DIETARY PROTEIN AND ENERGY REQUIREMENTS OF MEAT TYPE JAPANESE QUAIL *(COTURNIX COTURNIX JAPONICA)* FOR GROWTH

By

K. NARAYANANKUTTY

THESIS

submitted in partial fulfilment of
the requirement for the degree

Doctor of Philosophy

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Poultry Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy - Trichur

1987

DEDICATED
TO
ALMIGHTY

DECLARATION

I hereby declare that this thesis entitled "DIETARY PROTEIN AND ENERGY REQUIREMENTS OF MEAT TYPE JAPANESE QUAIL (*Coturnix coturnix japonica*) FOR GROWTH" 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,
11-8-1987.

K. NARAYANANKUTTY

CERTIFICATE

Certified that this thesis, entitled "DIETARY PROTEIN AND ENERGY REQUIREMENTS OF MEAT TYPE JAPANESE QUAIL (*Coturnix coturnix japonica*) FOR GROWTH" is a record of research work done independently by Sri. K. Narayanankutty 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.

Dr. A. Ramakrishnan, Ph.D.,
(Chairman, Advisory Board)
Director,
Centre for Advanced Studies in
Poultry Science.

Mannuthy,
11 -8-1987.

ACKNOWLEDGEMENTS

I express my deepest sense of gratitude to Dr. A. Ramakrishnan, Ph.D., Director, Centre for Advanced Studies in Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy for his valuable guidance, constant encouragement and constructive criticism during the period of study. But for his unstinted support and help as the Chairman of the Advisory Committee it would have been difficult for me to have completed this work.

I am greatly indebted to Dr. A.K.K. Unni, Ph.D., Senior Scientist, All India Co-ordinated Research Project on Poultry for Eggs, Mannuthy; Dr. R. Sabarinathan Nair, Ph.D., Professor, University Poultry and Duck Farm, Mannuthy; Dr. M.G. Ramakrishna Pillai, Ph.D., Professor of Physiology and Dr. C.T. Thomas, Ph.D., Professor of Nutrition for their wholehearted help and valuable suggestions as members of advisory committee.

I am highly greatful to Dr. K. Radhakrishnan, Dean-in-Charge, College of Veterinary and Animal Sciences, Mannuthy and Dr. M. Krishnan Nair, Ph.D., Director, Veterinary Education and Research, Kerala Agricultural University for granting permission to carry out this investigation.

I place on record my sincere thanks to Sri. N. Raveendranathan, Associate Professor of Statistics,

College of Co-operation and Banking, Mannuthy; Sri.V.K.G. Unnithan, Associate Professor,of Statistics, College of Horticulture, Vellanikkara; Sri. M. Viswanathan Nair, Senior Programmer, Computer Centre, Vellanikkara; and staff members of Department of Statistics, College of Veterinary and Animal Sciences, Mannuthy for rendering help in statistical analysis of the data pertaining to this study.

The help extended by the staff members and post-graduate scholars of the Department of Poultry Science and all other sincere friends and wellwishers is highly cherished.

Co-operation and help rendered by Dr. T.C. Brahma, Asst. Professor, Department of Dairying and Animal Husbandry, College of Agriculture, Assam Agricultural University is acknowledged.

I am grateful to the Indian Council of Agricultural Research for the award of Senior Fellowship in Animal Nutrition (including Poultry Nutrition) and Kerala Agricultural University for granting study leave.

The acknowledgements would not be complete unless the understanding and accommodative spirit shown by my family members especially my wife Smt. Leelavathy and son Master Nikhil Krishnan is placed on record. My parents have been a guiding force throughout my studies.

Mannuthy,

-1987.

(K. Narayanankutty)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

Introduction

INTRODUCTION

Many developing countries are experiencing gross under-nutrition and malnutrition in human diet. The phenomenon is glaringly evident with animal protein sources which have high biological value. The gap between availability and demand for animal products is of the order of about five million tonnes (Phogat and Chopra, 1984). The per capita availability of poultry meat in India during 1985 was estimated to be in the order of 240 g (Anon., 1986b) which is quite low when compared to many developed countries.

The world over, production of poultry and game have captured the imagination of meat consumers on account of the variation it offers from red meat. While chicken, among poultry, have established itself as the principal species of meat production, ducks and quails are also becoming birds with appeal.

Quail, popularly known as 'Bater' is a table delicacy since olden times. Japanese quail comes under the class 'Aves', family 'Phasianidae' and genus 'Coturnix', hence named '*Coturnix coturnix japonica*' (Phogat and Chopra, 1984) and is a native habitat of Japanese Islands (Pani, 1978).

Of late a few species have been domesticated. In the earlier phase of domestication, Japanese quails (*Coturnix coturnix japonica*) were essentially maintained as fancy birds to listen to their song (popularly called 'quail song').

Subsequently this species was used as an experimental bird in the field of medical, nutritional and biochemical research. In the recent past many countries have taken up rearing Japanese quail as a commercial meat producer. In India too, the trend has been set to commercially exploit this species. It was in 1974 that Japanese quails were first introduced in India at the Poultry Division of IVRI (now CARI) and since then a lot of attention is being paid by researchers on the nutrition, management and other aspects of rearing this species for commercial exploitation.

Considering the production potential and large acceptability as a source of meat and egg, quail production is progressing very fast all over the country. The possibility of expansion potentiality of quail and its products are immense and challenging. This will bring a new shape for rural development by way of self-employment, thereby increasing the national income. The increased production of quail meat, egg and its products and making their availability easier and cheaper will promote the consumption of these nourishing products by weaker sections of the society.

Feed is one of the most important factors which determine the success of any poultry enterprise and quail is no exception. Balanced feeding of nutrients play a key role in the profitability. Central to an understanding of growth and food utilization in any species is a knowledge of their energy and

nitrogen (N) metabolism. Protein and energy represent approximately 90% of the cost of the ingredients in a ration (Anon., 1983) and these are the nutrients the levels of which a nutritionist is constantly trying to alter in his search for least cost rations. Many nutritional adjustments which have no effect on live weight gain per se do have dramatic effects on carcass finish and subsequent production. Since there appears to be no such information in quails, it is necessary to examine the extent to which the quality characteristics of meat type quail carcass and subsequent production could be influenced by nutrition, particularly by the alteration of dietary energy and protein levels and the ratios between them.

The interaction between genetic potential and the plane of nutrition under a given environment serves as a guideline about the performance of quails in tropical and sub tropical countries. Very limited work has been undertaken in this direction. Much research work has been done on nutrient requirements of quail in temperate zones. Evidence is available for chicken that the nutrient requirements established in temperate zones may not be applicable in tropics. Hence there is scope for assessing the nutrient requirements for Japanese quails in tropical environment.

The research work carried out on the nutrition of Japanese quail is rather scanty. The NRC (1971) has suggested the requirements in respect of few nutrients only, while ISI has

not made any recommendations on the nutrient requirements of Japanese quail. Therefore the present study has been undertaken to establish the dietary protein and energy requirement of Japanese quail raised for meat production. The results of the study will help in the formulation of economic and efficient ration for quails for meat production. Further, it is also the objective of this project to assess the optimum age of slaughter of meat type quail, both in terms of feed efficiency and meat characteristics.

Review of Literature

REVIEW OF LITERATURE

Energy-protein requirement

The ingredients chosen for manufacture of poultry feeds should be judiciously selected for the formulation of economic rations since protein and energy rich sources are very costly. In recent years poultry nutritionists have been attempting to arrive at biological optimum levels of protein and energy in poultry rations under different agroclimatic conditions for economic production. The requirements of these nutrients are also influenced by the size and strain of bird, housing system and environment, stage of growth and production, and the ratio between these nutrients in the diet and its inter-relationship with other nutrients present in the diet.

Although few reports have been published recently with respect to the nutrient requirements of Japanese quail, the response in terms of the quality and yield of meat of these birds to the changes of protein and energy is not clear. In chicken to greater extent the feed intake is required to meet the energy requirement. However, this adjustment is not linear and birds offered high energy diets tend to deposit additional fat by consuming more energy (Hill, 1956; Donaldson et al., 1956, 1957; Wells, 1963; Morris, 1968). This effect has not been documented in Japanese quail (Coturnix coturnix japonica) by changing the dietary energy.

The results of studies carried out in India and abroad on

the protein and energy requirements and processing yields and losses of growing quails are projected below:

Baldini et al. (1953a) found that the protein requirement of the growing quails upto six weeks of age was not more than 20 per cent when the diet was supplemented with vitamin B_{12} and antibiotics. A supplement containing vitamin B_{12} and antibiotic, aureomycin, had a beneficial effect on the growth and livability of the quail when included in low protein diets. When fed diets containing protein percentages of 28.5, 24.4 and 20.5 the body weight upto six weeks for quails, during growing period were 98, 97 and 82 g respectively and mortality per cent were 9, 6 and 46 and feed per gain were 3.36, 3.18 and 3.42 respectively. The authors also reported that the addition of an antibiotic and B_{12} vitamin supplement to the 20 per cent protein diet resulted in growth equal to that obtained with the 28 per cent protein diets but with the consumption of less feed and less protein.

Baldini et al. (1953b) confirmed their earlier finding in another experiment that the protein requirement of the growing quails upto six weeks was not more than 20 per cent of the diet provided the amino acid, lysine is supplied in adequate amount. The lysine requirement of the growing quail was estimated to be 1.3 per cent of the diet when the protein level was 20 to 24 per cent.

An energy level of 2970 KCal ME/kg diet was suggested for quail starter diets by Scott (1966).

Weber and Reid (1967) conducted a series of three experiments to study the protein requirement of young coturnix quail to five weeks of age. The sole protein source was soyabean meal (44 per cent protein) supplemented with methionine. The first and second experiments used protein levels from 15.1 to 28.8 and 13.5 to 36.3 per cent respectively in increments of approximately 5 per cent. The third experiment involved protein levels of 12.5 to 31.3 per cent in varying increments. All experimental diets were isocaloric. The dietary level of productive energy was 2068 KCal/kg. The first experiment revealed that a significant increase in body weight was obtained with each added increment of protein upto a level of24.5 per cent. Feed conversion was inversely related to dietary protein level. Birds fed the 15.1 per cent protein diet had a feed conversion of 5.00 compared with a feed conversion of 4.19 and 3.88 at 24.5 and 28.8 per cent protein levels respectively.

In the second experiment with dietary protein levels ranging from 13.5 to 36.3 per cent, the 24.6 per cent protein produced a significant increase in growth compared to either of the lower protein diets fed (13.5 and 18.7 per cent). Increasing the dietary protein content beyond 24.6 per cent did not produce any additional increase in growth rate.

In the third experiment, growth rate levelled off at 23.3 per cent protein.

Based on the results of these experiments they suggested

that with the types of diets and amino acid levels employed, the dietary protein requirement of coturnix quail to five weeks of age was not in excess of 23 to 24 per cent.

Gropp and Zucker (1969) in their experiment with Japanese quails fed diets containing protein levels of 10, 15, 20 and 25 per cent (from 3-6 weeks age) and reported that at 6 weeks age quails weighed an average of 95.4, 107.1, 109.8 and 111.9 g respectively. Feed conversion with 10 per cent protein was significantly worse than for the other feeds. They further reported that females gained significantly more weight than males on each feed and with 25 per cent protein level they gained 12 per cent more than with 15 per cent protein while cocks gained only 3 per cent.

Vogt (1970) observed that the protein requirement of starter quail was not more than 26 per cent in the diet containing 2890 KCal ME/kg.

Lepore and Marks (1971) reported that growing quail require an energy level of 3080 KCal ME/kg and 24 per cent protein in the diet.

National Research Council (NRC, 1971) tentatively recommended 24 per cent protein in the diet of growing quail upto three weeks of age and to be reduced to 20 per cent from 3 weeks of age onwards.

Reviewing the nutrition of Japanese quail, Vohra (1971) proposed a protein requirement of 25 per cent upto three weeks of age and 20 per cent from three to five weeks of age.

Vohra and Roudybush (1971) conducted an experiment to determine the effect of various levels of dietary protein viz., 20, 25, 30 and 35 per cent on the growth and subsequent egg production of the coturnix. The body weights of the coturnix fed 20 per cent dietary protein level was not different statistically from those fed 25 per cent, but was lower than those fed 30 per cent protein by fifth week of age. No significant differences were observed in the body weight of coturnix fed 30 or 35 per cent protein. By the sixth week, the body weights were statistically of the same magnitude for all the groups. In conclusion, a dietary level of about 25 per cent protein and an energy level of 2880 KCal ME/kg diet had been recommended by them for the feeding of growing and laying coturnix.

Andrews et al. (1973) conducted two experiments in batteries with raised wire floors to study the protein requirement of Bobwhite quail chicks. Quail chicks were fed protein levels ranging from 20 per cent to 30 per cent in a corn-soya diet. In the first experiment with protein levels of 20, 22, 24, 26, 28 and 30 per cent, the body weight at 6 weeks of age averaged 73.1 $\pm$ 3.8, 80 $\pm$ 2.3, 87.3 $\pm$ 2.2, 81.3 $\pm$ 2.6, 95.2 $\pm$ 1.9 and 98.3 $\pm$ 2.3 g respectively and in the second experiment with the same protein levels the weight averaged at 6 week age, 81.3 $\pm$ 2.4, 94 $\pm$ 1.8, 99.7 $\pm$ 1.6, 101.8 $\pm$ 2.3, 112.9 $\pm$ 1.5 and 106 $\pm$ 1.7 g respectively.

Wilson et al. (1975) used a starter diet containing 3047 KCal ME/kg diet satisfactorily with a protein level of 28 per cent.

Axuan and Young (1976) observed that quail chicks from one to ten days of age required 25 per cent dietary protein and 2400 KCal ME/kg diet. When the dietary protein level was maintained at 25 per cent, increasing the ME level of the diet upto 3000 KCal/kg did not significantly reduce the growth ($P < 0.05$). Feed intake was significantly reduced ($P < 0.05$) when the metabolizable energy of the diet was increased above 2850 KCal/kg and growth was decreased when the diet contained more than 3000 KCal/kg.

Based on the review of research carried out on nutrient requirements of Japanese quail Panda et al. (1977) summarised that the protein and energy requirements were 25 per cent and 3000 KCal ME/kg respectively upto 3 weeks of age and from 4 to 5 weeks of age these were 20 per cent and 2700 KCal ME/kg respectively.

