xie *et al.* (1994) found that the optimum requirement for digestible energy and crude protein were 13.81 MJ / kg and 16 per cent at 20 to 35 kg; 13.81 MJ / kg and 14 per cent at 35 to 60 kg and 13.81 MJ / kg and 12.77 per cent at 60 to 90 kg body weight in pigs.

2.3 Feed conversion efficiency and average daily gain

Aunan *et al.* (1961) reported that there were highly significant differences for daily gain between breeds. Duroc pigs gained weight faster and more efficiently than Hampshire.

Dhudapker *et al.* (1971) found that there was no significant difference in average daily gain when pigs were fed ration with three different levels of digestible energy (3500, 3200 and 3000 kcal DE / kg of ration), the average daily gain being 460 g. Also, no significant difference in the efficiency of feed utilisation was noticed.

Cunningham *et al.* (1973) reported that the effect of level of dietary protein on feed efficiency was highly significant. They found that pigs fed 14 per cent protein diet had a feed efficiency of 3.2 compared to a feed efficiency of 3.87 for pigs fed 10 per cent protein diet.

Kumar *et al.* (1974) reported that feed efficiency in pigs decreased gradually with increase in body weight.

Cromwell *et al.* (1978) opined that increasing the dietary energy level from 2900 to 3670 kcal of metabolizable energy / kg resulted in linear improvement in gain.

Agrawal *et al.* (1982) obtained no significant difference in the mean daily weight gain, time taken to attain slaughter weight and feed / gain ratio, when 30 and 60 per cent maize in the ration of pigs were replaced by wheat bran.

Campbell *et al.* (1984) found that there was a significant interaction between the effects of dietary protein content and feeding level for growth rate and feed conversion ratio. Pigs fed at the higher level (1.93 kg feed per pig per day at 45 kg to a maximum of 2.97 kg per pig per day at 80 kg live weight) grew faster than those fed at restricted levels (1.51 kg per pig per day at

45 kg to a maximum of 2.32 kg per pig per day at 80 kg live weight).

Thomas and Singh (1984a) found that when pigs were fed rations with 100 per cent, 90 per cent and 85 per cent of NRC levels of digestible energy, there was significant reduction in average daily gain as the plane of feeding was reduced.

Sikka *et al.* (1987) reported that the efficiency of feed utilization in pigs maintained on 14 and 16 per cent protein diets was lower than those maintained on 18, 20 and 22 per cent protein diets.

2.4 Apparent digestibility of nutrients

2.4.1 Influence of energy levels in the diet

Dhudapker *et al.* (1971) observed that the digestibility of organic matter and Nitrogen free extract was significantly higher with ration containing 3500 kcal of DE per kg than for rations with 3200 and 3000 kcal of DE per kg.

Thomas and Singh (1984a) found that when pigs were fed rations with 100 per cent, 90 per cent and 85 per cent of NRC level of digestible energy, there was significant reduction in the digestibilities of dry matter, organic matter, ether extract, crude carbohydrate and crude protein.

2.4.2 Influence of protein levels in the diet

Sikka *et al.* (1987) conducted metabolism trials to assess the effect of protein level on nitrogen digestibility and observed that in summer, the apparent nitrogen digestibility of 14 and 16 per cent protein diets were lower (71.24 and 72.05) than those of 20 and 22 per cent protein diets (76.75 and 77.15). In winter, the digestibility of nitrogen of the 14 per cent protein diet (71.50) was lower than that of 20 and 22 per cent (76.75 and 77.80) but higher than that of 16 per cent (69.61).

2.4.3 Influence of fibre levels

Ranjhan *et al.* (1972) found that the dry matter and crude protein digestibility were significantly decreased when high fibre diets were fed to pigs during the finishing period.

2.5 Body weight

The body weight of pigs at sixth month of age ranged from 55.0 to 57.6 kg, when varying levels of tapioca starch waste was added in swine ration (Sebastian, 1972).

Pandey *et al.* (1997) reported that genetic group, season of birth and weaning weight had highly significant effect on body weight at all ages whereas, sex and interaction between genetic group, and sex had no significant influence at all ages. Birth weight had highly significant influence during pre weaning period but its effect was non-significant during post - weaning period.

2.6 Factors influencing carcass quality

There are many factors that affect the carcass quality in swine.

2.6.1 Influence of energy levels

Robinson (1965) recorded positive correlation between energy intake and carcass length in swine, and no significant effect of energy level was obtained on any of the other carcass characteristics.

As the dietary level of energy increased there was a faster growth rate and low lean content in pigs (Robinson, 1976). He also observed that the dressing percentage was significantly higher in animals on low plane of nutrition than those on high plane.

Increased energy levels increased carcass back fat thickness (Baird *et al.*, 1970) and decreased energy levels decreased carcass back fat (Talley *et al.*, 1976).

Ramachandran (1977) reported that variation in dietary energy and protein levels in the rations of pigs did not have any affect the carcass traits. However, Metz *et al.* (1980) observed that restriction of the daily energy intake by 20 per cent carried an eight per cent lower carcass muscle growth and 28 per cent lower fatty tissue growth.

Thomas and Singh (1984b) reported that the dressing percentage, carcass length, eye muscle area and back fat thickness were significantly low as the level of DE in the rations were decreased from 100 per cent or 90 per cent to 85 per cent of NRC standards.

Sivaraman and Mercy (1986) could not obtain significant difference in any of the carcass characteristics studied when pigs were fed rations varying in dietary energy and protein levels except that the leaf fat weight showed a positive correlation with the energy content of the ration.

Kyriazakis and Emmans (1992) indicate that an increase in the intake of energy significantly increase the body weight, protein and lipid gain of pigs slaughtered.

Heugten and Stumpf (1996) reported that a metabolizable energy level of 3275 kcal / kg feed was sufficient to maximize average daily gain and a further increase in the level of energy resulted in increased back fat thickness in finishing pigs.

2.6.2 Influence of dietary protein levels

Varying dietary protein levels of 14, 16 and 18 per cent did not had a significant effect on daily gains and carcass measurement in pigs as reported by Aunan *et al.* (1961).

Cunningham *et al.* (1973) found that carcass from pigs fed 10 per cent protein diet had more back fat, less per cent ham, loin and smaller loin eye area compared to pigs fed 14 per cent protein.

Irvin *et al.* (1975) reported that increasing the protein level from 12 to 18 per cent resulted in decreasing back fat and increasing lean for straight bred while not affecting back fat thickness in crossbred pigs.

Pigs fed high protein diet showed better feed efficiency, average daily gain and yielded carcass containing a higher percentage of lean cut, less back fat and more loin eye area than those fed low protein diet (Cromwell *et al.*, 1978).

Campbell *et al.* (1984) reported that, for pigs given diet deficient in crude protein, rate of protein deposition was linearly related to protein intake but independent of energy intake. For pigs given inadequate crude protein, rate of protein deposition was related to energy intake independent of crude protein intake.

Latimier and Dourmad (1994) studied the effect of three protein feeding strategies for grower and finisher pigs and found that growth rate and feed conversion efficiency were similar in all groups, while the dressing percentage decreased with increased dietary protein.

Xie *et al.* (1994) reported that back fat thickness was influenced by energy level and the lean percentage by crude protein level.

2.6.3 Influence of calorie: protein ratio

Sharda and Vidyasagar (1986) reported that pigs fed diets containing 16.2, 14.4, 12.6 and 11.7 per cent crude protein and 3500, 3300, 3300 and 3300 Kcal digestible energy per kg diet during 10 to 20, 20 to 35, 35 to 60 and 60 to 75 kg body weight periods respectively, produced leanest carcass. The dressing per cent and carcass length were not influenced to a great extent by altering the calorie: protein ratio in the diet.

2.6.4 Influence of crude fibre in the diet

There was a significant reduction in back fat thickness when the fibre level was increased and energy level was decreased in diet of pigs after they reached 50 kg body weight (Ranjhan *et al.*, 1972).

Baird *et al.* (1975) showed that feeding a diet which had four per cent crude fibre, resulted in lower dressing per cent and back fat thickness, but higher percentage of ham, loin and significantly more lean cuts than those fed a diet, which had eight per cent crude fibre.

2.6.5 Influence of live weight and age at slaughter

The yield of head, hot and chilled carcass dressing per cent, back fat thickness and loin eye area were significantly more in higher age group while, per cent ham and lean cut carcass were significantly higher in young animals (Anjaneyalu *et al.*, 1984).