Wilson et al. (1977) conducted two experiments to determine whether Bobwhite quail chicks would adjust feed consumption according to energy intake from hatching to five weeks of age. Three starter diets which were calculated to contain 2850, 3010 and 3170 KCal ME/kg and 26, 27.4 and 28.9 per cent protein were fed throughout the five week experiment. The study indicated that Bobwhite quail chick responds to dietary energy levels in a manner similar to that of chicken. The study also indicated that there was a tendency for decreased

calorie consumptions but more efficient utilization of energy and protein consumed.

Studies were conducted by Marks (1978) to investigate the growth patterns of two selected quail lines and a control line after long term selection for high 4 week body weight. The treatment 1 (control diet) consisted of a 28 per cent protein diet from 0 to 6 weeks of age, treatment 2 consisted of a 28 per cent protein diet from 0 to 2 weeks of age followed by a 20 per cent protein diet from 2 to 6 weeks of age, treatment 3 consisted of a 20 per cent protein diet from 2 to 6 weeks of age and treatment 4 consisted of 20 per cent protein diet from 0 to 6 weeks of age.

Six week body weights of selected lines fed treatment three were equal to or superior (100 to 104%) to body weights of birds fed treatment 1. These data suggested that compensatory growth occurs in quail following under nutrition from 0 to 2 weeks of age on a low protein diet (20%) and that fast growing line selected for a high 4 week body weight are comparable in demonstrating greater compensatory growth than non-selected control line.

Panda and Srivastava (1978) conducted an experiment with growing quails from day old to six weeks of age employing 18, 21, 24, 27 and 30 per cent protein at an energy concentration of 2800 KCal ME/kg. The body weights obtained were 77.2 $\pm$ 2.75, 91.1 $\pm$ 1.25, 102.2 $\pm$ 1.43, 106.6 $\pm$ 1.18 and 109.6 $\pm$ 1.36 g with feed consumption of 331, 353, 371, 392

and 396 g and feed efficiencies 4.74, 4.21, 3.90, 3.94 and 3.87 and mortality per cent 16.3, 12.5, 2.5, 8.3 and 3.8 respectively for the above mentioned protein levels from 0 to 6 weeks age.

Panda et al. (1980) observed that the body weight growth was maximum during the first 4 weeks of age and reduced considerably thereafter. The feed used for the study contained a protein per cent of 27 and metabolizable energy of 2800 KCal/kg. With the increase in age, feed efficiency decreased and after the 4th week the ratio became fairly wide indicating that the economical zone of quail meat production might be upto 4 weeks of age. The body weights at 1, 2, 3, 4, 5 and 6 weeks of age averaged 18.42, 30.61, 61.56, 85.56, 110 and 123.29 g respectively with mean body weight gains of 11.51, 12.19, 30.95, 24.0, 24.44 and 13.23 g respectively. The mean feed consumptions per week were 24.48, 42.64, 81.71, 100.15, 142.82 and 151.53 g with feed efficiencies of 1.329, 2.192, 2.417, 2.916, 3.560 and 4.467 respectively for the same weeks mentioned above.

Three levels of protein (21, 24 and 27 per cent) each at two levels of energy (2600 and 2800 KCal ME/kg) were tested by Srivastava et al. (1980b) on two groups of male and two groups of female quails from 3 to 5 weeks age. Weight gain were influenced significantly ($P < 0.05$) by dietary protein, whereas feed efficiency was influenced significantly ($P < 0.05$) both by protein and energy content of the diet. Increasing

the protein content of the diet from 24 to 27 per cent did not significantly ($P \geq 0.05$) influence the weight gain. Better efficiency of feed utilization was obtained on diets containing 24 or 27 per cent protein and 2800 KCal ME/kg than on other diets. No differences due to sex were observed in the requirements of protein and energy. It was concluded that the protein content of growing quail diets may not be greater than 24 per cent during four and five weeks age. Lowering the energy content of the diet from 2800 to 2600 KCal ME/kg resulted in decreased feed utilization.

Srivastava et al. (1981) conducted an experiment to study the effect of broiler concentrate in quail rations. Four starter diets, one control (with protein per cent 26.8 and an energy level of 2850 KCal ME/kg without broiler concentrate) and three experimental diets (using broiler concentrate with or without vitamin and mineral supplementation) were prepared. For the three experimental diets protein and energy levels were 26.4 per cent with 2888, 26.5 per cent with 2880 and 27.1 per cent with 2850 KCal ME/kg respectively. It was observed that the average body weight and feed efficiency ratio on control starter diet and on broiler concentrate with or without vitamin plus mineral supplementation revealed no significant difference from 0 to 6 weeks of age. Although feed consumption in the control was high, it was compensated with the corresponding numerical improvement in body weight. The average body weights for control and the three experiments

were 132.3, 127.6, 126.5 and 128.9 g respectively for 0 to 6 weeks of age. The feed efficiencies were 4.17, 4.08, 4.11 and 4.18 with a total feed consumption of 551.30, 521.7, 519.7 and 539.1 g respectively for the control and the three experiments from 0-6 weeks of age.

An experiment was conducted by Farrell et al. (1982) to study the calorimetric measurements of the energy and nitrogen metabolism of Japanese quail and it was observed that expressed per unit body weight, food and metabolizable energy intake and body weight gain decreased between 2 and 3 weeks of age, but remained constant thereafter. No differences were observed between sexes for any variable measured. Efficiency of utilization of metabolizable energy for energy retention was only 0.33 (majority energy was retained as protein tissue). Nitrogen retention (g/d) increased with increasing dietary 'N' intake but when expressed as a proportion of N intake, declined from 0.46 at 2 weeks to 0.33 at 4 weeks. Fat retention increased substantially during week 4.

A study was conducted to examine the protein requirement of young endangered masked Bobwhite quail (Colinus virginianusridywayi) by Serafin (1982). Five practical starting rations containing 24 to 32 per cent proteins were fed alone and supplemented with methionine for 5 weeks. Supplemental methionine significantly improved growth of quail fed diets containing 24 and 26 per cent protein. Increasing the protein level improved growth of quail fed unsupplemented

diets but did not do so when diets contained supplemental methionine. It was then, concluded that a methionine supplemented ration containing 24 per cent protein appeared adequate for supporting rapid growth of masked Bobwhite quail.

Srivastava and Panda (1982) conducted an experiment with growing quails from four to five weeks of age employing three dietary calorie-protein ratios (104, 117 and 133) each at 2800 KCal ME/kg feed. It was observed that body weight increased significantly with decrease in calorie-protein ratio from 134 to 117 and further decrease to 104 showed a non-significant improvement. The mean body weights and feed efficiencies at 5 weeks of age, for calorie-protein ratio of 133, 117 and 104 were 99, 103 and 105 g; and 4.41, 4.08 and 3.96 respectively. The quails fed the widest calorie-protein ratio diet gained significantly less rapidly than the other diets. Total feed consumption was slightly lower but the amount of feed consumed per unit weight gain was greater when the high calorie-protein ratio diet was fed which reduced significantly with the decrease in calorie-protein ratio to 117 or 104.

Lee et al. (1983) carried out an experiment to determine the protein requirement of breeding Japanese quail in the tropics. The quails were given diets with metabolizable energy 2600 KCal/Kg and with protein 18, 20, 22, 24 or 26 per cent, from 5 weeks old. It was concluded that breeding quails reared in the tropics require a protein per cent not more than 24.

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

Zelenka et al. (1984) fed quails from seven days age diet containing 26, 24, 20, 16 or 14 per cent protein and observed that 26 per cent protein resulted in reasonably constant body weight.

Sinha and Verma (1984) in their experiment with growing Japanese quails employing similar isoenergetic diets containing 24, 26 or 28 per cent crude protein given to 3 groups of 46 or 47 quails for 6 weeks, starting at one week old observed that despite a trend to more rapid growth on higher protein, differences between treatments in growth rate and feed conversion efficiency were not significant.

Eliasvila et al. (1985) conducted an experiment to evaluate different diets for fattening quails. After receiving starter high in energy and protein 4 groups of 380 Japanese quails were switched between days 13 and 18 to fattening feed high in metabolizable energy and protein, 2880 KCal ME/kg and 24.3 per cent or low in both, 2642 KCal ME/kg and 20.8 per cent or high in one constituent and low in other. All variants included maize, soya, fish meal and meat meal. Feed intake and final body weight at 33 days differed little among groups. With high metabolizable energy weight gain peaked in week 4

and with low metabolizable energy in week 3. Subsequent weight gain pattern depended on protein level, decline being more graded with low protein. A high ME:CP ratio produced irregular growth curves with deficient protein supply limiting final growth. Curves were similar with a low ratio, but final body weight was less affected. Owing to energy production from part of the excess protein with intermediate ratio, growth curves were more irregular. Feed conversion differed little among treatments, but curves were more irregular with a high ratio than a low.

A study was conducted to investigate the influence of reducing the protein levels during different stages of growth on performances and meat quality at Central Avian Research Institute (Anon., 1986a). For the study, day old quail chicks of meat line reared on diet containing 27 per cent protein at 2800 KCal ME/kg were offered one of the two diets containing 25 or 23 per cent protein after 2, 3, 4 weeks of age. The results indicated that the live weight and feed efficiency of birds were not found to be influenced by any of the dietary treatments except for poor performances in groups which received 23 per cent protein after 2 weeks of age. This showed that protein requirement of quails for maximum growth and feed efficiency was high initially but decreased as market age approached. Mean total feed intake, energy intake and protein retention were not found to be influenced by any of the dietary treatments.

Babu et al. (1986) in their experiment with Japanese quails from zero to six weeks of age, employing protein levels of

24, 26 and 28 per cent in starter (0-3 weeks of age) and 21, 23 and 25 per cent (4-6 weeks of age) in finisher diets, at a constant energy level of 2700 KCal ME/kg, observed that for optimum body weight gain and feed efficiency the protein requirement was 26 per cent for starter and 23 per cent for finisher diets. They also observed that the dietary protein level had no effect on feed consumption, but higher levels promoted better feed efficiency.

A level of 27 per cent protein and 2800 KCal ME/kg is recommended for optimal growth upto 3 weeks of age and 24 per cent protein with same energy level during 4 to 5 weeks of growing period (Panda, 1986).

Ulmek (1986) while reviewing the nutrition of Japanese quail summarised that quail requires ration containing 3200 to 3400 KCal ME/kg, if the protein level is about 25 per cent. However, a level of 25 per cent dietary protein was recommended for optimum growth.

It was reported that the average total feed consumption per quail upto five weeks were 421.4, 412.4 and 408.1 g and the feed efficiencies were 3.16, 3.13 and 3.23 for diets containing protein levels of 30, 27 and 24 per cent respectively (Anon.,1986a) and also reported that the average cumulative feed intake and feed efficiency ratio both increased significantly with increase of age.

Yield and losses

Amon et al. (1970) processed the Bobwhite quails in lots of 50 at 10, 12, 14, 16 and 18 weeks of age and reported that the ready to cook yields averaged 71 per cent and were similar for birds of all ages and both sexes. The meat bone ratio for birds of each sex increased with age. Dawson et al. (1971) carried out an experiment to study the processing and yield characteristics of Bobwhite quail. The quails were processed at 10, 12, 14, 16 and 18 weeks of age and observed that at 10 weeks of age live weights of males and females averaged 156 g and at 12 and 14 weeks of age males outweighed the females but at 18 weeks of age females averaged about 5 g more than males. The yield and dressed weight were the same for males and females and increased from 89 per cent at 10 weeks of age to 92.5 per cent at 18 weeks of age. The ready to cook yields increased slightly from 10 to 18 weeks of age averaging 71 per cent.

Jones et al. (1979) conducted an experiment with D_1 variety of Japanese quail to study the carcass yield and reported that live weight averaged 164 g at 9 weeks of age and 148 g after a 15 hr period without feed and water. Carcass yield was calculated to be 69 per cent based on pre-shrink weight and 77 per cent after feed and water withdrawal. A 164 g coturnix quail yielded a carcass weighing 113 g $\pm$ 8.44 carcass weight was desired by the consumer.

A shrinkage of 7.9 per cent was observed when 5 week old

Japanese quails were starved for 12 hours before slaughter (Choudhary, 1978).

Pandey et al. (1979) studied the effect of pre-slaughter characteristics and cut-up-parts of Japanese quail, the following results were obtained. Japanese quail of five weeks old were fasted for 0, 8, 12 and 16 hours before slaughter. The per cent weight losses due to 8 and 12 hours fasting were 4.44 ± 0.33 and 4.68 ± 0.41 respectively and 16 hours fasting caused a weight loss of 11.11 ± 0.39 per cent. The dressed weight per cent for a live weight of 112.75 ± 2.11 fasted for 12 hours was 87.17 ± 0.37 and for the control (without fasting) which had a live weight of 106.12 ± 2.11, the dressed weight per cent was 90.51 ± 0.35. Eviscerated per cent for the control one and fasted one (12 hours) were 69.42 ± 0.75 and 65.97 ± 0.39 per cent respectively. The giblet, blood, feather and inedible offal percentages for the control and fasted for 12 hours were 7.42 ± 0.17 and 5.66 ± 0.10; and 5.43 ± 0.24 and 2.51 ± 0.17; and 4.16 ± 0.26 and 5.68 ± 0.24; and 12.82 ± 0.52 and 19.66 ± 0.39 respectively.

The percentage cut-up-parts for the control were 30.55 ± 0.7, 13.03 ± 0.37, 9.85 ± 0.39, 9.51 ± 0.40, 25.74 ± 1.28 and 4.8 ± 0.45 for breast, thigh, drumstick, wing, back and neck respectively and the same for fasted birds were 30.49 ± 0.33, 12.84 ± 0.62, 9.80 ± 0.32, 11.39 ± 0.40, 24.76 ± 0.66 and 6.02 ± 0.22 respectively.

Singh and Panda (1980) reported a significant increase in dressing percentage upto 6 and 7 weeks while Singh et al.

(1980) noted an increased meat yield of quail from 5 to 6 weeks and remained rather constant thereafter yielding 78 per cent edible meat. It was also reported that in quails sex had no significant effect on live weight upto eight weeks of age.

Singh et al. (1980) carried out an experiment to study the slaughter characteristics of Japanese quail (Coturnix coturnix japonica) at different stages of growth. Sixteen quails from each sex at 5, 6, 7 and 8 weeks of age were processed and it was observed that sex had no significant effect on live weight upto 6 weeks but females significantly outweighed males afterwards. Younger birds tended to have more shrinkage per cent due to starvation. Dressing percentage increased significantly upto 6 and 7 weeks in females and males respectively. Evisceration per cent was nearly the same in both sexes upto six weeks, but the same in males was significantly higher than females during later period of growth. Females of the same age had higher percentage of giblets than males. Total offal per cent increased significantly in females than males at 7 and 8 weeks. Breast constituted the highest followed by back, thigh, wing , drumstick and neck, among the cut-up parts.

The mean live weight for combined sexes at 5 and 6 weeks of age were 113.0 $\pm$ 2.46 and 128.7 $\pm$ 1.84 respectively. The percentage shrink, dressed weight, evisceration, giblet and total offals at 5 and 6 weeks were 8.4 $\pm$ 0.35 and 8.9 $\pm$ 0.24; 88.3 $\pm$ 0.31 and 91.8 $\pm$ 0.26; 67.2 $\pm$ 0.37 and 70.3 $\pm$ 0.35; 6.6 $\pm$ 0.11 and 6.1 $\pm$ 0.08 and 26.1 $\pm$ 0.32 and 23.6 $\pm$ 0.31 respectively.

For the cut-up parts the average per cent breast, thigh, drumstick, back, wing and neck at 5 and 6 weeks were 38.3 ± 0.31 and 39 ± 0.37; 14.6 ± 0.21 and 14.8 ± 0.14; 10.6 ± 0.14 and 10.5 ± 0.20; 15.3 ± 0.26 and 15 ± 0.17; 11.2 ± 0.2 and 11 ± 0.17 and 7.2 ± 0.13 and 7.4 ± 0.13 respectively.

Srivastava et al. (1980a) conducted experiment to study the optimum slaughter age of quails. Day old quail chicks were reared on starter diets containing a calorie-protein ratio of 95 with a metabolizable energy of 2800 KCal/kg from 0 to 8 weeks of age. Weekly body weight gain was found to be significantly reduced after 6 weeks of age. No difference in evisceration percentage could be noticed from 4 to 8 weeks of age. Meat to bone ratio increased significantly at 5th week of age. Judges preferred meat of 5 weeks old quails over others. Feed cost and cost of production increased significantly with the increase of age. From the results it was concluded that quail can be slaughtered at 5 weeks of age for maximum return and meat quality.

Studies were conducted by Edward (1981) to determine if feeding quails with diets varying widely in calorie-protein ratio during the period of rapid growth rate would have a significant effect in body composition.b Five diets varying in protein levels from 15 to 30 per cent and containing approximately 3200 KCal ME/kg were fed for six weeks in experiment one and 7 weeks in experiment two. The quails were sacrificed at 2, 4 and 6 weeks of age in experiment 1 and 3, 5 and 7 weeks

of age in experiment 2. Results indicated that more than 24 per cent protein was needed in the diet for maximum growth rate.

Singh et al. (1981) reported that there was significant ($P<0.05$) increase in total meat yield of the carcass from 5 to 6 weeks of age in both sexes and remained rather constant thereafter. Total edible and inedible components of the carcass were approximately 78 per cent and 22 per cent respectively. Meat to bone ratio was significantly ($P<0.05$) higher in both sexes at 7 weeks of age and remained constant thereafter. Of the various components of the carcass, the breast contained highest per cent of meat followed by thighs, drumsticks, backs, wings and neck. There was significant ($P<0.05$) increase in total meat yield of the carcass from 5 to 6 weeks of age in both sexes and remained rather constant, thereafter with corresponding decrease in bony portion. Meat to bone ratio increased significantly ($P<0.05$) in both the sexes taken together till 7 weeks of age and remained constant thereafter.

On an average breast and thighs accounted for 67.5% of edible meat. Drumstick yielded 11.4% of edible meat while back, neck and wings supplied 21%. The meat-bone ratio at five and six weeks of age averaged 2.4 ± 0.08 and 3.4 ± 0.07 respectively for males and that for females averaged 2.6 ± 0.08 and 3.3 ± 0.12 at five and six weeks of age respectively.

Srivastava and Panda (1982) reported that the dressing yield was not influenced by the dietary treatments when quails

were fed three dietary calorie-protein ratio (104, 117 and 133) each at 2800 KCal ME/kg, during growing period from 4-5 weeks of age. The dressing, evisceration, giblet and total offal percentages at 5 weeks of age for the calorie-protein ratio 104, 117 and 133 averaged 88.3, 89.7 and 89.3; 65.6, 65.2 and 66; 7.2, 7.5 and 7.3; and 28.1, 27.3 and 26.1 respectively.

The effect of different dietary calorie-protein ratio (95, 105 and 115) each at different energy levels (2600, 2800 and 3000 KCal ME/kg) at slaughter age and subsequent production performance of quail broilers (upto 5 weeks of age) was studied (Anon., 1983). It was observed that body weight of quail was affected significantly by different calorie-protein ratio and energy levels of the diet. Within the energy levels body weight and feed efficiency decreased with increase of calorie-protein ratio of the diet. The results indicated that broiler quails perform well at slaughter age of 5 weeks age with calorie-protein ratio of 95 at 2800 to 3000 KCal ME/kg.

Three dietary protein levels (25, 28 and 31 per cent) at a constant level of 2800 KCal ME/kg were tested each on four groups of 20 day old quail chicks of meat line to 11 weeks of age (Anon., 1983). The results indicated that the weekly body weight gain reduced significantly in all the dietary treatments after 5 weeks of age and no difference could be noticed in dressing percentage of the birds in all the dietary treatment at any age.

Baranovska et al. (1983) suggested 73 days of age as optimum for slaughtering quails. The body weight for males and females averaged 108.5 and 133 g respectively at 73 days of age. The weight of breast muscle as per cent of body weight averaged 16.9 and 15.9 and leg muscle averaged 7.2 and 6.1 respectively for males and females.

The quails (both males and females) of 4, 5, 6, 7 and 8 weeks of age were employed to study the effect of age and sex on slaughter characteristics by Choudhary and Mahadevan (1983). and observed that the females were heavier than the males at 7 weeks of age and there was an upward trend in dressing percentage from 7 to 8 week in case of males whereas in females the dressing percentage continued to be nearly same in all age groups. The shrinkage per cent differed between different age groups and between sexes of same age group only at 5 weeks of age. It was also noticed that the differences in mean live weight between sexes were non-significant upto 6 weeks of age. The blood volume varied with age and weight. When the body weight increased with age, blood volume declined. Difference between the sex was not apparent upto 6 weeks of age. The per cent total offal was nearly the same upto six weeks of age. The data for various slaughter characteristics obtained by the above workers were shown below.

The mean live weight for males at 5 and 6 weeks of age were 86.77 $\pm$ 1.71 and 114 $\pm$ 1.08 g respectively and for females these were 86.36$\pm$2.36 and 114.7$\pm$2.26 g respectively.

The shrinkage per cent at 5 and 6 weeks of age for male and female were 8.34 ± 0.64 and 4.88 ± 0.30; and 7.17 ± 0.30 and 4.52 ± 0.22 respectively. The percentage blood, feather, dressed, eviscerated and total offal for males at 5 and 6 weeks of age averaged 8.60 ± 0.43 and 4.81 ± 0.15; 5.80 ± 0.44 and 10.04 ± 0.36; 85.58 ± 0.21 and 85.48 ± 0.30; 58.89 ± 0.75 and 61.94 ± 0.28 and 32.82 ± 0.36 and 30.58 ± 0.31 respectively and for the females the above values at 5 and 6 weeks age were 8.55 ± 0.25 and 4.93 ± 0.14; 5.79 ± 0.39 and 10.26 ± 0.26; 85.58 ± 0.28 and 85.04 ± 0.28; 59.10 ± 0.38 and 61.48 ± 0.36 and 33.27 ± 0.37 and 30.92 ± 0.35 respectively.

Narahari et al. (1983) reported significant differences in body weight and ready to cook yield based on age and sex of the Japanese quail.

Sato et al. (1983) carried out an experiment to study the genetic parameters of live, eviscerated organs and muscle weights in Japanese quail males. Slaughtering the quails at 8 weeks of age showed that the live weight (g) and per cent eviscerated carcass and dressed averaged 91.02, 65.24 and 71.62 respectively.

The live weight (g), per cent shrinkage, evisceration, giblet, blood, feather and total offals averaged 128.70 ± 2.17, 9.37 ± 0.42, 65.60 ± 0.33, 7.05 ± 0.12, 3.95 ± 0.10, 4.65 ± 0.22 and 27.35 ± 0.30 respectively for Japanese quails of both sex at 5 weeks of age (Anon., 1985).

Chidananda et al. (1985) collected data on groups of

10 males and 10 females killed at each ages 5, 6, 7, 8, 9 and 10 week and reported that meat percentage of the carcass increased significantly upto 7 week of age (63.06%) to the maximum at 9 week of age (64.38%). The meat-bone ratio increased significantly at 9 week, with values at 8 week not significantly different from at 9 week and values at 7 week not significantly differed from those at 8 week.

Sreenivasiah et al. (1985) reported that percentage dressed weight and giblet for Japanese quails at 6 weeks of age averaged 60 to 65 and 5 to 6. The meat-bone ratio at the same week averaged 3.94.

Singh and Panda (1985) stated that the per cent yields of tandoori quail over eviscerated weights were not significantly affected by the age of the birds. However, the same increased with increase in the age of bird. During 5th and 6th week of age the mean live weight (g), percentage evisceration and yield were 113.30 ± 4.03, 66.84 ± 0.84 and 82.55 ± 1.62; and 120.70 ± 2.60, 67.66 ± 0.84 and 83.96 ± 1.28 respectively.

The effect of three dietary protein levels of 30, 27 and 24 per cent at a constant energy level of 2800 KCal ME/kg on 4 groups of 20 quail chicks each of meat line to 11 weeks of age was studied (Anon., 1986a) and was observed that body weight gain in both sexes increased significantly upto 9 weeks of age, although the rate of gain decreasod sharply after 5 weeks of age under all dietary treatments.

The yields of slaughter i.e., shrinkage, ready to cook weight, giblet weight and total offal weight were all found to be significantly influenced by age but not by dietary protein levels except for giblet weight. With the advancement of age the shrinkage and giblet percentages were reduced showing minimum values at fifth and seventh week, respectively. Ready to cook per cent and total offals increased with maximum yield at 5 week and 9 week of age, respectively. The carcass component weight and meat yield data also were not found to be influenced much by dietary treatments.

The day old quail chicks of meat line reared on diet containing 27 per cent protein at 2800 KCal ME/kg were offered one of the two diets containing 25 or 23 per cent dietary protein after 2, 3, 4 weeks of age and the results indicated that the live weight and feed efficiency of birds were not found to be influenced by any of the dietary treatments except for poor performance in groups which received 23 per cent protein after 2 weeks of age (Anon., 1986a). The yields of slaughter such as per cent dressed, ready to cook, giblet, and total offal weights did not differ between the dietary regime (Anon., 1986a).

Panda (1986) suggested that the ideal commercial age of marketing quail for meat is about 5 weeks. It was noticed that the ready to cook percentage in quails aged 5 to 8 weeks varied from 70 to 75 per cent. The author also reported that of the various components of the carcass breast constituted the highest cut followed by back, thigh, wing, drumstick and neck.

Tserveni Gousi and Yannakopoulos (1986) conducted an experiment with Japanese quails of 42 days age to study the effect of sex on carcass characteristics and observed that carcass yield was significantly greater in males than females although the carcass weight was similar. The breast and legs constituted a major proportion of body weight being 34.6 and 32.1 per cent for males and females respectively, but their yields were not influenced by sex. The average carcass yield in males was greater than that of females (76.9 compare to 72.7%).

Mohan et al. (1986) on studying the carcass characteristics and keeping quality trials of male and female Japanese quail at 6 and 8 week of age observed that irrespective of age, the female Japanese quail had shown superiority in slaughter weight, ready to cook yield and meat-bone ratio over males. The edible yield had increased with advancement of age. The mean slaughter weight (g), ready to cook yield (%) and meat-bone ratio of male and female (combined) Japanese quail at 6 week of age were 129.1 $\pm$ 1.76, 71.4 $\pm$ 0.44 and 3.57 $\pm$ 0.05 respectively. The above values for 8 weeks were 143.2 $\pm$ 2.91, 73.5 $\pm$ 0.54 and 4.26 $\pm$ 0.09 respectively.

Chemical composition of quail meat

A good quality of meat should possess tenderness, juiciness and desirable flavour (Lawrie, 1966). These qualities mainly depend on the physio-chemical properties, level of proteins, fats and other chemical constituents present in the meat.

Amon et al. (1970) reported that the proximate composition of protein, fat and moisture were not influenced by age or sex.

Dawson et al. (1971) also reported that protein, fat and moisture did not vary significantly among age groups or between sexes of Bobwhite quails.

Marks (1971) observed that fat content of the carcass of 4 week old quail was not influenced by sex or feeding diets varying from 18 to 30 per cent protein with a metabolizable energy per cent protein ratio from 160-92. It was also observed that neither protein nor water content of the carcass of 4 week old quail was influenced by the protein level of the diet.

Lepore and Marks (1971) found that the fat content of the carcass increased rapidly at 6 and 8 weeks of age. It was also noticed that the age influenced the water content of the carcass and there was slight trend for the protein content to increase with age.

Srivastava et al. (1980a) in an experiment with quails employing starter diet containing a caloric-protein ratio of 95 with a metabolizable energy of 2800 KCal/kg from 0 to 8 weeks of age observed that moisture content reduced and fat content increased significantly at 6 weeks of age.

No positive correlation was obtained between the calorie-protein ratio of the diet and lipid content of the carcass, when quails were given diets varying in protein levels from 15 to 30 per cent and metabolizable energy of approximately 3200 KCal/kg for 6 weeks in experiment I and 7 weeks of age

in experiment II (Edward, 1981). The increasing level of protein in the diet caused faster growth rate upto highest level fed. Sex did not have any significant effect on the carcass composition. The author also reported that the data on body composition at all of the various ages studied in the experiments indicated that quail differ from the chicken when there is highly significant correlation between widening calorie-protein ratio of the ration and increased fat content of the carcass. Higher fat content of the carcass occurred in the quail receiving high protein ration just the opposite situation that is seen in chick. The worker explained that the Japanese quails are very active and the carcass fat stays very low until the bird reaches maturity. A very high rate of activity by the quail partially explain the high protein and amino acid requirements of the quail compared to the chicken.

Farrel et al. (1982) reported that nitrogen retention increased with increasing dietary nitrogen (N) intake, but when expressed as a proportion of N intake declined from 0.46 at 2 weeks to 0.33 at 4 weeks. Fat retention increased subsequently during week 4. Carcass analysis showed that fat, protein and ash were higher for quails at 5 weeks than at 2 weeks of age. The researchers also reported that over a similar chronological period the Japanese quail is not as efficient a converter of food to body weight gain as the broiler chicken; the difference can probably be explained mainly

by the large difference in physiological ages and the related contribution of maintenance energy requirement.