Sivaraman and Mercy (1986) suggested that for obtaining better carcass in terms of dressing percentage, optimum slaughter weight for pigs should be 75 kg. Mishra et al. (1992) observed an increasing trend in the dressing percentage, carcass length and back fat thickness with increase in carcass weight.

Kumar and Barsaul (1987) concluded that the slaughter of pigs at 70 kg body weight would be better and more commercial than at higher weights.

Singh *et al.* (1997) observed progressive increase in carcass length, carcass weight and back fat thickness with the advancement of age. He also suggested that the amount of fat in the early age is comparatively lesser.

Pigs with lesser weight are more desirable for lean cuts as with advancing age and live weight, above 70 kg, the proportion of ham was reduced and that of bacon increased (Singh *et al.* 1998).

2.6.6 Effect of breed

Aunan *et al.* (1961) indicated that there was a highly significant effect of breed on all measures of carcass leanness and daily gain in pigs. Hampshire pigs produced longer carcass with less fat, larger loin area with higher yield of lean cut.

Arora *et al.* (1994) reported non-significant effect of genetic groups on carcass traits except the loin eye area.

Singh *et al.* (1997) reported that crossbred pigs had more dressing percentage compared to pure breeds including exotic and desi pigs. They have also reported that among pure breeds, Hampshire pigs had significantly higher (30.40 cm^2) loin eye area than Large White Yorkshire crosses (23.66 cm^2).

The study conducted by Singh *et al.* (1998) to assess the influence of age on carcass traits showed that, the optimum slaughter age for Landrace and Large White Yorkshire were 131 to 190 days and 371 to 430 days, respectively.

Rohilla *et al.* (2000) found that the slaughter weight, hot carcass weight, dressing percentage, and back fat thickness were significantly higher for Hampshire pigs followed by Large White Yorkshire and Naga local pigs.

2.6.7 Influence of season

Baird *et al.* (1975) found that winter fed pigs gained more slowly, had a higher dressing per cent, yielded more lean and primal cut with larger longissimus dorsi areas than the summer fed pigs.

Materials and Methods

3. MATERIALS AND METHODS

3.1 Animals

Thirty female Large White Yorkshire pigs with an average body weight of 31.4 kg belonging to the Centre for Pig Production and Research (CPPR), Mannuthy were used as experimental animals.

The pigs were divided into three groups of ten pigs each, as uniformly as possible with regard to age and body weight. Ten pigs in each treatment were randomly distributed into five replicates of two pigs each.

The three groups of pigs were randomly allotted to three dietary treatments (T_1, T_2 and T_3). Each replicate was housed in separate pen and were maintained under identical condition of management. All the animals were dewormed before the commencement of the experiment.

3.2 Experimental diets

The pigs were fed rations formulated to contain 16 and 14 per cent crude protein, 3080 and 3030 kcal of digestible energy, during the growing and finishing period, respectively. They were fed the grower ration until they attained an average body weight of 50 kg and thereafter changed to the finisher ration until the animals were slaughtered.

Animals in group I, II and III were allotted to the following three dietary treatments, *viz.*,

I) T_1 - Control: Standard grower and finisher ration.

II) T_2 - 25 per cent of total protein in T_1 replaced by protein from prawn waste.

III) T_3 - 50 per cent of the total protein in T_1 replaced by protein from prawn waste.

In T_2, protein from unsalted dried fish was replaced by protein from prawn waste. Similarly, in T_3 protein from both unsalted dried fish and groundnut cake was replaced by protein from prawn waste.

The method described in Association of Official Analytical Chemists (AOAC, 1990) was followed to estimate the chemical composition of the diets.

The ingredient and the chemical composition of grower and finisher rations (experimental diets) are given in Table 1, 2, 3 and 4 respectively.

Table 1 Percentage ingredient composition of Grower ration

Ingredients	Treatments (%)		
	T_1	T_2	T_3
Yellow maize	34.0	49.0	54.0
Rice polish	20.0	7.0	3.5
Wheat bran	25.5	23.0	21.5
GNC (Expeller)	9.5	9.5	-
Fish meal	9.5	-	-
Prawn waste	-	10.0	19.5
Min Mix*	1.0	1.0	1.0
Salt	0.5	0.5	0.5

* Mineral mixture without salt (KSE Ltd., Irinjalakuda).

Ingredients:
Calcium – 24.0%, Phosphorus – 12%, Magnesium – 0.15%, Sulphur – 0.5%, Iron – 0.5%, Zinc – 0.38%, Manganese – 0.15%, Copper – 0.5%, Iodine – 0.33%, Cobalt – 0.02%, Fluorine (max) – 0.04%, Acid insoluble ash (max) – 2% and moisture – 4%.

Vitamin supplement:
** INDOMIX – A, B_2, D_3 added @ 25g per 100 Kg feed mixed (Nicholas Piramal India Ltd., Mumbai)
Composition per gram
Vitamin A – 40,000 IU, Vitamin B_2 – 20 mg, Vitamin D_3 – 5,000 IU

*** INDOMIX – BE added @ 25g per 100 Kg feed mixed (Nicholas Piramal India Ltd., Mumbai)

Composition per gram
Vitamin B_1 – 4mg, Vitamin B_6 – 8mg, Vitamin B_{12} – 40mcg, Niacin– 60mg, Calcium panthothenate – 40mg, Vitamin E – 40mg.

Table 2 Percentage ingredient composition of finisher ration

Ingredients	Treatments (%)		
	T_1	T_2	T_3
Yellow maize	30.0	45.0	57.0
Rice polish	26.5	19.0	6.0
Wheat bran	29.0	19.5	18.0
GNC (Expeller)	6.5	6.0	-
Fish meal	6.5	-	-
Prawn waste	-	9.0	17.5
Min Mix*	1.0	1.0	1.0
Salt	0.5	0.5	0.5

Table 3 Percentage chemical composition of grower ration on dry matter basis

Item	Treatments (%)		
	T_1	T_2	T_3
Dry matter	89.2	88.8	89.0
Crude protein (N x 6.25)	16.1	16.0	16.1
Ether extract	5.4	5.6	5.7
Crude fibre	6.2	6.1	5.8
NFE	61.1	60.3	59.8
Total ash	11.2	12.0	12.6
AIA	5.4	4.8	4.6
Ca	0.98	1.21	1.22
P	0.70	0.63	0.67

Table 4 Percentage chemical composition of finisher ration on dry matter basis

Item	Treatments (%)		
	T_1	T_2	T_3
Dry matter	88.8	90.1	89.7
Crude protein (NX6.25)	14.0	14.1	14.2
Ether extract	6.0	6.2	6.3
Crude fibre	7.8	7.9	7.6
NFE	62.1	59.9	59.9
Total ash	10.1	11.9	12.01
AIA	6.0	4.2	4.1
Ca	1.02	1.51	1.45
P	0.68	0.80	0.73

The prawn waste was collected from Aroor, Cochin, where major seafood industries are located. The sodium azide (NaN_3) at 0.065 per cent was used as preservative to prevent decomposition during transportation. The prawn waste was cooked and the required quantity of prawn waste was weighed and mixed well with the feed.

3.3 Feeding trial

The pigs of each pen were group fed. *Ad libit*um feeding was followed throughout the experimental period. They were fed in the morning (9.00 AM) and evening (4.30 PM) and were allowed to consume as much feed as they could within a period of one hour. Clean drinking water was provided in all the pen throughout the experimental period.

The pigs were weighed once in a fortnight to record the gain in body weight.

3.4 Digestibility trial

Digestibility trial was conducted at the end of the experiment to determine the digestibility coefficient of nutrients of the experimental diets. The feed and faecal samples collected during the digestibility trial were analysed for proximate composition as per methods prescribed by AOAC (1990).

3.5 Slaughter studies

Four animals from each treatment were selected randomly and slaughtered and dressed as per standard procedure at the end of the experiment for evaluation of the carcass traits.

The head was removed at the atlanto-occipital joint and the dressed weight of the carcass without head was recorded to determine dressing percentage of hot carcass. Weight of head was also recorded.