Srivastava and Panda (1982) conducted experiment in quails employing three dietary calorie-protein ratio (104, 117 and 133) each at 2800 KCal ME/kg during growing period from 4 to 5 weeks of age and reported that the treatments had significant effect on moisture and fat content of the quail meat of both sexes. Though, there was a gradual increase in meat protein with decreasing level of calorie-protein ratio in the diet it was found to be significantly different. Fat content was the lowest at calorie-protein ratio of 104 in both sexes.

The average moisture per cent for males were 75.35, 75.79 and 76.52 for the diets containing calorie-protein ratio 133, 117 and 104 respectively. The protein and fat percentages for these ratio averaged 18.33, 19.16 and 19.20 respectively; and 1.72, 1.69 and 1.54 respectively in males.

In females the moisture, protein and fat per cent averaged 73.40, 73.88 and 74.87; 20.45, 20.79 and 21.03; and 2.7, 2.59 and 2.38 for the three dietary calorie-protein ratio respectively.

It was reported that the moisture, crude protein, ether extractives and total ash percentages averaged 77.56 $\pm$ 0.15, 18.27 $\pm$ 0.20, 1.76 $\pm$ 0.07 and 0.92 $\pm$ 0.11 respectively for leg muscle and the same for breast muscle averaged 76.42 $\pm$ 0.08, 19.64 $\pm$ 0.34, 1.59 $\pm$ 0.03 and 1.02 $\pm$ 0.09 respectively (Anon., 1985).

The effect of three dietary protein levels of 30, 27 and 24 per cent at a constant energy level of 2800 KCal ME/kg on 4 groups of 20 quail chicks each of meat line to 11 weeks of age was studied (Anon., 1986a) and observed that dietary treatment and age were found to have a significant effect on body and meat composition of quail broiler. The carcass fat deposition increased with increase of age with less marked effect in protein content of the diet, significantly increased the fat content of the carcass, contrary to the situation that is seen in chicken. A significant increase in carcass fat was found at 5 week of age. Between sexes, carcasses of male quails were found to contain more fat than females.

Day old quail chicks of meat line reared on diet containing 27 per cent protein at 2800 KCal ME/kg were offered one of the two diets containing 25 or 23 per cent dietary protein after 2, 3, 4 weeks of age (Anon., 1986a) and the results indicated that a significant decrease in carcass fat with slight increase in moisture was observed with the decrease of protein content of diet after 2 weeks starting period. Maximum fat was found in the carcass of quails which received 27 per cent protein diet upto 4 weeks of age. Abdominal fat, liver and plasma lipid although followed a similar trend as carcass fat were not found to be statistically accountable between the dietary treatments.

Choudhary and Mahadevan (1986) observed that the ether extract percentage from 4 to 8 weeks of age varied from 2.08

to 5.83. The per cent of ether extract increased with the advancement of age because the intramuscular fat increase upto a certain limit with advancing age. The moisture percentage from 4 to 8 weeks age varied from 75.09 to 73.12. It was explained that during growth some of the moisture is replaced by inter-tissue fat hence the moisture content was showing a downward trend in proportion to fat content. As age increased total ash percentage also increased.

Yoshizane Maeda et al. (1986) conducted experiments to elucidate the genetic variation in the liver lipid content of Coturnix quail and observed that the mean liver lipid content at 2 and 4 weeks of age were approximately 25 per cent on a dry weight basis in both sexes. After 6 weeks of age, the liver lipid content of the female was higher than that of male. Liver lipid content at 4 weeks aged female averaged 22.5 ± 2.7 per cent with a live body weight of 76 ± 8 g and for male 23.6 ± 2.5 per cent with a live body weight of 71 ± 7 g.

Blood parameters

Leveille and Sanberlick (1961) reported that the stage of nutrition influence the plasma protein levels.

Atwal et al. (1964) reported that plasma protein levels varied from 3.3 to 6.1 g/100 ml at 50 days old quails of both sexes. The haemoglobin (g %) for males and females at 29th day of age averaged 10.2 to 14.2 and 9.6 to 12.0 respectively.

Nirmalan and Robinson (1971) reported that in adult quails

plasma protein varied from 3.1 to 3.7 g/100 ml. Nirmalan and George (1972) in another study reported that total lipid in the whole blood averaged 1.80 and 1.97 g/100 ml for male and female quails respectively.

Nirmalan (1972) carried out an experiment to study the haematological parameters on the Japanese quails and observed that the body weights during 3, 4, 5 and 6 weeks of age in males averaged 63.8 ± 1.12, 80.4 ± 0.85, 87.7 ± 0.85 and 93.2 ± 1.12 respectively and for females those figures were 65.7 ± 1.67, 84.6 ± 2.11, 98.8 ± 2.86 and 106.7 ± 3.37 respectively. During first and second week the weights averaged 18.5 ± 0.18 and 39.6 ± 1.22 respectively for non-sexed chicks. The authors also found that the absolute blood volume ranged between 6.26 ml for young quail and 9.77 for the laying hen. During growth there was a decrease in the total blood volume. The blood volume should be considered in relation to the body weight. The plasma volume (ml) averaged 4.45 ± 0.07, 4.64 ± 0.12, 4.97 ± 0.10 and 6.51 ± 0.16 respectively for young quails, adult males, non-laying and laying hens and the plasma volume (ml/100 g body weight) for these birds averaged 5.91 ± 0.07, 4.73 ± 0.10, 4.29 ± 0.12 and 4.73 ± 0.69 respectively. It was found that the total plasma protein increased with increase in age. The total plasma protein in the blood of young, adult, non-laying and laying quails averaged 2.7 ± 0.1, 3.1 ± 0.1, 3.7 ± 0.2 and 3.5 ± 0.1 g/100 ml respectively.

Deshmukh and Suryawanshi (1982) studied the effect of gonadal hormones on some haematological parameters in the

Rain quail (Coturnix coromandelica) and reported that administration of estrogen decreased haemoglobin percentage whereas testosterone increased the level of hemoglobin. For the control groups hemoglobin level averaged 12.40 ± 0.22 and 10.40 ± 0.22 g/100 ml respectively for males and females.

Abdominal fat

Sadjadi and Becker (1980) found that abdominal fat percentages of 107 day old female quails mated and unmated were 3.18 and 3.04 percentages respectively.

The abdominal fat percentage for quails (both sex) of 5 weeks age averaged 0.95 ± 0.31 (Anon., 1985).

Becker et al. (1985a) in the study with 58 day old quails found that the abdominal fat percentages for the sire and dams of the parents averaged 3.39 ± 1.02 and 1.39 ± 0.64 respectively and for the sons and daughters of the progeny the values averaged 2.75 ± 1.08 and 1.23 ± 0.65 respectively.

Becker et al. (1985b) reported the largest loss in abdominal fat weight as 1.10 g and per cent abdominal fat of body weight as 0.91 in another study.

Darden and Marks (1985) observed relatively low abdominal fat at 4 week of age in quails. The abdominal fat percentage during 2 and 8 weeks of age averaged 0.14 and 1.31 respectively and the live body weights during 2, 4, 6 and 7 weeks were 37.8, 82.9, 106.7 and 115.1 g respectively.

Materials and Methods

MATERIALS AND METHODS

An experiment was designed and conducted at the Centre for Advanced Studies in Poultry Science, College of Veterinary and Animal Sciences, Kerala Agricultural University, Mannuthy, to evaluate the dietary protein and energy requirements of meat type Japanese quail (Coturnix coturnix japonica) for growth, under the prevailing environmental conditions of Kerala.

Three hundred and twenty-four quail chicks of seven days of age were selected per trial for the experiment. The chicks were divided into nine treatment groups of 36 each. Each group was replicated six times with six quail chicks each. Allotment of treatments and replicates were made at random. All the quail chicks were wing banded and housed in identical cages of 30 cm x 25 cm x 30 cm providing 750 cm^2 floor area in each cage. The actual floor space available per chick in each cage was 100 cm^2. Feeders and waterers were provided inside the cages.

The cages were placed in a well ventilated and well lighted room. Artificial heat was provided inside the experimental room by suspending 12, 100 watt bulbs from above, at a height of 60 cm from chick level during second week to maintain a temperature at 33°C (90°F). During third week temperature was reduced to 31°C (85°F) by reducing the number of lighted bulbs to nine. From fourth week onwards all the bulbs were removed and only one bulb was provided at the roof level to provide artificial light during night hours.

The quail chicks were housed in cages with a floor mesh size of 0.21 x 0.21 cm upto three weeks of age and thereafter they were housed in cages having hexagonal mesh floor of 2 cm x 2 cm size.

The quail chicks for the experiment were obtained in three batches at three weeks interval between batches. Each batch of experiment lasted six weeks. The quail chicks required for the experimentation were obtained from the same source in order to keep the genetic make up constant.

Three levels of protein viz., 22, 24 and 26 per cent and three levels of metabolizable energy of 2700, 2900 and 3100 KCal per kg were employed in a factorial arrangement. The allotment of quail chicks to different treatment groups as well as to different cages were made at random.

The quail chicks under different treatment groups were fed different rations varying in protein and energy content as outlined earlier. The composition of different treatment diets is given in table 1. The ingredients required for the formulation of the diet were procured in one lot and were analysed for proximate composition. The feed was mixed three times during the entire period of experiment. After each mixing, the mixed feed was analysed for its protein and energy content. However, marginal adjustments were made in all the ingredients to obtain the required protein and energy levels of the diets. The individual ingredients as well as the mixed rations were analysed each time for their crude protein and energy levels.

The metabolizable energy values of the ingredients and rations were calculated using the prediction equation suggested by Carpenter and Clegg (1956). The available carbohydrate was estimated by the application of anthrone reagent (Clegg, 1956). The proximate composition of ingredients as well as the ration was estimated according to the procedure described in A.O.A.C. (1970).

Feed and water were provided ad lib. The routine managemental practices were followed throughout the experimental period.

The meteorological variables of macroclimate such as temperature and relative humidity of the shed, where the experiment was conducted were recorded monthly. The general observations were made for three, six-week periods.

Individual body weights were taken every week end to study the pattern of body weight gain under the different feeding regimes.

Feed intake data was recorded at every week end and the feed efficiency (feed/weight gain) was calculated.

The quail chick mortality during the experimental period was recorded for assessing the livability.

At the end of fifth and sixth week two quails from each replicate, making a total of 12 per treatment, were slaughtered. The eviscerated carcass, at the rate of one per replicate, making a total of six per treatment were taken for the

estimation of cut-up parts and from these three carcasses per treatment were taken at random for the estimation of meat bone ratio.

The quails were slaughtered and dressed as per procedure described by Indian Standards Institution (ISI, 1973) and processing yields and losses were determined. The defeathering was done completely by manual fine plucking. The cut-up parts were separated from the eviscerated carcass as prescribed by Mountney (1983) and proportions of different parts of carcass were estimated. The meat-bone ratio was derived by separating the meat manually. The meat from neck was separated with the aid of a forceps as much as possible. The skin was included with meat and cartilagenous materials were included along with the bones for calculation of the ratio.

At the time of killing blood was collected for estimation of serum protein, serum lipid and haemoglobin. The total serum protein and haemoglobin were estimated in four samples collected from each treatment. Modified biuret method (Inchiosa, 1964) was employed for the determination of total serum protein and the haemoglobin estimation was done as per the procedure described by Benjamin (1979) by using haemoglobinometer. Ethylene diamine tetra acetate (EDTA) was used as the anticoagulant.

The total serum lipid was estimated as described by Josyln (1970) in two samples collected from each treatment.

Four ready-to-cook carcasses from each treatment were

prepared and made into homogenous material for chemical analysis. Aliquot was used for estimating the moisture content and estimation of the crude protein, ether extract and total ash were carried out as per A.O.A.C. (1970) in moisture free samples.

During slaughter of quails, liver from four quails per treatment were collected, marked and sealed in polyethylene bags and stored in deep freezer for subsequent estimation of protein and lipid contents. The liver samples were thawed, dried and finely ground before analysis. Estimation of protein and ether extractions of the liver samples were made, employing the procedure described in A.O.A.C. (1970).

Estimation of abdominal fat was carried out as per the procedure described by Sadijadi and Becker (1980).

After six weeks of the study, the excreta was collected from three replicates of each treatment for nitrogen balance studies. The droppings were weighed and sample was taken for moisture determination. The balance quantity was placed in a polyethylene bag, sealed and kept in a deep freezer for nitrogen determination. This procedure was repeated for two days. The same birds were kept without any feed for two days for estimating the endogenous nitrogen loss. Using the data on nitrogen content of the droppings, feed intake and endogenous nitrogen loss the nitrogen balance was calculated.

The data collected were subjected to statistical analysis (Snedecor and Cochran, 1967).

Table 1. Per cent composition of experimental diets

Ingredients	Protein (%)	22			24			26		
	Energy (KCal ME/kg)	2700	2900	3100	2700	2900	3100	2700	2900	3100
	Diet number	I	II	III	IV	V	VI	VII	VIII	IX
Groundnut oil cake		27.00	33.00	34.00	30.00	31.00	32.00	36.00	36.00	37.00
Yellow maize		50.50	57.00	51.00	38.00	37.00	37.00	32.00	34.00	38.00
Fish meal		10.00	4.00	4.00	13.00	13.00	13.00	13.00	13.00	13.00
Rice Bran		10.00	3.00	3.00	14.00	11.00	7.00	14.00	10.00	3.00
Groundnut oil		0.50	1.00	6.00	3.00	6.00	9.00	3.00	5.00	7.00
1 Mineral mixture		1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Common salt		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
2 Rovimix AB_2D_3(g)		25	25	25	25	25	25	25	25	25
3 Rovimix E-25 (g)		10	10	10	10	10	10	10	10	10
4 Liv.52 (g)		200	200	200	200	200	200	200	200	200
Analysed value:-										
Protein (%)		22.34	22.01	22.32	24.26	24.26	23.91	25.97	26.19	26.07
Energy (KCal ME/kg diet)		2715.89	2905.96	3105.34	2719.30	2901.39	3104.16	2718.66	2881.65	3106.90

1 - Poultrymin (Aries Agro-Vet Industries Private Ltd.) contained calcium (Min) - 32.00%, Phosphorus (Min) - 6.00%, Copper (Min)- 100 ppm, Cobalt (Min) - 60 ppm, Manganese (Min) 2700 ppm, Iodine 100 ppm, Zinc 2600 ppm, Iron 0.1% and Magnesium 1000 ppm.

2 - Rovimix $A+B_2+D_3$ (Roche Products Ltd) contained Vitamins A, B_2 and D_3 at levels of 40,000 I.U., 20 mg and 5,000 I.U. per g, respectively.

3 - Rovimix E-25 (Roche Products Ltd.) contained vitamin E 250 I.U. per g of 250 mg dl -tocopherylacetate.

4 - Liv.52 powder (The Himalayan Drug Co.)

RESULTS

A 3 x 3 factorial experiment with 22, 24 and 26 per cent dietary protein and 2700, 2900 and 3100 KCal ME/kg as outlined in the materials and methods, was conducted to decipher variation, if any, in the requirement of energy and protein for quails during growth period. The results obtained are presented in this chapter.

The mean temperature and humidity (monthwise) from September 1986 to February 1987 (period of experiment) in the experimental shed is depicted in table 2.

Production Parameters

Body weight

The mean body weight of quails fed the nine different rations is presented in table 3. The initial (seventh day of age) body weight of quails alloted to the different treatment group ranged from 13.62 to 14.28 g. But the differences in body weight among the treatment groups were not statistically significant.

At second week of age the highest body weight was recorded for quails fed dietary treatments VII and IX (26% protein and 2700, 3100 KCal ME/kg diet). The lowest body weight was recorded in quails fed diets III and VI (3100 KCal ME/kg diet and 22 and 24 per cent protein). The other treatment groups were intermediate in body weight (Fig.1). However the statistical analysis of the data revealed that the mean weekly body

Table 2. Monthwise mean temperature and relative humidity recorded in the experimental shed

Month and year	Temperature (°C)		Relative humidity (%)
	Maximum	Minimum	
September 1986	31.0	28.0	85.5
October 1986	31.2	28.6	78.0
November 1986	31.1	28.1	73.0
December 1986	31.8	28.6	68.0
January 1987	32.2	28.9	56.0
February 1987	31.2	28.9	68.0

Table 3. Mean weekly body weight (g) of quails fed experimental diets

Age (week)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
7th day (initial)	1	13.16	13.18	13.28	13.17	13.08	13.12	13.35	13.39	13.12	13.20
	2	14.61	13.61	13.78	13.72	13.72	13.84	14.00	14.17	14.22	13.96
	3	14.73	15.00	14.33	14.28	14.75	13.89	15.00	14.72	15.50	14.69
	Mean^{NS}	14.17	13.93	13.80	13.72	13.85	13.62	14.12	14.09	14.28	13.95
2	1	28.95	27.50	25.41	28.78	27.55	27.00	29.77	27.01	26.89	27.65
	2	24.39	25.10	24.05	29.12	25.50	26.22	29.00	28.78	30.28	26.94
	3	32.56	32.26	26.68	27.09	28.34	25.67	30.39	30.23	32.05	29.47
	Mean	28.63^{ab}	28.29^{ab}	25.38^{a}	28.33^{ab}	27.13^{ab}	26.30^{a}	29.72^{b}	28.67^{ab}	29.74^{b}	28.02
3	1	48.67	47.14	43.78	51.66	47.05	47.42	51.32	53.02	49.10	48.79
	2	46.27	44.05	40.07	45.94	40.78	41.72	48.15	49.11	51.11	45.25
	3	51.50	48.63	44.47	47.60	48.25	43.26	51.91	51.67	48.25	48.39
	Mean	48.81^{de}	46.61^{bcd}	42.77^{a}	48.40^{cde}	45.36^{abc}	44.13^{ab}	50.46^{e}	51.27^{e}	49.49^{de}	47.48
4	1	74.89	70.01	66.05	75.86	70.13	70.96	77.99	78.76	73.45	73.12
	2	72.78	67.47	60.84	73.67	63.97	65.63	79.44	79.50	73.28	71.29
	3	72.61	70.25	63.71	71.64	70.11	63.28	77.95	76.95	72.15	70.96
	Mean	73.43^{c}	69.24^{b}	63.53^{a}	73.72^{c}	68.07^{a}	66.62^{ab}	78.46^{d}	78.40^{d}	74.63^{cd}	71.79
5	1	102.53	88.49	89.50	95.17	93.29	92.06	102.11	101.50	96.47	95.79
	2	93.38	83.33	81.10	91.78	84.04	84.76	99.11	100.28	97.22	104.45
	3	90.20	90.27	84.33	86.71	87.57	80.60	97.97	96.52	92.77	89.61
	Mean	95.40	87.36	84.98	91.55	88.30	85.81	99.73	99.43	95.32	96.62
6	1	116.21	103.00	105.70	110.69	109.03	111.00	124.75	123.72	117.53	113.45
	2	117.00	102.33	106.95	119.75	103.80	105.70	121.50	119.58	122.00	113.27
	3	113.33	113.72	99.78	107.81	111.86	107.33	115.00	114.09	108.17	110.12
	Mean	115.78	106.35	104.14	112.55	108.23	108.00	120.42	119.13	115.90	112.28

Values bearing the same superscript do not differ significantly

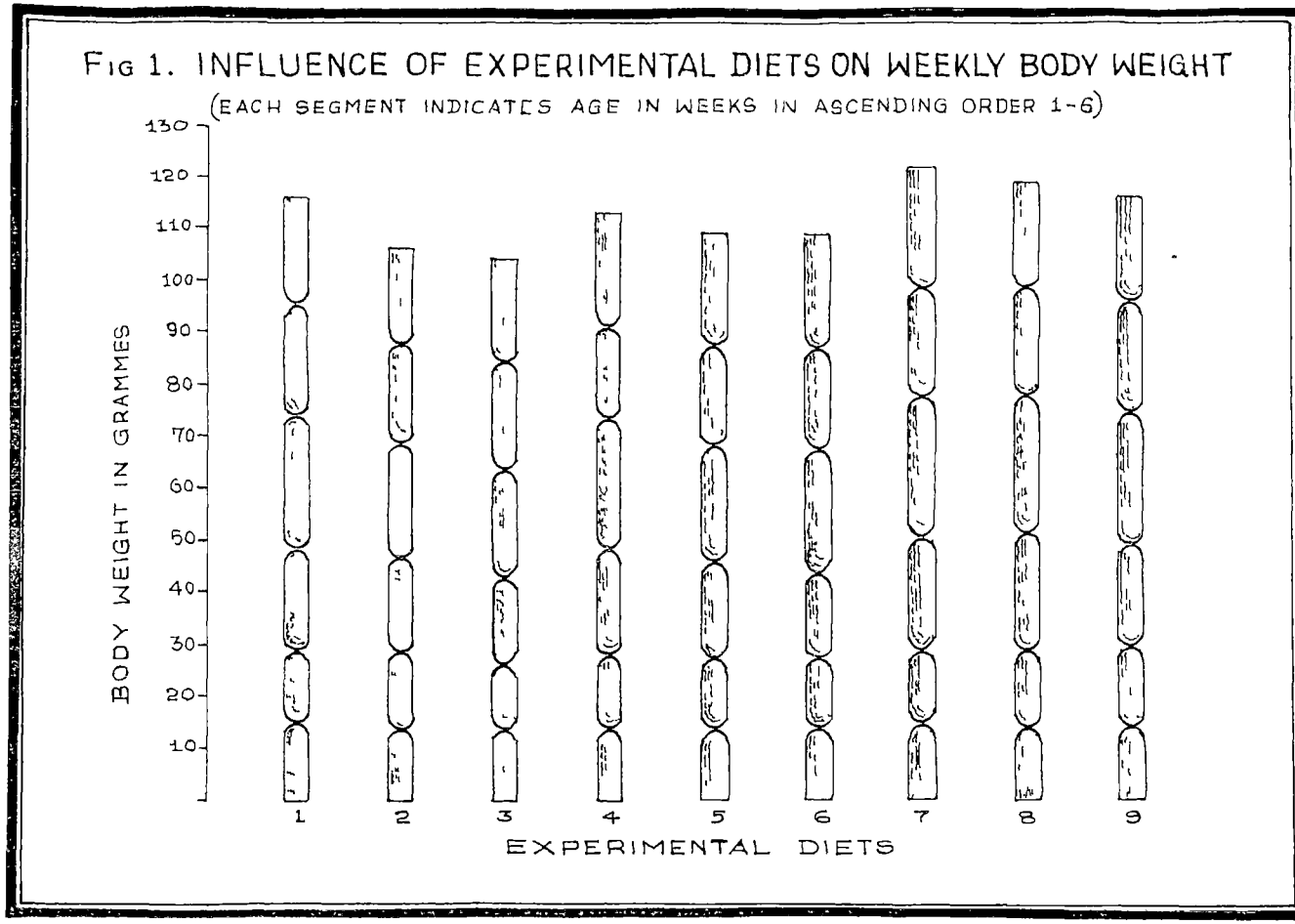


FIG 1. INFLUENCE OF EXPERIMENTAL DIETS ON WEEKLY BODY WEIGHT
(EACH SEGMENT INDICATES AGE IN WEEKS IN ASCENDING ORDER 1-6)
BODY WEIGHT IN GRAMMES
130
120
110
100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
EXPERIMENTAL DIETS

weight of birds fed dietary treatments I, II, III, IV, V, VI and VIII were homogeneous. Likewise those recorded in quails fed diets I, II, IV, V, VII, VIII and IX were also homogeneous.

The body weight of quails recorded at third week of age showed that the highest body weight of 51.27 g was recorded in those quails fed diet VIII (26 per cent protein and 2900 KCal ME/kg diet). The lowest body weight (42.77 g) was observed in quails fed ration containing 22 per cent protein 3100 KCal ME/kg. The overall trend of the result suggested that the body weight is influenced ($P < 0.01$) both by the protein level as well as by the energy level. Quails fed ration containing more than 24 per cent protein had definitely better body weight. On the contrary there was a trend towards lowered body weight as the energy level was increased in the diet.

The mean weekly body weight of quails fed different treatment diets at fourth week of age showed that the highest body weight was recorded in quails fed diet containing 26 per cent protein and 2700 KCal ME/kg (diet VII) whereas the lowest body weight was recorded in quails fed a diet containing 22 per cent protein and 3100 KCal ME/kg (diet III). The statistical analysis of the data revealed that both levels of protein and energy in the diet influenced ($P < 0.01$) body weight at this age. The general trend was that body weight increased with progressive increase in protein in the diet and the body weight decreased as the energy level increased. Eventhough best body weight was obtained with a diet containing 26 per cent protein and 2700 KCal ME/kg,

the difference in body weight among the diets containing 26 per cent protein and the three levels of energy employed in the experiment were not statistically significant.

At fifth week of age highest body weight was recorded for the group of quails fed diet VII containing 26 per cent protein and 2700 KCal ME/kg diet, while the lowest was recorded in the group of quails fed diet containing 22 per cent protein and 3100 KCal ME/kg (diet III). However, the statistical analysis of the data revealed that neither protein nor energy levels significantly influenced body weight at this age.

The body weight of quails fed varying levels of energy and protein at sixth week of age showed highest weight of 120.42 g in groups fed 26 per cent protein and 2700 KCal ME/kg (diet VII) while the lowest body weight of 104.14 g was recorded in groups fed diet III containing 22 per cent protein and 3100 KCal ME/kg energy. However the statistical analysis of the data did not show any significant influence due to dietary energy levels or protein levels.

Body weight gain

The body weight gain of quails fed different dietary treatments from second to sixth week of age is presented in table 4. The statistical analysis of the data revealed that the body weight gain was not influenced by the dietary treatments from third week of age through sixth week. However, the weekly body weight gain during the second week of age was observed to be influenced ($P < 0.01$) by the levels of protein

Table 4. Mean weekly body weight gain (g) of quails fed experimental diets

Age (week)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
2	1	16.10	15.32	12.23	15.61	14.46	13.93	16.42	16.45	13.83	14.93
	2	12.61	11.33	10.28	15.39	11.78	12.39	15.00	14.28	16.11	13.24
	3	17.17	15.97	12.19	13.22	13.76	11.78	15.31	15.51	14.89	14.42
	Mean	15.29^{e}	14.21^{cd}	11.57^{a}	14.74^{de}	13.33^{bc}	12.70^{b}	15.58^{e}	15.41^{e}	14.94^{de}	14.20
3	1	18.99	18.66	18.08	22.88	18.79	19.63	21.55	23.20	22.36	20.46
	2	18.97	19.05	16.10	16.83	15.28	15.50	19.66	20.33	19.94	17.96
	3	19.61	17.71	18.29	19.63	18.97	17.35	21.23	20.28	18.75	19.09
	Mean	19.19	18.47	17.49	19.78	17.68	17.49	20.81	21.27	20.39	19.17
4	1	26.23	23.50	22.12	24.19	23.08	23.01	26.67	25.72	24.34	24.32
	2	26.51	23.41	22.74	27.22	24.70	23.60	31.11	30.61	26.67	26.29
	3	21.11	22.73	19.25	22.38	21.87	20.02	21.02	25.53	24.68	22.07
	Mean	24.62	23.21	21.37	24.60	23.22	22.20	26.27	27.29	25.23	24.23
5	1	26.59	19.04	22.81	20.31	23.16	21.09	24.23	22.74	23.02	22.55
	2	20.60	15.91	18.28	18.11	18.41	19.12	19.66	19.11	19.45	18.74
	3	17.67	20.00	20.27	16.73	17.69	16.59	19.22	19.58	20.12	18.65
	Mean	21.62	18.32	20.45	18.38	19.75	18.93	21.04	20.48	20.86	19.98
6	1	18.75	21.29	29.75	19.65	24.47	24.08	26.58	27.67	26.53	24.31
	2	28.19	24.92	23.42	27.50	26.42	25.72	25.75	27.08	27.25	26.25
	3	27.17	29.08	23.47	26.47	30.58	27.03	24.44	23.81	20.28	25.81
	Mean	24.70	25.10	25.55	24.54	27.16	25.60	25.59	26.19	24.69	25.46

Values bearing the same superscript do not differ significantly

and energy in the diet. A mean gain in weight of 15.58 g, the highest gain, was observed in group fed 26 per cent protein with 2700 KCal ME/kg (diet VII). Likewise a lowest gain in weight of 11.57 g was observed in the group fed 22 per cent protein and 3100 KCal ME/kg (diet III). This weight gain was significantly ($P < 0.01$) lowest when compared to other treatment combinations.

The overall body weight gain of quails upto fifth and sixth week of age as influenced by the diets is presented in table 7. The mean body weight gains were 77.93 and 103.39 g for the above periods respectively.

The body weight gain from initial to fifth week of age and initial to sixth week of age as influenced by the nutrients and its statistical analysis is presented in table 8 and 11 respectively.