The length of the carcass was measured from the anterior edge of the aitch bone (os-sacrum) to the anterior aspect of the first rib. The back fat thickness was estimated as an average of the measurement taken opposite to the first rib, the last rib and last lumbar vertebra. The loin eye area or the area of the longissimus dorsi muscle at the 10^{th} intercostal space was cut and traced on a transparent paper (butter paper) and the area was calculated by plotting the trace surface on graph paper.

The dressing percentage was calculated as follows:

$$\frac{\text{Carcass weight}}{\text{Live body weight}} \text{ X } 100$$

3.6 Statistical analysis

The data obtained were analysed by the Completely Randomised Design (CRD) method as described by Snedecor and Cochran (1995). The means were compared using LSD test.

Results

4. RESULTS

4.1 Proximate composition of prawn waste

Proximate composition of six samples of prawn waste collected for the experimental purpose is presented in Table 5. The average values in percentage for the various constituents were: dry matter – 21.24, crude protein – 38.54, Ether extract – 4.87, crude fibre – 14.66, nitrogen free extract – 12.4, ash – 29.50, acid insoluble ash – 1.54, calcium – 9.96 and phosphorus - 1.52.

Table 5 Average per cent chemical composition of prawn waste on dry matter basis

Component	Average* with SE (%)
Dry matter	21.24 ± 0.31
Crude protein	38.54 ± 0.60
Ether extract	4.87 ± 0.07
Crude fibre	14.66 ± 0.42
Nitrogen free extract	12.40 ±2.49
Total ash	29.50 ± 2.14
Acid insoluble ash	1.54 ± 0.156
Calcium	9.96 ± 0.35
Phosphorus	1.52 ± 0.16

* Average of six values

4.2 Live Weight Gain and Feed Conversion Efficiency

The result on the mean values of body weight of pigs under the three dietary treatment T_1, T_2 and T_3, recorded at fortnightly intervals are presented in Table 6 and graphically represented in Fig.1. The data on fortnightly average daily gain and fortnightly feed conversion efficiency are presented in Tables 7 and 8, respectively and graphically represented in Fig.2 and 3 respectively. Table 9 contains data on cumulative average daily gain and feed conversion efficiency of animals of the three dietary treatments (Fig. 4 and 5). The average value for body weight gain of animals belonging to the groups T_1, T_2 and T_3 were 34.7, 35.95 and 34.35 kg respectively.

4.3 Digestibility coefficient of nutrients

The chemical compositions of faeces of pigs fed with different experimental diets were shown in Table 10. Data on digestibility coefficient of nutrients of the three experimental diets T_1, T_2 and T_3 are presented in Table 11 and graphically represented in Fig.6. The digestibility coefficient of dry matter of T_1, T_2 and T_3 were: Dry matter 58.5, 62.4 and 61.2; crude protein 65.1, 68.4 and 62.1; Ether extract 33.6, 37.9 and 33.2; crude fibre

25.2, 26.6 and 26.4; and nitrogen free extract 76.2, 75.5 and 79.6 respectively.

4.4 Carcass characteristics

Data on carcass characteristics of pigs maintained on the three experimental diets T_1, T_2 and T_3 are depicted in Table 12.

The values for body weights of slaughter were 64.25, 64.5 and 64.75 kg, respectively for T_1, T_2 and T_3; 47.87, 46.2 and 48.2 kg for dressed weight without head; 4.6, 4.3 and 4.6 kg for head weight; 66.5, 67 and 65 cm for carcass length; 2.64, 2.56 and 2.79 for back fat thickness, 7.0, 7.01 and 6.4 for ham weight; 74.33, 71.6 and 74.98 for dressing percentage and 21.46, 23.30 and 24.92 for lion eye area.

4.5 Economics of gain

Data on cost of feed per kg body weight gain of pigs maintained on the three dietary treatments are presented in Table 12 and Fig.7. The values were Rs. 28.95, Rs. 23.84 and Rs. 21.18 for T_1, T_2 and T_3 respectively.

Table 6 Fortnightly body weights (kg) of pigs maintained on three dietary treatments (Mean ± Se)[a]

Fortnights	Treatments			
	T_1	T_2	T_3	F value
0	31.4± 0.34	31.4±0.28	31.4±0.45	0.27 (NS)
1	37.70±0.40	37.95±0.40	36.8±0.91	0.93 (NS)
2	44.50±0.51	45.05±0.67	43.05±0.68	2.69 (NS)
3	50.20±0.74	51.55±1.02	49.50±0.84	1.39 (NS)
4	55.90±1.21	57.00±1.00	55.65±1.00	0.44 (NS)
5	61.50±1.30	62.55±1.13	61.00±0.88	0.22 (NS)
6	66.10±1.51	67.35±1.99	65.75±0.94	0.29(NS)

NS Non significant

a Mean of ten values with SE

Fig.1. Fortnightly average body weight of pigs fed on the three dietary treatments

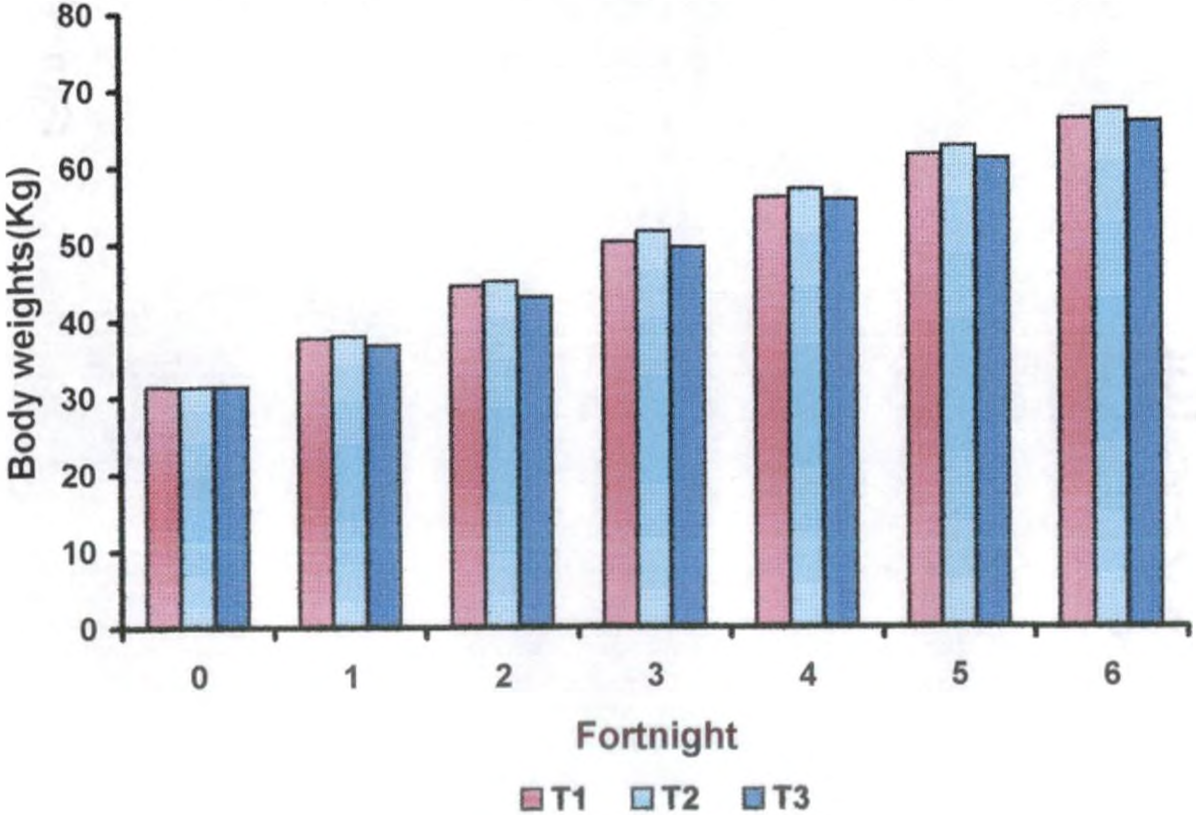


Table 7 Fortnightly average daily gain (g) of pigs maintained on three dietary treatments (Mean ± SE)[a]