Feed consumption

The mean daily feed consumption recorded for quails fed different combinations of energy and protein from second week of age to sixth week of age is presented in table 5. The statistical analysis of the data revealed that the dietary treatments influenced ($P < 0.01$) feed consumption during second, third and fourth week of age, whereas it had not exerted any influence during fifth and sixth week of age. The overall feed consumption during second week of age was 8 g/quail chick/day. The lowest feed consumption (6.05 g/chick/day) was recorded in group fed a diet IX (26% protein and 3100 KCal ME/kg) which

Table 5. Weekwise, mean daily feed consumption (g) of quails fed experimental diets

Age (week)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
2	1	8.35	8.32	8.31	8.41	8.33	8.29	8.37	8.29	8.26	8.33
	2	8.58	8.78	8.58	8.72	8.57	8.51	8.71	8.33	8.19	8.55
	3	7.97	7.83	7.62	7.91	7.79	7.67	7.95	7.86	7.69	7.81
	Mean	8.30^{de}	8.31^{e}	8.17^{bc}	8.34^{e}	8.23^{cd}	8.16^{b}	8.34^{e}	8.16^{b}	8.05^{a}	8.23
3	1	8.61	8.60	8.57	8.63	8.58	8.52	8.64	8.56	8.45	8.57
	2	9.24	9.23	9.15	9.29	9.21	9.14	9.24	9.17	9.11	9.20
	3	8.84	8.75	8.61	8.87	8.73	8.43	9.15	8.74	8.45	8.73
	Mean	8.90^{de}	8.86^{cde}	8.78^{b}	8.93^{e}	8.84^{bcd}	8.70^{a}	9.01^{f}	8.82^{bc}	8.67^{a}	8.83
4	1	14.49	13.89	14.11	13.96	13.99	14.07	13.89	13.80	13.88	14.00
	2	14.68	14.25	13.88	14.36	13.90	14.02	14.28	13.89	13.92	14.13
	3	13.69	13.92	13.79	13.89	13.89	13.52	14.13	13.76	13.76	13.82
	Mean	14.28^{d}	14.02^{bc}	13.93^{ab}	14.07^{c}	13.92^{ab}	13.87^{a}	14.09^{c}	13.82^{a}	13.85^{a}	13.98
5	1	16.39	15.69	15.80	15.78	15.47	15.71	15.77	15.64	15.62	15.76
	2	16.67	15.58	15.09	15.96	16.08	15.38	15.94	15.87	15.74	15.81
	3	15.72	16.55	16.31	16.50	16.17	15.74	16.94	16.28	15.91	16.24
	Mean	16.26^{a}	15.94^{a}	15.73^{a}	16.08^{a}	15.91^{a}	15.61^{a}	16.22^{a}	15.93^{a}	15.76^{a}	15.94
6	1	19.75	20.09	19.67	19.77	19.86	19.53	19.68	19.78	19.75	19.76
	2	19.00	18.72	18.21	18.77	18.87	18.45	19.52	19.39	19.30	18.92
	3	19.85	19.66	19.22	19.81	19.69	19.31	19.56	19.58	19.20	19.54
	Mean	19.53^{a}	19.49^{a}	19.03^{a}	19.45^{a}	19.47^{a}	19.10^{a}	19.59^{a}	19.58^{a}	19.42^{a}	19.41

Values bearing the same superscript do not differ significantly

was significantly ($P < 0.01$) different from all other dietary combinations. The highest value for feed consumption (8.34 g) per bird per day was recorded in groups fed 24 and 26 per cent protein with 2700 KCal ME/kg. The general pattern revealed that the feed consumption decreased as the energy level in the diet was increased.

During the third week of age as well as during the fourth week of age the trend of results were similar, namely, decreased feed consumption with increasing energy levels in the diet.

The overall feed consumption of quails upto fifth and sixth week of age as influenced by the diets is presented in table 7. The mean feed consumptions were 328.89 and 464.74 g per bird for the above periods respectively.

The feed consumption from initial to fifth week of age and initial to sixth week of age as influenced by the nutrients and its statistical analysis is presented in tables 9 and 11 respectively.

Feed efficiency

The mean feed efficiency of quails fed different treatment diets recorded weekly is presented in table 6. The feed efficiency calculated at the second week of age of bird revealed that the best efficiency was recorded for the groups fed 26 per cent protein and 2900 KCal ME/kg (diet VIII). The poorest feed efficiency was for the group fed 22 per cent protein with 3100 KCal ME/kg (diet III). However, the feed efficiency of

Table 6. Mean weekly feed efficiency (feed/weight gain) of quails fed experimental diets

Age (week)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
2	1	3.71	3.81	4.76	3.81	4.05	4.19	3.60	3.55	4.20	3.96
	2	4.84	5.38	5.98	4.15	5.29	4.94	4.17	4.10	3.59	4.72
	3	2.36	2.49	3.17	3.11	2.86	3.30	2.71	2.58	2.68	2.81
	Mean	3.64^{ab}	3.89^{bc}	4.64^{d}	3.69^{ab}	4.07^{c}	4.14^{c}	3.49^{a}	3.41^{a}	3.49^{a}	3.83
3	1	3.24	3.24	3.29	2.66	3.27	2.92	2.83	2.63	2.68	2.97
	2	3.47	3.23	3.94	3.74	4.22	4.10	3.19	2.93	2.75	3.51
	3	3.09	3.39	3.13	3.00	3.35	3.52	3.23	2.95	3.35	3.22
	Mean	3.27^{cd}	3.29^{cd}	3.45^{de}	3.13^{bc}	3.62^{e}	3.51^{e}	3.08^{bc}	2.84^{a}	2.92^{b}	3.23
4	1	3.76	4.26	4.50	4.06	4.26	4.30	3.66	3.81	3.99	4.07
	2	4.00	4.31	4.43	3.64	4.54	4.15	3.23	3.19	3.68	3.91
	3	4.63	4.72	4.62	3.79	4.68	4.65	4.43	4.75	4.19	4.49
	Mean	4.13	4.43	4.52	3.83	4.49	4.37	3.77	3.92	3.95	4.16
5	1	4.34	5.78	4.91	5.48	4.77	5.31	4.57	4.85	4.78	4.98
	2	5.61	6.90	5.93	6.22	6.25	5.79	5.78	5.85	5.72	6.00
	3	6.39	5.94	5.81	6.94	6.83	6.70	6.26	5.98	5.66	6.28
	Mean	5.45	6.21	5.55	6.21	5.95	5.93	5.54	5.56	5.39	5.75
6	1	7.55	6.74	6.07	6.95	5.67	5.33	5.22	5.31	5.24	6.01
	2	5.70	5.35	5.65	4.80	5.21	5.10	5.59	5.37	5.01	5.31
	3	5.14	4.56	5.79	5.37	4.75	5.73	5.68	6.17	6.68	5.54
	Mean	6.13^{b}	5.55^{ab}	5.84^{ab}	5.71^{ab}	5.21^{a}	5.39^{ab}	5.50^{ab}	5.62^{ab}	5.64^{ab}	5.62

Values bearing the same superscript do not differ significantly

quails fed 26 per cent protein were uniformly superior irrespective of energy level.

The feed efficiency values worked out for third week of age for quails on different diets also revealed that the best efficiency was for groups fed 26 per cent protein with 2900 KCal ME/kg. The poorest feed efficiency was for groups fed 24 per cent protein with 2900 KCal ME/kg. Here again the feed efficiency of quails fed 26 per cent protein was superior over the other groups irrespective of the energy levels.

The feed efficiency during the fourth and fifth weeks of age did not show any significant difference due to dietary treatments, whereas during sixth week of age the feed efficiency was shown to be influenced ($P < 0.01$) by the dietary treatments. An efficiency of 5.21 was recorded in groups fed 24 per cent protein with 2900 KCal ME/kg and 6.13 for groups fed 22 per cent protein and 2700 KCal ME/kg being the best and the poorest respectively. However, the differences among the various groups did not show any definite trend implicating influences of energy level, protein level or a combination of this.

The overall feed efficiency of quails upto fifth and sixth weeks of age as influenced by the diets is presented in table 7. The mean feed efficiencies were 4.24 and 4.58 for the above periods respectively. At the end of both these ages the efficiency was superior in groups fed 26 per cent protein irrespective of energy levels (Fig. 2 and 3).

Fig.2. INFLUENCE OF PROTEIN AND ENERGY LEVELS ON FEED EFFICIENCY FROM 1 to 5 AND 1 to 6 WEEKS OF AGE

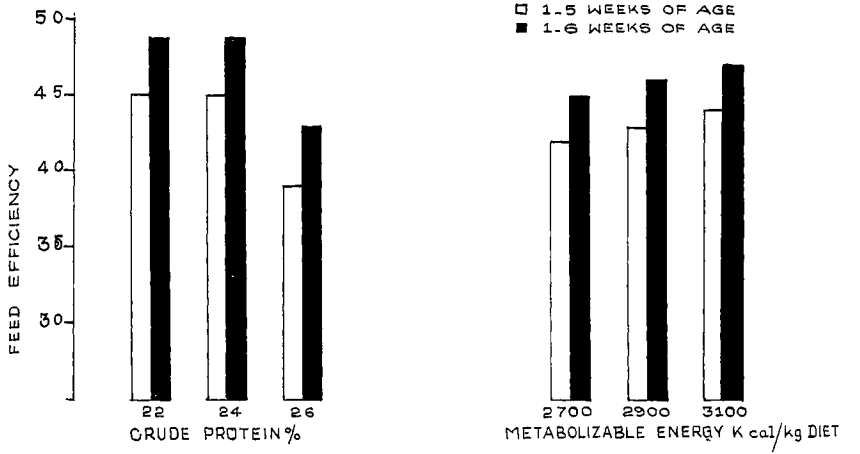
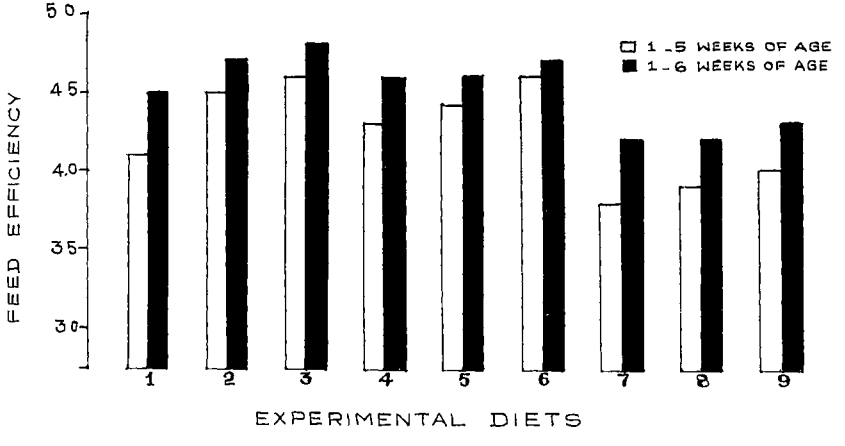


FIG.3. INFLUENCE OF EXPERIMENTAL DIETS ON FEED EFFICIENCY FROM 1 to 5 AND 1 to 6 WEEKS OF AGE



The feed efficiency from initial to fifth week of age and initial to sixth week of age as influenced by the nutrients and its statistical analysis is presented in tables 10 and 11 respectively.

Yield and losses

The yield and losses recorded in birds slaughtered at fifth and sixth weeks of age is presented in tables 12 and 13 respectively. The statistical analysis of the data revealed that the yield and losses during processing of quails at two ages namely fifth and sixth weeks of age were not influenced by the dietary treatments.

The per cent shrinkage in quails fed the different dietary treatments ranged from 7.57 to 9.57 with an overall mean of 8.18 for the fifth week and ranged from 7.09 to 8.64 with an overall mean of 7.78 for the sixth week.

The percentage of blood loss varied from 4.14 to 5.08 with an overall mean of 4.58 at fifth week of age and 3.70 to 5.37 with an overall mean of 4.51 at sixth week of age.

The per cent feather ranged from 6.33 to 7.53 with an overall mean of 7.04 for the fifth week of age and 6.18 to 7.64 with an overall mean of 6.78 for the sixth week of age.

The per cent dressed weight ranged from 87.52 to 89.26 with an overall mean of 88.36 for the fifth week of age and 87.57 to 89.79 with an overall mean of 88.49 for the sixth week of age.

Table 7. Consolidated performance of quails fed experimental diets

Traits	Experimental diets									Mean
	I	II	III	IV	V	VI	VII	VIII	IX	
Initial to fifth week of age										
Body weight gain (g)	80.72	74.21	70.88	77.5	73.98	71.32	86.89	84.45	81.42	77.93
Feed consumption (g)	334.18	329.91	326.27	331.94	328.30	324.38	333.62	327.11	324.31	328.89
Feed efficiency	4.14	4.45	4.60	4.28	4.44	4.55	3.84	3.87	3.98	4.24
Initial to sixth week of age										
Body weight gain (g)	105.42	99.31	96.43	102.04	101.14	96.92	112.48	110.64	106.11	103.39
Feed consumption (g)	470.89	466.34	459.48	468.09	464.59	458.08	470.75	464.17	460.25	464.74
Feed efficiency	4.47	4.70	4.76	4.59	4.59	4.73	4.19	4.20	4.34	4.58

Table 8. Body weight gain (g) of quails fed different levels of protein and energy

Energy KCal ME/kg	Initial to fifth week of age			Mean	Initial to sixth week of age			Mean
	Protein (%)				Protein (%)			
	22	24	26		22	24	26	
2700	80.72	77.50	86.89	81.70^{c}	105.42	102.04	112.48	106.65^{b}
2900	74.21	73.98	84.45	77.55^{b}	99.31	101.14	110.64	103.70^{ab}
3100	70.88	71.32	81.42	74.54^{a}	96.43	96.92	106.11	99.82^{a}
Mean	75.27^{a}	74.27^{a}	84.25^{b}		100.39^{a}	100.03^{a}	109.74^{b}	

Values bearing the same superscript do not differ significantly

Table 9. Feed consumption (g) of quails fed different levels of protein and energy

Energy KCal ME/kg	Initial to fifth week of age			Mean	Initial to sixth week of age			Mean
	Protein (%)				Protein (%)			
	22	24	26		22	24	26	
2700	334.18	331.94	333.62	333.25[c]	470.89	468.09	470.75	469.91[c]
2900	329.91	328.30	327.11	328.44[b]	466.34	464.59	464.17	465.03[b]
3100	326.27	324.38	324.31	324.99[a]	459.48	458.08	460.25	459.27[a]
Mean	330.12[a]	328.21[a]	328.35[a]		465.57[a]	463.59[a]	465.06[a]	