Fortnights	Treatments			
	T_1	T_2	T_3	F value
1	419.99± 24.67	399.99± 10.11	359.99± 50.68	3.13 (NS)
2	453.33± 21.80	473.33± 23.85	416.66± 27.64	1.77 (NS)
3	379.99± 24.67	433.33± 26.24	426.66± 15.34	2.83 (NS)
4	380.10± 36.93	363.93± 22.36	410.00± 25.4	0.09 (NS)
5	373.33± 22.90	370.00± 21.39	356.66± 15.19	1.57 (NS)
6	306.6± 19.20	319.99± 54.44	316.66± 14.14	0.06 (NS)

NS Non significant

a Mean of ten values with SE

Fig.2. Fortnightly average daily gain of pigs maintained on the three dietary treatments

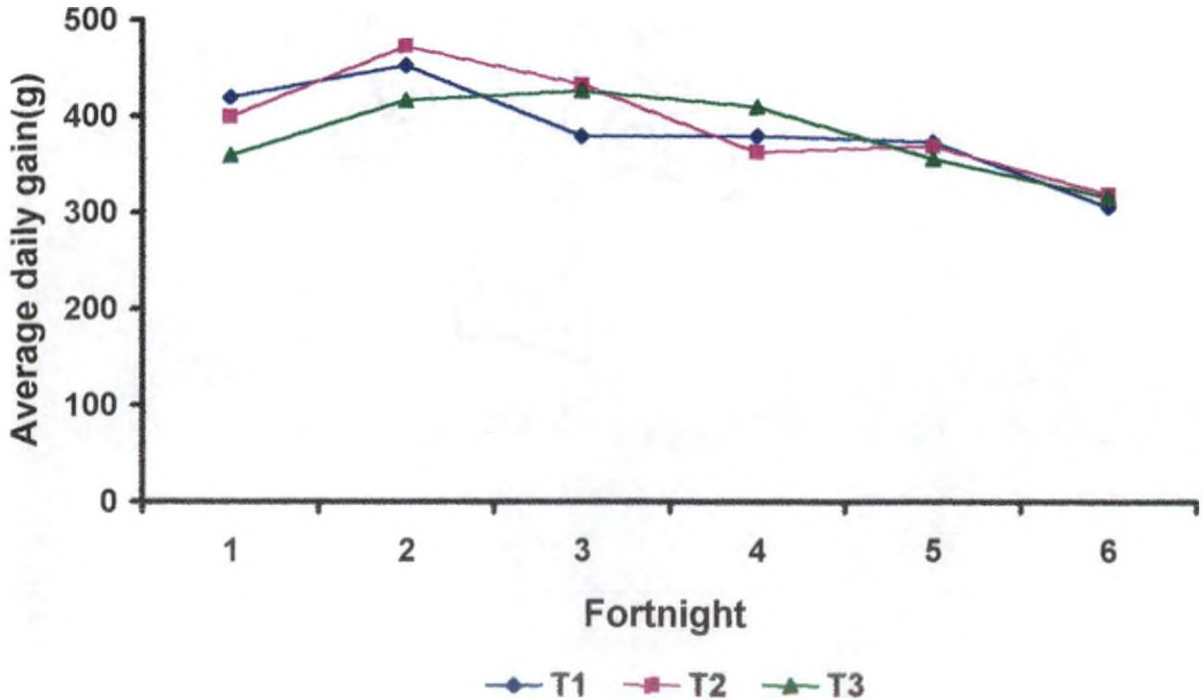


Table 8 Feed conversion efficiency of pigs maintained on three dietary treatments at fortnightly intervals (Mean ± SE) [a]

Fortnights	Treatments			
	T_1	T_2	T_3	F value
1	3.57±0.20	3.75±0.10	4.16±0.70	2.34 (NS)
2	3.28±0.15	3.16±0.17	3.60±0.29	1.33 (NS)
3	5.26±0.30	4.61±0.27	4.80±0.16	1.10 (NS)
4	5.26±0.55	5.50±0.30	4.87±0.26	0.01 (NS)
5	5.36±0.32	5.40±0.30	5.60±0.47	1.37 (NS)
6	6.53±0.47	6.00±0.76	6.31±0.36	0.02 (NS)

NS Non significant

a Mean of ten values with SE

Fig.3. Fortnightly feed conversion efficiency of pigs maintained on the three dietary treatments

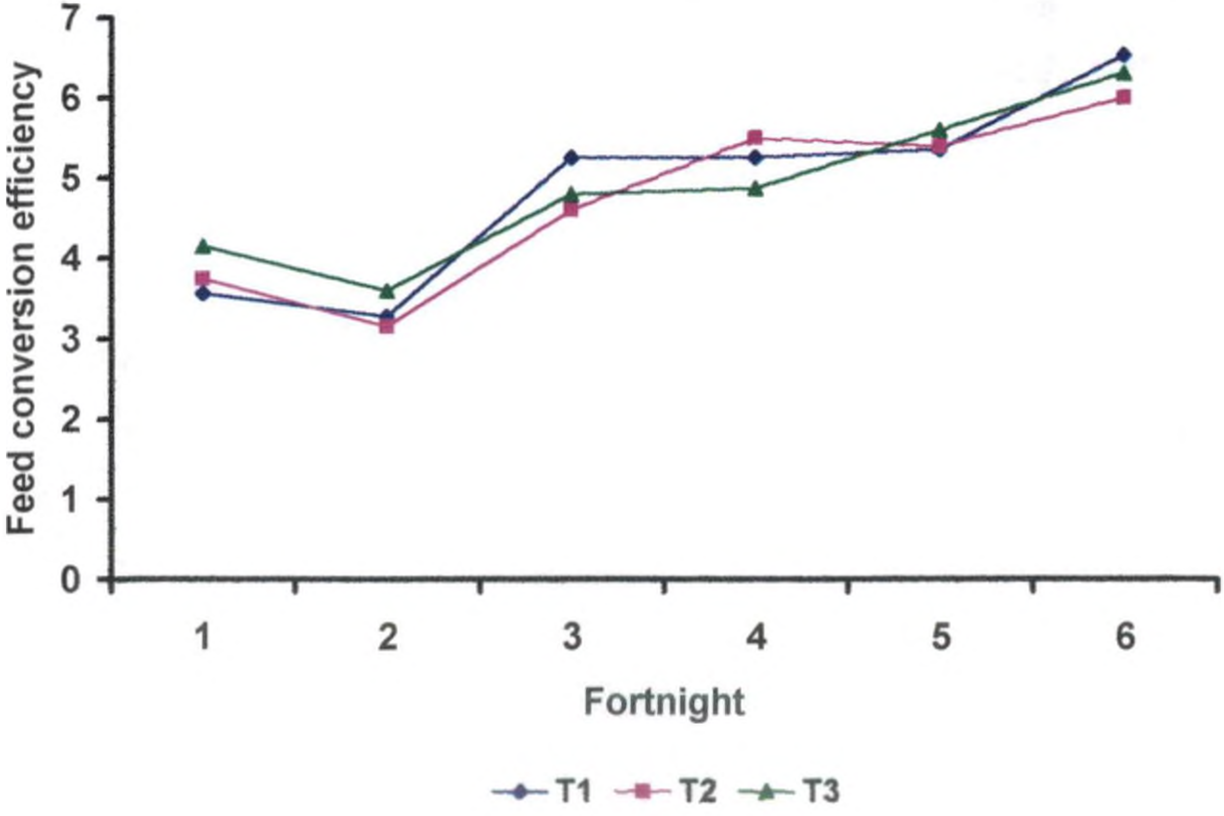


Table 9 Cumulative average daily gain and feed conversion efficiency of pigs maintained on three dietary treatments (Mean ± SE)

Item	Treatments			
	T_1	T_2	T_3	F value
Initial body weight (kg)	31.4±0.39	31.4±0.28	31.4±0.45	0.27 (NS)
Final body weight (kg)	66.1±1.51	67.35±1.99	65.75±0.94	0.02 (NS)
Body weight gain (Kg)	34.7±1.28	35.95±1.77	34.55±1.04	0.14 (NS)
Total feed intake (kg)	165.00	165.00	165.00	
Average daily gain (g)	385.56± 18.41	393.32± 20.32	381.10± 16.13	0.23 (NS)
Feed conversion efficiency*	4.86±0.45	4.73±0.41	4.89±0.36	1.56 (NS)

NS Non significant

Fig.4. Cumulative average daily gain of pigs maintained on the three dietary treatments

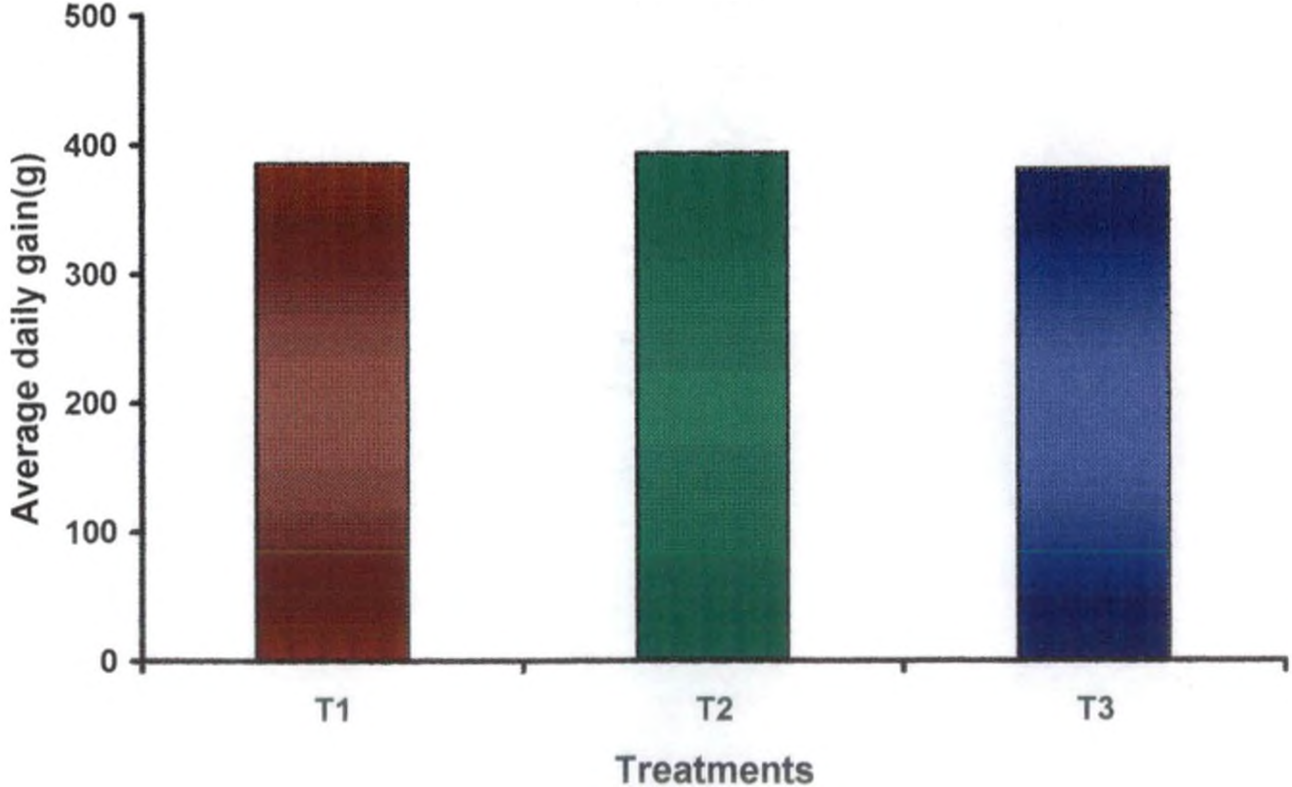


Fig.5. Cumulative feed conversion efficiency of pigs maintained on the three dietary treatments

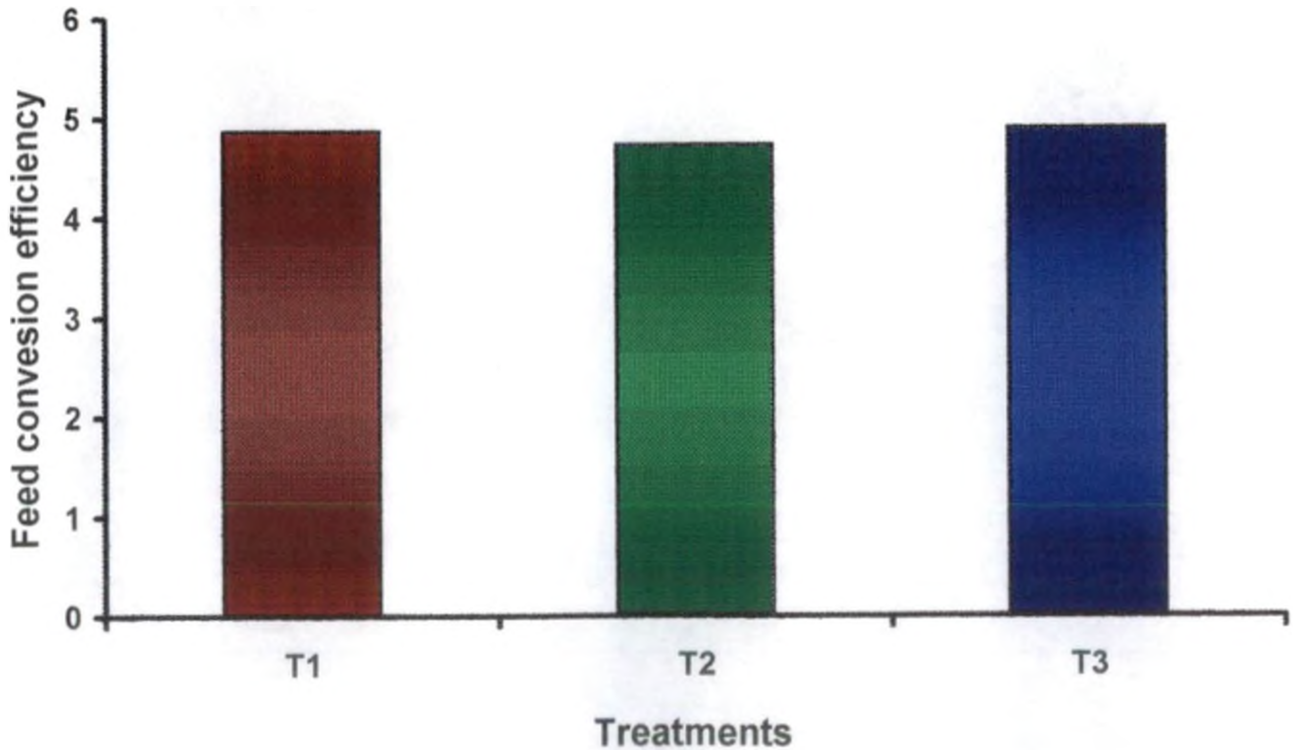


Table 10 Per cent chemical composition of faeces of pigs fed three dietary treatments[a]

Item	Treatments		
	T_1(%)	T_2(%)	T_3(%)
Moisture	65.29	68.19	64.09
Crude Protein (N x 6.25)	11.78	11.74	13.16
Ether extract	5.58	6.01	7.34
Crude fibre	18.21	13.21	13.92
Nitrogen free extract	35.75	40.05	32.83
Total ash	28.68	28.89	32.75
Acid insoluble ash	17.98	14.58	11.30

a Average of ten values on dry mater basis

Table 11 Average digestibility coefficient of nutrients of the three dietary treatments (Mean ± SE)[a]

Nutrients	Treatments			
	T_1	T_2	T_3	F Value
Dry matter*	$58.53^{b} \pm 0.36$	$62.45^{c} \pm 1.5$	$61.20^{cd} \pm 0.60$	4.38
Crude protein**	$65.10^{b} \pm 0.37$	$68.44^{c} \pm 1.23$	$62.14^{d} \pm 1.71$	6.46
Ether extract	33.64±0.63	34.95±2.54	33.27±1.32	0.15 (NS)
Crude fibre	25.21±0.81	26.67±1.30	26.41±1.27	0.27 (NS)
Nitrogen free extract**	$76.20^{b} \pm 0.25$	$75.59^{b} \pm 1.05$	$79.63^{c} \pm 0.34$	7.13

NS Non significant

a Mean of ten values

b, c, d Means with different superscripts within the same row differ significantly

* Significant ($p<0.05$)