Values bearing the same superscript do not differ significantly

Table 10. Feed efficiency of quails fed different levels of protein and energy

Energy KCal ME/kg	Initial to fifth week of age				Initial to sixth week of age			
	Protein (%)			Mean	Protein (%)			Mean
	22	24	26		22	24	26	
2700	4.14	4.28	3.84	4.09[a]	4.47	4.59	4.19	4.42[a]
2900	4.45	4.44	3.87	4.25[a]	4.70	4.59	4.20	4.50[a]
3100	4.60	4.55	3.98	4.38[a]	4.76	4.73	4.34	4.61[a]
Mean	4.40[b]	4.42[b]	3.90[a]		4.64[b]	4.59[b]	4.24[a]	

Values bearing the same superscript do not differ significantly

Table 11. ANOVA on consolidated performance of quails fed different levels of protein and energy

Source	DF	MSS		
		Weight gain	Feed consumption	Feed efficiency
Initial - Fifth week of age				
Protein	2	1371.281**	41	5.401**
Energy	2	573.469**	824**	0.461
Protein x energy	4	64.781	14.5	0.546
Error	153	43.027	141.686	0.285
Initial - Sixth week of age				
Protein	2	1343.125**	28	2.583**
Energy	2	540.625**	1488**	0.472
Protein x energy	4	54.156	26	0.137
Error	153	65.426	112.837	0.15

** Significant at ($P < 0.01$)

Table 12. Mean yields and losses (%) in quails slaughtered at fifth week of age

Traits	Experimental diets									Mean
	I	II	III	IV	V	VI	VII	VIII	IX	
Shrinkage	7.61	7.57	8.13	7.74	8.41	8.39	8.30	8.91	9.57	8.18
Blood	4.44	4.35	5.08	4.99	4.48	4.41	4.66	4.72	4.14	4.58
Feather	6.93	7.53	7.40	6.97	7.15	6.33	7.11	7.03	6.93	7.04
Dressed yield	88.63	88.12	87.52	87.94	88.37	89.26	88.23	88.25	88.93	88.36
Total offal	25.11	24.28	23.95	24.45	24.95	25.01	24.77	24.80	23.43	24.53
Eviscerated yield	67.04	68.47	67.75	68.04	67.52	67.91	68.17	68.01	68.99	67.99
Giblet	7.95	7.25	8.30	7.51	7.53	7.08	7.06	7.19	7.58	7.49
Ready to cook yield	74.89	75.72	76.05	75.55	75.05	74.99	75.23	75.20	76.57	75.47

Table 13. Mean yields and losses (%) in quails slaughtered at sixth week of age

Traits	Experimental diets									Mean
	I	II	III	IV	V	VI	VII	VIII	IX	
Shrinkage	7.26	7.54	7.22	8.64	7.97	7.09	8.24	8.14	7.90	7.78
Blood	4.03	3.70	4.10	4.65	5.37	4.15	4.95	5.04	4.63	4.51
Feather	6.59	6.53	6.18	6.95	7.06	6.67	7.00	6.42	7.64	6.78
Dressed yield	89.38	89.79	89.72	88.40	87.57	89.18	88.05	88.59	87.73	88.49
Total offal	21.15	20.88	22.10	21.96	22.37	21.42	22.15	23.27	24.67	22.22
Eviscerated yield	71.99	71.57	70.16	70.74	69.69	71.24	70.44	70.34	68.11	70.48
Giblet	6.86	7.55	7.74	7.30	7.94	7.34	7.41	6.39	7.22	7.33
Ready to cook yield	78.85	79.12	77.90	78.04	77.63	78.58	77.85	76.73	75.33	77.78

The total offal in processing ranged from 23.43 to 25.11 per cent and the mean was 24.53 per cent at fifth week of age. At sixth week of age the values ranged from 20.88 to 24.67 with a mean loss of 22.22 per cent.

The mean eviscerated percentage was 67.99 and the values ranged from 67.04 to 68.99 per cent for the fifth week of age and for the sixth week of age the mean eviscerated per cent value was 70.48 and ranged from 68.11 to 71.99 per cent.

The giblet yield ranged from 7.06 to 8.30 per cent with a mean of 7.49 at fifth week of age and 6.39 to 7.94 with a mean of 7.33 at sixth week of age.

The mean per cent ready to cook yield was 75.47 and ranged from 74.89 to 76.57 per cent for the fifth week of age and for the sixth week of age the mean yield was 77.78 per cent and ranged from 75.33 to 79.12 per cent.

Cut-up-parts

The mean per cent cut-up-parts obtained from quails slaughtered at fifth and sixth week of age are presented in tables 14 and 15 respectively. The yields of different cut up parts at fifth and sixth week of age were not shown to be influenced by dietary treatments employed in this study.

The mean breast yield was 35.41 per cent at fifth week of age and 35.55 per cent at sixth week of age. The contribution by thigh was 13.64 per cent in quails slaughtered at fifth week as 12.8 per cent in quails slaughtered at sixth week of age.

Table 14. Mean cut-up-parts (%) in quails slaughtered at fifth week of age

Cut-up-parts	Experimental diecs									Mean
	I	II	III	IV	V	VI	VII	VIII	IX	
Breast	35.80	33.72	33.58	34.45	35.20	35.94	37.54	36.90	35.55	35.41
Thigh	14.16	13.80	14.09	13.99	13.12	13.51	13.30	12.98	13.84	13.64
Drumstick	10.96	11.43	11.70	11.77	11.47	12.48	11.05	11.47	12.15	11.61
Wing	10.60	10.55	11.16	10.67	9.92	10.36	9.92	10.80	10.61	10.51
Neck	6.38	6.65	6.01	6.77	6.71	5.80	5.95	5.86	6.51	6.29
Back	22.10	23.85	23.46	22.35	23.58	21.91	22.24	21.99	21.34	22.54

Table 15. Mean cut-up-parts (%) in quails slaughtered at sixth week of age

Cut-up-parts	Experimental diets									Mean
	I	II	III	IV	V	VI	VII	VIII	IX	
Breast	36.21	34.90	34.98	35.53	36.58	35.40	37.05	33.41	35.90	35.55
Thigh	12.99	13.26	12.70	12.63	12.95	13.16	12.55	12.90	12.03	12.80
Drumstick	11.23	10.98	10.55	10.55	11.30	11.49	10.41	11.13	11.02	10.96
Wing	9.39	9.53	9.77	9.24	9.37	9.79	9.15	9.96	8.50	9.41
Neck	5.81	5.70	6.51	6.43	6.25	6.26	6.53	6.10	6.46	6.23
Back	24.37	25.63	25.49	25.62	23.55	23.90	24.31	26.50	26.09	25.05

The drumstick yield was 11.61 and 10.96 per cent for quails slaughtered at fifth and sixth week of age respectively.

The wing, neck and back constituted 10.51, 6.29, and 22.54 per cent respectively for quails slaughtered at fifth week of age. The corresponding values for quails slaughtered at sixth week of age were 9.41, 6.23 and 25.05 respectively.

Meat-bone ratio

The meat-bone ratio of the quails slaughtered during fifth and sixth week of age is presented in tables 16 and 17. Dietary treatments did not significantly influence this ratio either during fifth or sixth week of age. The ratio varied from 1.81 to 2.05 during fifth week and 1.93 to 2.05 during sixth week of age.

Biochemical parameters

Liver protein

The mean per cent liver protein of quails fed different levels of protein and energy estimated during fifth and sixth week of age is presented in table 18. The liver protein value ranged from 57.06 to 64.71 per cent at fifth week and 54.12 to 64.47 per cent at sixth week of age. It could be seen from the table that during both the ages the liver protein progressively increased with increase in protein content of the diet.

Liver lipid

The mean liver lipid content of quails fed different levels of protein and energy which were slaughtered at fifth

Table 16. Mean meat-bone ratio in quails, slaughtered at fifth week of age

Experimental diets	Meat (%)	Bone (%)	M:B
I	67.23	32.77	2.05
II	66.85	32.95	2.03
III	64.35	35.65	1.81
IV	63.47	36.53	1.74
V	65.12	34.88	1.87
VI	64.16	35.84	1.79
VII	65.21	34.79	1.87
VIII	67.59	35.08	1.93
IX	66.96	33.04	2.03
Mean	65.66	34.61	1.90

Table 17. Mean meat-bone ratio in quails slaughtered at sixth week of age

Experimental diets	Meat (%)	Bone (%)	M:B
I	67.24	32.76	2.05
II	66.54	33.46	1.99
III	65.83	34.17	1.93
IV	66.87	33.13	2.02
V	66.26	33.74	1.96
VI	66.38	33.62	1.97
VII	66.67	33.33	2.00
VIII	66.66	33.34	2.00
IX	66.03	33.97	1.94
Mean	66.50	33.50	1.98

Table 18. Mean per cent liver protein of quails fed experimental diets

Age (weeks)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
5	1	59.47	60.74	58.64	61.96	61.95	62.01	63.76	63.56	64.79	61.87
	2	59.76	61.21	60.87	62.02	62.32	61.91	63.75	63.19	64.89	62.21
	3	51.96	52.16	53.71	57.24	59.83	61.42	62.51	63.81	64.46	58.51
	Mean	57.06[a]	58.04[a]	57.57[a]	60.41[b]	61.36[b]	61.78[bc]	63.34[cd]	63.52[cd]	64.71[d]	60.86
6	1	57.09	56.52	56.20	60.86	61.26	61.48	63.75	63.91	64.74	60.65
	2	53.67	53.70	54.73	61.73	61.54	60.53	63.94	64.67	65.05	59.95
	3	52.35	52.13	52.53	55.87	57.67	58.88	60.40	62.50	63.62	57.33
	Mean	54.37[a]	54.12[a]	54.49[a]	59.49[b]	60.16[b]	60.30[b]	62.70[c]	63.69[cd]	64.47[d]	59.31

Values bearing the same superscript do not differ significantly

and sixth week of age is presented in table 19. The values ranged from 12.44 to 18.23 per cent at fifth week and from 12.52 to 18.01 at sixth week of age. At both the ages it revealed that the liver lipid progressively increased with increase in energy level in the diet.

Serum protein

The mean serum protein values of quails at fifth and sixth week of age fed different levels of protein and energy is presented in table 20. The overall mean serum protein was 5.78 g per cent at fifth week and 5.82 g per cent during the sixth week of age. The general trend of the values as could be seen from the table is that at both these ages the values tended to show an increasing trend with the increase in the protein content in the ration.

Serum lipid

The mean serum lipid values at fifth and sixth week of age of quails fed different levels of protein and energy is presented in table 21. The mean value was 2.36 g per cent at fifth and 2.28 g per cent at sixth week of age. The overall result revealed that the mean serum lipid values were significantly ($P < 0.01$) highest at highest energy level in the diet.

Haemoglobin

The mean haemoglobin values at fifth and sixth week of age of quail under the different dietary treatments is presented in table 22. It was 9.65 g per cent at fifth week

Table 19. Mean per cent liver lipid of quails fed experimental diets

Age (weeks)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
5	1	12.86	15.62	19.34	14.43	15.42	19.36	13.96	16.69	18.69	16.26
	2	13.09	14.79	18.00	14.34	17.05	18.87	13.90	16.00	19.11	16.13
	3	11.36	12.46	15.85	12.02	13.82	16.01	12.27	15.35	16.88	14.00
	Mean	12.44[a]	14.29[c]	17.73[e]	13.60[b]	15.43[d]	18.08[e]	13.38[b]	16.01[d]	18.23[e]	15.46
6	1	12.03	14.76	18.03	13.71	16.45	17.89	13.56	16.49	18.70	15.74
	2	12.89	14.10	17.07	13.99	15.38	16.51	14.03	16.01	18.26	15.36
	3	12.63	13.65	16.86	12.31	14.77	17.05	13.15	15.57	17.06	14.78
	Mean	12.52[a]	14.17[c]	17.32[f]	13.34[b]	15.53[d]	17.15[f]	13.58[b]	16.02[e]	18.01[g]	15.29

Values bearing the same superscript do not differ significantly

Table 20. Mean serum protein of quails fed experimental diets (g %)

Age (weeks)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
5	1	5.90	5.63	5.73	6.20	5.74	5.73	5.94	6.39	5.90	5.91
	2	5.66	5.76	5.66	5.64	5.63	5.66	5.75	5.65	5.66	5.67
	3	5.63	5.63	5.78	5.66	5.74	5.87	5.78	5.86	5.88	5.76
	Mean	5.73	5.67	5.73	5.84	5.70	5.75	5.82	5.97	5.81	5.78
6	1	5.90	5.59	5.66	5.99	5.70	5.67	6.20	6.04	6.02	6.00
	2	5.67	5.72	5.58	5.96	5.63	5.61	5.89	5.64	5.64	5.71
	3	5.71	5.64	5.62	5.66	5.73	5.79	5.97	5.89	5.84	5.76
	Mean	5.79	5.64	5.62	5.87	5.69	5.68	6.02	6.04	6.02	5.82

Table 21. Mean serum lipid of quails fed experimental diets (g %)

Age (weeks)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
5	1	1.46	2.04	2.80	2.16	2.36	2.87	2.32	2.54	2.96	2.39
	2	1.42	1.88	2.82	2.05	2.20	2.84	2.34	2.57	3.01	2.35
	3	1.39	1.89	2.64	2.05	2.28	2.86	2.37	2.51	2.96	2.33
	Mean	1.42^{a}	1.94^{b}	2.75^{g}	2.09^{c}	2.28^{d}	2.86^{h}	2.34^{e}	2.54^{f}	2.98^{i}	2.36
6	1	1.37	2.04	2.70	2.11	2.42	2.71	2.31	2.57	2.96	2.36
	2	1.42	1.86	2.60	1.95	2.36	2.65	2.26	2.49	2.94	2.28
	3	1.30	1.66	2.03	2.14	2.22	2.76	2.22	2.48	2.95	2.20
	Mean	1.36^{a}	1.85^{b}	2.44^{ef}	2.07^{c}	2.33^{de}	2.71^{g}	2.26^{d}	2.51^{f}	2.95^{h}	2.28

Values bearing the same superscript do not differ significantly

Table 22. Mean haemoglobin values of quails fed experimental diets (g %)

Age (weeks)	Trial No.	Experimental diets									Mean
		I	II	III	IV	V	VI	VII	VIII	IX	
5	1	9.50	9.45	9.65	9.55	9.55	9.50	9.50	9.55	9.75	9.56
	2	9.80	9.70	9.80	9.75	9.80	9.95	9.95	10.00	9.75	9.83
	3	9.60	9.60	9.55	9.55	9.55	9.55	9.50	9.55	9.70	9.57
	Mean	9.63	9.58	9.67	9.62	9.63	9.67	9.65	9.70	9.73	9.65
6	1	9.60	9.75	9.65	9.70	9.75	9.80	9.65	9.85	9.85	9.73
	2	9.70	9.85	9.65	9.65	9.55	9.80	9.75	9.70	9.75	9.71
	3	9.65	9.65	9.65	9.60	9.65	9.65	9.70	9.65	9.65	9.65
	Mean	9.65	9.68	9.65	9.65	9.65	9.75	9.70	9.73	9.75	9.70

of age and 9.7 g per cent at sixth week of age. The statistical analysis of the data revealed that haemoglobin levels were not influenced by the dietary treatments.