** Significant ($p<0.01$)

Fig. 6. Digestibility coefficients of nutrients of the three experimental diets

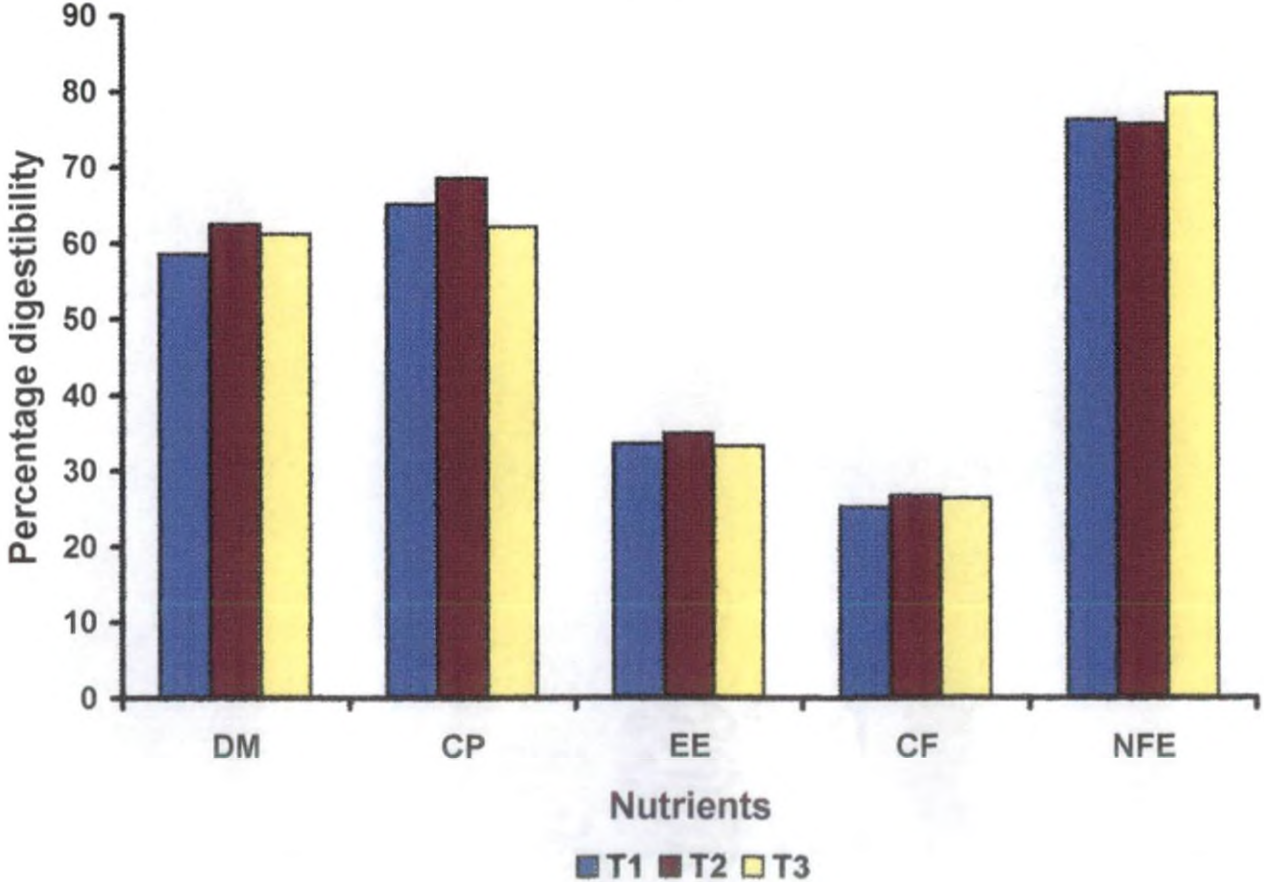


Table 12 Carcass characteristics of pigs fed three dietary treatments[a]

Item	Treatments			
	T_1	T_2	T_3	F Value
Live body weight (kg)	64.25±2.09	64.5±2.5	64.75±1.43	0.17 (NS)
Dressed weight (kg)	47.873±2.10	46.25±3.065	48.25±0.75	0.23 (NS)
Head weight (kg)	4.62±0.11	4.39±0.13	4.61±0.06	0.56 (NS)
Carcass length (cm)	66.5±1.32	67.00±0.40	65.25±1.10	0.77 (NS)
Back fat thickness (cm)	2.64±0.12	2.56±0.20	2.79±0.17	0.43 (NS)
Loin eye area (cm^2)	21.46±0.31	23.31±0.24	24.92±0.57	1.53 (NS)
Ham weight	7.0±0.30	7.01±0.55	6.40±0.16	0.79 (NS)
Dressing percentage	74.33±1.99	71.6±2.92	74.92±0.45	0.46 (NS)

NS Non significant

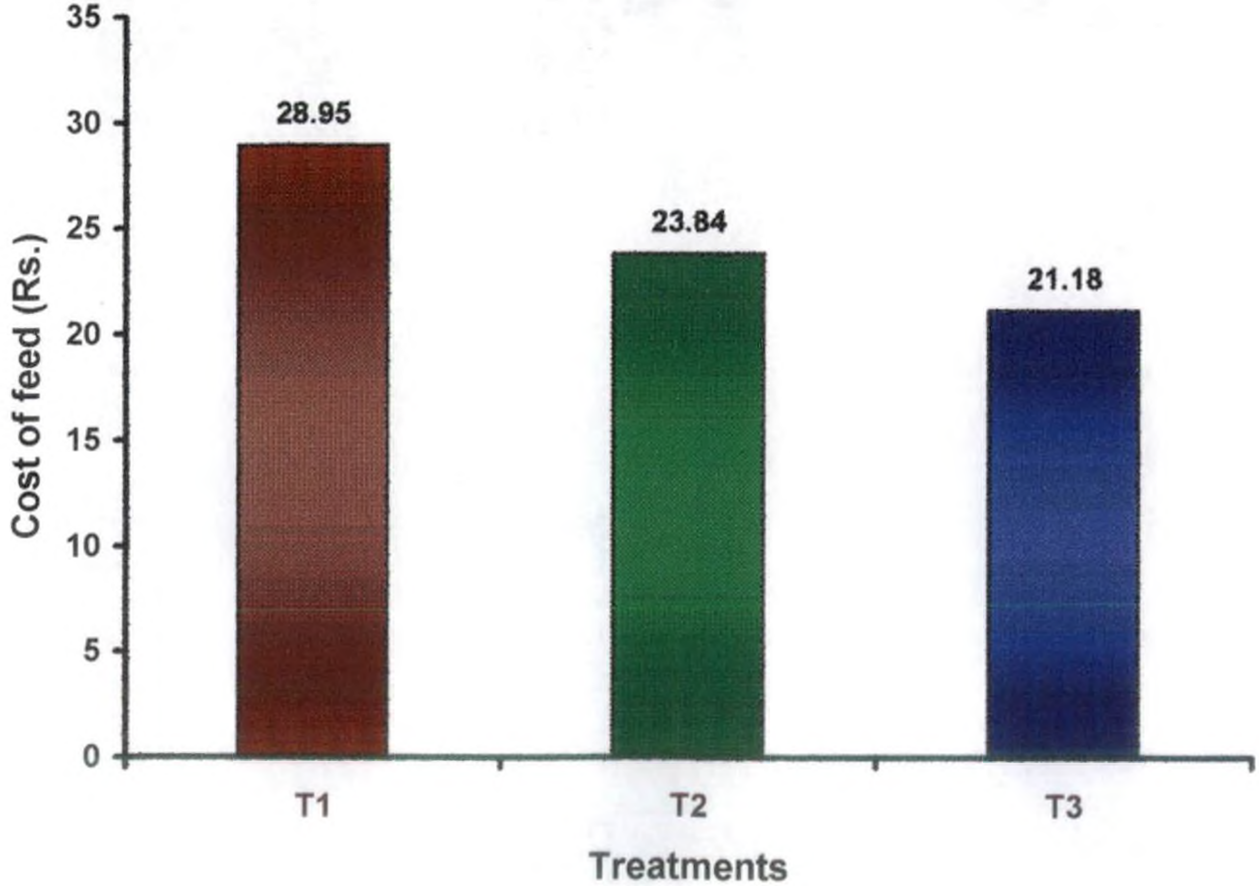
a Mean of four values with SE

Table 13 Cost of feed (Rs.) per kg body weight gain of pigs maintained on three dietary treatments

Item	Treatments		
	T_1	T_2	T_3
Cost/kg of grower ration[a]	6.46	5.43	4.33
Cost/kg of finisher ration[a]	5.96	5.10	4.40
Cost of feed per kg body weight gain (Rs.)	28.95	23.84	21.18

a Cost feed ingredients is based on the rate contract fixed for the supply of various feed ingredients to the farm for the year 2000 - 01.

Fig.7. Cost of feed (Rs.) per kg weight gain of pigs fed different experimental diets



Discussion

5. DISCUSSION

5.1 Body Weight

Treatments T_2 and T_3 containing prawn waste replacing 25 and 50 per cent of animal protein from unsalted dried fish (T_2) and unsalted dried fish + ground nut cake (T_3) respectively, attained almost similar body weights. The body weights recorded for three experimental diets T_1, T_2 and T_3 were 66.1, 67.35 and 65.75 kg respectively at the sixth fortnight. The values recorded for the three experimental diets did not differ ($p>0.05$).

Angel (1935) obtained beneficial effect on supplementing shrimp at 5 to 20 per cent level in the rations of growing pigs. Similar observation was made in the present investigation.

However, a significantly lower growth rate ($p<0.05$) has been reported in pigs fed shrimp shell at 5 per cent and 10 per cent levels in the rations replacing dried fish (Anon, 1988). Similar results obtained when 50 and 100 percent of the animal protein from unsalted dried fish was replaced by protein from prawn waste (Mohan, 1991).

5.2 Average daily gain

The body weight gain during the experimental period were 34.7, 35.95 and 34.55 kg for T_1, T_2 and T_3, respectively. The average daily body weight gain were 385.56, 393.32 and 381.10 g for pigs T_1, T_2 and T_3, respectively. The data indicate that although there was a trend for a higher average daily gain for the pigs in T_2 than those in T_1 and T_3, there was no significant difference between the groups.

Husby (1980) obtained daily weight gain of 770 g in growing pigs, when crab meal replaced 50 percent of soyabean meal. Similar observations were recorded by Luberda *et al.* (1981) who reported an average daily gain of 641, 608 and 606 g, when krill meal was used at 10, 20 and 30 per cent respectively, to replace fish meal in the rations of growing pigs.

Mohan (1991) recorded lesser average daily gain of 236 and 200 g, when prawn waste was included at 50 and 100 per cent as the animal protein source instead of unsalted dried fish respectively.

The better performance of diet containing prawn waste in promoting growth of pigs in the present study may be attributed to better digestibility due to cooking.

5.3 Feed conversion efficiency

The data given in Table 8 and represented in Fig. 2 indicate that pigs maintained on treatments T_1, T_2 and T_3 exhibited almost similar feed conversion efficiency of 4.87, 4.73 and 4.89, respectively. The values for three dietary treatments did not differ significantly.

Ranjhan *et al.* (1972) reported a value of 3.0 and 4.1 for pigs up to 50 kg and 50 to 70 kg body weights, respectively when protein and energy levels in the rations were varied.

Kumar *et al.* (1974) using standard grower and finisher rations obtained a feed conversion efficiency of 3.4, 4.0 and 4.5 for body weights of 50 kg, 50 to 70 kg and 70 to 90 kg, respectively. Similar observations were made by Husby (1980) and Batterham *et al.* (1985) in pigs maintained on king crab meal and prawn offal silage, respectively.

However, feed conversion efficiency of 4.2 and 5.4 was reported in pigs fed rations containing 5 and 10 per cent shrimp shell respectively (Anon, 1988). Mohan (1991) reported feed efficiency of 4.8 and 5.2 for pigs fed rations containing prawn waste at different levels, which is in agreement with the values obtained for pigs on diets T_1, T_2 and T_3 of the present study.

5.4 Digestibility coefficients of nutrients

5.4.1 Dry matter

The dry matter digestibility of diet T_2 (62.4) was significantly higher ($p<0.05$), than those obtained for the diets T_1 (58.5) and T_3 (61.20). There was no significant difference between T_2 and T_3.

Devi (1981) obtained dry matter digestibility coefficients that ranged from 79.6 to 81.8 for diets containing 16 per cent protein with varying levels of dried tapioca chips.

Thomas and Singh (1984a) reported that lowering of digestible energy content of grower pig ration by 10 per cent from NRC level resulted in dry matter digestibility to drop from 81.08 to 60.39 per cent. The digestibility coefficients of dry matter obtained in the present study were found to be lower than those reported by the above workers.

5.4.2 Crude protein

The data on digestibility coefficients of crude protein presented in Table 10 show a significantly higher digestibility ($p<0.01$) in pigs fed diet T_2 as compared to those on diets T_1 and T_3, the values being 68.44, 65.10 and 62.14 respectively.

Devi (1981) obtained average digestibility coefficients crude protein that ranged from 73.0 to 80.3 and 72.4 to 75.3 respectively, Which are higher than those obtained in the present investigation. Similar observations are also made by Thomas and Singh (1984a) who reported that crude protein digestibility lowered from 80.04 to 68.17, when digestible energy content of the grower rations for pigs was lowered by 15 per cent from NRC levels.

Eggum *et al.* (1982) reported that the crude protein digestibility ranged from 57.0 to 73.0 for diets containing varying levels of crude fibre. The above values are in agreement with those obtained for the diets T_1, T_2 and T_3 in the present study.

5.4.3 Ether extract

The digestibility coefficients of ether extract of the diets T_1, T_2 and T_3, were 33.64, 37.95 and 33.27 (Table.10). There was no significant difference between the three experimental groups.

Eggum *et al.* (1982) obtained values that ranged from 27.6 to 35.0 for crude fat in pigs fed diets containing varying levels of crude fibre, which are almost similar to those obtained in the present investigation.

Fernandez *et al.* (1986) conducted digestibility experiments in growing pigs with 26 feed stuffs and diets, and reported that the digestibility coefficients of crude fat was widely variable.

Thomas and Singh (1984a) reported that lowering of digestible energy content of growing pig rations by 10 per cent from NRC level resulted in ether extract digestibility to drop from 91.76 to 76.84 and further lowering by five per cent brought down the ether extract digestibility to 55.1 per cent.

The values reported by Ranjhan *et al.* (1972) and Devi (1981) ranged from 68.7 to 79.0 and 66.9 to 69.9 respectively, these being higher than those obtained in the present experiment.

5.4.4 Crude fibre

The digestibility coefficients of crude fibre for the three experimental diets T_1, T_2 and T_3 were 25.21, 26.27 and 26.41 respectively (Table 10). The values did not differ significantly between the treatments.

Eggum *et al.* (1982) obtained digestibility coefficients of crude fibre that ranged from 24.0 to 31.2 in pigs fed on diets containing 13 per cent crude protein and varying levels of crude fibre. Values obtained for diets T_1, T_2 and T_3 in the present investigation are almost similar to those reported by the above workers.

Ranjhan *et al.* (1972) obtained values ranging from 30.7 to 46.2 for diets with varying crude fibre level. Devi (1981) also reported digestibility coefficient of crude fibre values ranging from 37.1 to 40.0 for diets containing 16 per cent crude protein and varying levels of dried tapioca chips.

The values obtained by the above workers are higher than those obtained in the present investigation.

5.4.5 Nitrogen free extract

The digestibility coefficients of nitrogen free extract for the three experimental diets T_1, T_2 and T_3 were 76.2, 75.5 and 79.6 respectively. The value was higher ($p<0.01$) for pigs fed diet T_3 than for those fed with T_1 and T_2.

Rekha (2001) reported that the digestibility coefficients of nitrogen free extract that ranged from 75.3 to 86.1 for diets containing 16 per cent crude protein and varying levels of DE in the diet. The above figures found to be almost similar to those obtained in the present investigation.

Mohan (1991) obtained values of 61.8 to 76.1, when pigs were maintained on two different levels of prawn waste.

However, Ranjhan *et al.* (1972) obtained values ranging from 58.9 to 64.5 for diets with varying levels of crude fibre. Ramamoorthi (1999) stated values of 67.7, 60.3 and 54.9, when pigs were fed diets containing different levels of silk worm pupae meal. The values obtained by Vasudevan (2000) ranged from 54.78 to 62.2 when pigs were given ration containing maize ground to different particle size. The values obtained by the above workers are considerably lower than those obtained in the present study.

5.5 Carcass characteristics

5.5.1 Dressing percentage

The dressing percentage for pigs in the three dietary treatments T_1, T_2 and T_3 presented in Table 12 were 74.33, 71.60 and 74.92 respectively, and they did not differ significantly.

Talley *et al.* (1976) reported values ranging between 73.0 and 77.0 for dressing percentage of pigs fed different levels of metabolizable energy while Anjaneyulu *et al.* (1984) obtained dressing percentage ranging from 70.9 to 71.4 for pigs slaughtered at the age of 191 to 290 days. These are in agreement with the results obtained in the present study.

However, the values reported by Baird *et al.* (1975), Sebastian (1972), Ramachandran (1977), Devi (1981), Thomas and Singh (1984b), Sivaraman and Mercy (1986) and Sharda and Vidyasagar (1986) were slightly higher than the values obtained in the present investigation.

5.5.2 *Carcass length*

The carcass length of pigs in the three dietary treatments T_1, T_2 and T_3 were 66.5, 66.7 and 65.25 cm respectively, and they did not differ significantly.

Sebastian (1992), Baird *et al.* (1975) Ramachandran (1977), Devi (1981), Anjaneyulu *et al.* (1984), Thomas and Singh (1984b), Sharda and Vidyasagar (1986), Sivaraman and Mercy (1986) and Arora *et al.* (1994) obtained carcass length ranging from 68.5 to 80.0 cm for pigs slaughtered from 70 to 90 kg. These values are higher than those recorded in the present study.

5.5.3 *Back fat thickness*

The Back fat thickness of pigs maintained on the three dieting treatment T_1, T_2 and T_3 were 2.64, 2.56 and 2.79 cm, respectively (Table 12). There was no significant difference between the treatments.

Baird *et al.* (1975), Talley *et al.* (1976) and Seerley *et al.* (1978) reported higher values in pigs fed rations containing varying levels of crude fibre, crude protein and dietary energy.

However, Devi (1981) and Vasudevan (2000) obtained values ranging from 2.2 to 2.8 cm, which were similar to those obtained in the present study.

Thomas and Singh (1984b) observed a reduction in back fat thickness form 4.5 to 2.7 cm in growing pigs when the digestible energy content of the ration was lowered by 10 and 15 per cent of NRC standards.

5.5.4 Weight of ham

The average values for the weight of ham of pigs belonging to three dietary treatments T_1, T_2 and T_3 presented in Table 12 were 7.0, 7.0 and 6.4 kg, respectively. With respect to the half carcass weight and percent yield of ham to the live weight were 21.7, 21.7 and 19.76 per cent respectively. No significant difference could be observed between the treatments T_1, T_2 and T_3.

The observation in the percent study are in agreement with in values reported for yield of ham by Sebastian (1972), Baird *et al.* (1975), Ramachandran (1977), Devi (1981) and Sivaraman and Mercy (1986) in pigs maintained on rations containing ranging levels of energy and protein.

5.5.6 Loin eye area

The average values for eye muscle area of pigs in the three treatments T_1, T_2 and T_3 presented in Table 12 were 21, 23 and 24 cm^2 respectively. There was no significant difference between the three treatments.

Sebastian (1972), Baird *et al.* (1975), Talley *et al.* (1976), Seerley *et al.* (1978), Anjaneyulu *et al.* (1984), Thomas and Singh (1984b) and Arora *et al.* (1994) obtained values that ranged from 23.6 to 34.5 cm^2, which were almost similar to that obtained in the present study.

5.6 Economics of gain

The cost of feed per kg body weight gain of pigs maintained on the three dietary treatments T_1, T_2 and T_3 were Rs. 28.95, 23.84 and 21.18 respectively. The cost of feed per kg body weight gain was lower for T_3 than those for T_1 and T_2. The cost per kg weight gain was found to decrease as the prawn waste level in the feed increased.

It is therefore concluded that inclusion of prawn waste has positive indication as an economically viable alternative animal protein source in the rations for swine.

Summary

6. SUMMARY

A study was carried out to assess the nutritive value of prawn waste for growth in Large White Yorkshire pigs. Thirty female pigs with an average body weight of 31.4 kg were selected from the Centre for Pig Production and Research (CPPR), Mannuthy and were divided into three equal groups, viz., T_1, T_2 and T_3 as uniformly as possible with regard to age, and body weight. The ten pigs in each treatment were randomly distributed into five replicates of two pigs each. The pigs in the three groups were fed on three different experimental diets viz., T_1 - control standard grower (16 per cent CP) and finisher (14 per cent CP) ration, T_2 – 25 per cent of total protein in T_1 (unsalted dried fish) replaced by protein from prawn waste and T_3 – 50 per cent of the protein in T_1 (unsalted dried fish + ground nut cake) replaced by protein from prawn waste.

The experiment was conducted for three months. Each replicate was housed in separate pen and were maintained under identical conditions of management. The piglets were offered feed *ad libitum* twice a day. Records of daily feed intake and fortnightly body weights were maintained throughout the experimental period. Digestibility trial was carried out at the end

of the experiment to determine the digestibility coefficient of nutrients of the experimental diets. At the end of the experiment four animals from each treatment were slaughtered and carcass characteristics were studied.

The average daily gains were 385.5, 393.3 and 381.1 g and the cumulative feed conversion efficiencies were 4.87, 4.73 and 4.89 for the three groups T_1, T_2 and T_3, respectively.

The digestibility coefficients of nutrients were found to be higher for ration T_2 than those of T_1 and T_3. Significant difference ($p<0.05$) in the digestibility coefficient of dry matter was observed between the rations T_1 and T_2. Digestibility coefficient of crude protein in T_2 ($p<0.01$) was significantly higher than that of T_3 and for T_1 ($p<0.05$). Digestibility coefficient of nitrogen free extract of T_3 was significantly higher ($p<0.01$) than that of T_1 and T_2. The digestibility coefficient of ether extract and crude fibre were almost similar for all the three rations.

Carcass characteristics such as dressing percentage, carcass length, back fat thickness, loin eye area and ham weight were not significantly influenced by the inclusion of prawn waste at different levels.

The cost of production per kg weight gain of animals maintained on different dietary treatments were found to be Rs. 29.95, 23.84 and 21.18 for treatment T_1, T_2 and T_3, respectively. The decrease in the cost of feed per kg gain of animals fed with 25 and 50 per cent replacement of total protein in the diet with that of prawn waste is due to elimination of unsalted dried fish and ground nut cake in the diet.

From the present investigation it can be concluded that prawn waste can be economically incorporated in the rations of growing and finishing pigs as a replacement up to 50 per cent total protein in the diet with out affecting growth and carcass characteristics adversely.

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* Originals not seen

NUTRITIVE EVALUATION OF PRAWN WASTE FOR GROWTH IN LARGE WHITE YORKSHIRE PIGS

By

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ABSTRACT OF THE THESIS

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ABSTRACT

An experiment was conducted to assess the nutritive value of prawn waste for growth in Large White Yorkshire pigs.

Thirty female pigs with an average body weight of 31.4 kg were divided into three equal groups as uniformly as possible with regard to age and body weight. The three groups of pigs were maintained on three different experimental diets viz., T_1 control standard grower (16 per cent CP) and finisher ration (14 per cent CP), T_2 - 25 per cent of total protein in T_1 replaced by protein from prawn waste and T_3 – 50 per cent of total protein in T_1 replaced by protein from prawn waste.

The average daily gain recorded for the three groups T_1, T_2 and T_3 were 385.5, 393.3 and 381.1 g respectively. The cumulative feed conversion efficiencies were 4.87, 4.73 and 4.89 for the groups T_1, T_2 and T_3 respectively.

The digestibility coefficients of nutrients were significantly higher in T_2 for dry matter ($p<0.05$) and crude protein ($p<0.01$). Digestibility coefficient of nitrogen free extract was found significantly higher ($p<0.01$) for T_3 than those for T_1

and T_2. The digestibility coefficients of crude fibre and ether extract were almost similar for all the three groups.

Study of the carcass characteristics revealed that dressing percentage, carcass length, back fat thickness, loin eye area and ham weight were not significantly influenced by the inclusion of prawn waste at different levels.

The cost of feed per kg weight gain of animals in different treatments T_1 and T_2 and T_3 were Rs. 29.95, 23.84 and 21.18 respectively.

The above results indicate that, prawn waste can be used economically to replace the protein of the grower and finisher rations for pigs up to 50 per cent level.