Composition of ready to cook meat

The mean per cent compositions of ready to cook meat of quails fed different levels of protein and energy which were slaughtered at fifth and sixth week of age are presented in table 23.

The moisture content of the meat was 70.5 per cent at fifth week and 69.47 per cent at sixth week of age. The differences among the treatment groups as well as between age groups were not statistically significant.

The overall mean protein content (N x 6.25) of the meat obtained from quails slaughtered at fifth week of age was 60 per cent and at sixth week was 60.96 per cent. The differences among treatment groups as well as between age groups were not statistically significant.

The mean lipid content of the ready to cook meat obtained from quails slaughtered at fifth and sixth week of age were 14.89 and 14.44 per cent respectively. It could be seen from the table, the values were not very much altered among the two age groups studied. However, the dietary treatments had significantly influenced ($P < 0.01$) the lipid content of the meat. It was observed that the lipid content increased with increase in the energy level in the diet during both the ages.

Table 23. Mean per cent composition, on dry matter basis, of ready to cook meat of quails fed different levels of protein and energy

Experimental diets	Parameter	Moisture		Crude protein		Ether extractives		Total ash	
	Age (wk)	5	6	5	6	5	6	5	6
I		70.21	69.53	58.27	59.28	12.66[a]	12.11[a]	3.43	3.41
II		70.96	69.80	58.54	59.50	13.84[d]	14.02[c]	3.45	3.22
III		70.94	69.13	58.86	59.97	15.95[f]	15.81[e]	3.41	3.45
IV		70.48	69.43	58.95	59.94	12.99[b]	12.55[b]	3.35	3.41
V		70.39	69.65	58.92	60.48	14.75[e]	14.11[c]	3.35	3.37
VI		70.23	69.47	58.93	60.61	16.78[h]	16.46[f]	3.40	3.19
VII		70.46	69.33	62.29	62.52	13.32[c]	12.60[b]	3.65	3.55
VIII		70.09	69.35	62.47	63.0	16.15[g]	15.37[d]	3.62	3.49
IX		70.68	69.57	62.84	63.36	17.61[i]	16.99[g]	3.66	3.61
Mean		70.50	69.47	60.01	60.96	14.89	14.44	3.48	3.41

Values bearing the same superscript do not differ significantly

Further the interaction effect between energy and protein was also significant ($P < 0.01$) at both the ages of study.

The mean total ash of the meat obtained from quails slaughtered at fifth and sixth week of age were 3.48 and 3.41 per cent respectively. The values were not influenced by either age or dietary treatments.

Abdominal fat

Efforts to collect abdominal fat from quails that were slaughtered at fifth and sixth week of age which were under different dietary regiment failed because of the extremely poor abdominal fat deposition.

Nitrogen Retention

The absolute nitrogen retention in quails fed different levels of protein and energy is presented in table 24 and it ranged from 0.56 to 0.68 g. Eventhough higher numerical values for absolute nitrogen retention in relation to higher protein content was obtained, this magnitude of difference was not statistically significant among the three levels of protein employed.

Mortality

The mortality among the experimental quail chicks which occurred during the whole period of experimentation is tabulated and presented in table 25. The overall mortality was 6.28 per cent.

Table 24. Mean absolute nitrogen retention of quail chicks fed experimental diets (g)

Trial No.	Experimental diets									Mean
	I	II	III	IV	V	VI	VII	VIII	IX	
1	0.57	0.59	0.57	0.62	0.62	0.63	0.69	0.68	0.66	0.61
2	0.55	0.56	0.55	0.62	0.60	0.58	0.68	0.64	0.65	0.60
3	0.56	0.56	0.55	0.61	0.59	0.57	0.66	0.63	0.63	0.60
Mean	0.56	0.57	0.56	0.62	0.60	0.59	0.68	0.65	0.65	0.60

Table 25. Mortality pattern in quail chicks fed different levels of protein and energy upto 6 weeks of age(number)

Protein (%)	Energy (KCal ME per kg diet)		
	2700	2900	3100
22	7 (108)	8 (108)	11 (108)
24	5 (108)	5 (108)	7 (108)
26	8 (108)	5 (108)	5 (108)

Figures in parenthesis are total number of quails in each treatment group

Discussion

DISCUSSION

Production Parameters

Body weight

The body weight of quails at the fifth week of age ranged from 85 to 100 g with an overall mean of 96.6 g and at sixth week of age it ranged from 104 to 120 g with an overall mean of 112 g. The fifth and sixth week body weight of quails recorded is in agreement with those reported earlier (Srivastava et al., 1981; Srivastava and Panda, 1982; Anon., 1985).

The body weight of quails recorded at second, third, fourth, fifth and sixth week of age presented in table 3 revealed that at second week, the highest body weight was obtained in group fed diets VII and IX while the lowest was obtained with diet III. The statistical analysis of the data revealed that protein as well as energy levels in the diet significantly influenced ($P < 0.01$) body weight at this age. The difference in the mean when protein level in the diet alone is considered was not different between 22 and 24 per cent whereas it was significantly superior ($P < 0.01$) with 26 per cent protein. Considering the energy levels alone it was found that the difference in mean body weight between 2700 and 2900 KCal ME/kg was not statistically significant whereas the weight obtained with 3100 KCal ME/kg was significantly lower ($P < 0.01$). This therefore suggests that the protein requirement at second week of age is around 26 per cent

and energy requirement 2700 KCal ME/kg. The trend of the data on body weight at third and fourth week of age also presented a similar picture suggesting a requirement of 26 per cent protein and 2700 KCal ME/kg in the diet.

However at fifth and sixth week of age the body weight was not seen to be influenced either by the protein or the energy level employed in the study, thus pointing out to a lower requirement for these nutrients viz., 22 per cent protein and 2700 KCal ME/kg at these ages.

Baldini et al. (1953a,b) had suggested protein requirement of 20 per cent for growing quails upto six week of age. This was lower when compared to the requirement revealed in this study. However it should be pointed out that the lowered requirement as proposed by Baldini et al. (1953a,b) was with a diet supplemented with Vit. B_{12} and antibiotic or lysine and therefore cannot be compared. Most of the authors (Vogt, 1970; Lepore and Marks, 1971; Vohra and Rowdybush, 1971; Andrews et al., 1973 and Srivastava et al., 1980b) have placed the protein requirement both at fifth and sixth week as between 24 to 27 per cent whereas the present study indicated a protein requirement of only 22 per cent. However, Vohra (1971) reviewing the nutrition research on Japanese quail has pointed out a two stage requirement namely 24 per cent upto three weeks and 20 per cent thereafter. Babu et al. (1986) also reported that the protein requirement was higher (26 per cent) upto three week of age and was lower (23 per cent) subsequently.

The results of the present study also point to a two stage requirement of 26 per cent upto fourth week and 22 per cent during fifth and sixth week. In so far as energy levels are concerned, the experiment of Weber and Reid (1967) indicated that energy levels of 2600 to 2850 KCal ME/kg was adequate for growing quails. The result of the present study, which indicated an energy level of 2700 KCal ME/kg is in agreement with the above finding. However, Lepore and Marks (1971) had reported a higher requirement (3080 KCal/kg) of energy for growing quails. Panda et al. (1977) recommending nutrient requirements for Japanese quail, based on review of research carried out, has set a level for energy at 3000 KCal ME/kg upto three weeks and 2700 KCal/kg at fourth and fifth week. However, in the present study none of the ages tested had shown increased requirements of energy of more than 2700 KCal/kg. The only possible explanation for the higher requirement set by Panda et al. (1977) is that their deductions are mostly based on studies carried out in temperate climate and India being in tropical climate the environmental temperature is comparatively higher and therefore the possibility of lower energy requirements.

Body weight gain

The data presented in table 4 on body weight gain of quails at different ages fed the three levels of protein and energy revealed that significantly ($P < 0.01$) better weight gain at second week of age was obtained with diets I, VII and VIII. However, the weight gain obtained at this age by quails

fed diets IV and IX were statistically similar to diets I, VII and VIII. The better gain obtained with VII, VIII and IX can be explained in terms of the effect due to higher protein levels which agrees with those reported by Babu et al. (1986). However the higher gain in birds fed diet I (22 per cent protein with 2700 KCal ME/kg) is difficult to be explained in terms of normal biological response to this nutrient.

The weight gain at third, fourth, fifth and sixth week of age were not influenced by the dietary treatment as revealed by statistical analysis of the data. Weber and Reid (1967) had also observed in their experiment increased body weight gain with incremental protein levels upto 24.5 per cent. Likewise Panda et al. (1980) also reported that in growing quails the growth was maximum during the first four weeks of age.

The overall gain in weight of quails from first week of age (initial) to fifth week of age and sixth week of age is presented in table 7. The statistical analysis of the data (table 11) revealed that the body weight gain at fifth week of age was influenced ($P < 0.01$) by both protein and energy levels in the diet but the effect of interaction between these two nutrients was not statistically significant. Comparing the means it was observed that the mean weight gain of 84.25 g obtained with 26 per cent protein was significantly superior ($P < 0.01$) to that obtained with 22 and 24 per cent protein, the differences between these two levels being statistically non-significant. Likewise, analysing the effect of energy it was

observed that the mean body weight gain at fifth week (81.70 g) obtained with 2700 KCal ME/kg was significantly superior ($P < 0.01$) over the other two energy levels. It also revealed that the mean body weight gain of 77.55 g obtained with 2900 KCal ME/kg was superior to that obtained with 3100 KCal ME/kg.

In the absence of interaction, it can safely be surmised that for better body weight gain at fifth week of age, the requirements of protein and energy are in the order of 26 per cent and 2700 KCal ME/kg respectively.

The overall gain in body weight upto six week of age revealed that both protein and energy influenced ($P < 0.01$) this character. Here again the interaction effect was not significant. Comparing the mean values taking protein level alone into consideration, it was observed that the mean gain in weight of 109.74 g obtained with 26 per cent protein was significantly superior ($P < 0.01$) over the other two levels, the difference among them being statistically non-significant.

When energy level alone was considered it was found that the mean body weight gain at the sixth week of age was similar between diets containing 2900 KCal ME/kg and 3100 KCal ME/kg. Likewise the differences between the diets containing 2700 and 2900 KCal ME/kg were statistically homogeneous.

Thus it appears that for obtaining better body weight gain at sixth week of age the requirement of protein and energy in the diet are in the order of 26 per cent and 2700 KCal ME/kg respectively.

Feed consumption

The overall feed consumption of quails from 1 to 5 weeks of age ranged from 324 to 334 g/bird and that from 1 to 6 weeks of age ranged from 458 to 470 g/bird (Table 7).

Feed intake by quails during 0 to 5 weeks was reported as 408.1 to 421.4 g/bird (Anon., 1986a). Panda et al. (1980) reported feed intake from day old to five week of age as 391.8 g and from day old to six week of age as 543.33 g/bird.

Srivastava et al. (1981) reported a cumulative feed intake of 519.7 to 551.3 g/bird upto six week of age when fed with diets containing varying levels of crude proteins (CP) and metabolizable energy (CP: 26.4 to 29.1 per cent; ME = 2850 to 2888 KCal/kg). It could be seen that there is a wide degree of variation in feed consumption reported in the literature. However, the data on feed consumption obtained in this study also falls within these range of variation. The variations in feed consumption reported in literature could be due to variation in season of study, type of feed etc. which have been established to have influence on feed consumption. While analysing the data on feed consumption according to the age of bird it was seen that at second week of age the consumption was significantly lowest ($P<0.01$) with diet IX and highest with diets II, IV and VII. The feed consumption was statistically similar with diet I, thus indicating that lower the energy level in the diet higher is the feed consumption. This is in agreement with those reported by Axuan and Young (1976).

At third and fourth week of age the trend was more or less similar. The feed consumption data at fifth and sixth week of age showed that the feed consumption was not influenced either by protein or energy level or both.

The feed consumption from one to five weeks of age was worked out for quails fed different diets which is presented in table 7. The statistical analysis of the data (table 11) revealed that the dietary protein levels did not influence feed consumption which is in agreement with those reported by Babu et al. (1986). Whereas the levels of energy employed did influence ($P < 0.01$) the feed consumption. Comparing the means it was evident that each mean was independent of the other and also that the feed consumption decreased with increased energy levels in the diet.

The feed consumption upto six week of age was also subjected to statistical analysis (table 11). It also revealed the same trend viz., higher the energy level in the diet lower the feed consumption. Reduced feed consumption as a consequence to increased energy content has been reported by Axuan and Young (1976).

Feed efficiency

The overall feed efficiency of the quails fed different diets calculated weekwise is presented in table 6. At two weeks of age the feed efficiency was best with 26 per cent protein diet irrespective of the energy levels and poorest with 22 per cent protein with 3100 KCal ME/kg. The other

diets with other protein and energy levels were intermediaty in nature.

At third week of age the best feed efficiency was obtained with diet containing 26 per cent protein with 2900 KCal ME/kg and the poorest was with 24 per cent protein with 2900 or 3100 KCal ME/kg. The numerical differences among diets IV, VII and IX were not statistically significant. Thus it can be again surmised that the feed efficiency is better with higher protein levels and also that the energy levels in the diet exerted little influence on this parameter at this age.

The mean feed efficiency at fourth and fifth week of age were 4.16 and 5.75 respectively. The numerical differences observed with different treatment diets were not statistically significant. Whereas at sixth week of age the best feed efficiency of 5.21 was recorded with diet containing 24 per cent protein and 2900 KCal ME/kg and the poorest (6.13) was recorded with diet containing 22 per cent protein and 2700 KCal ME/kg.

The overall feed efficiency worked out from initial upto five week of age ranged from 3.84 to 4.6 and that upto six week of age varied from 4.2 to 4.76(Table 7).

Baldini et al. (1953a) reported that the feed efficiency ranged from 3.18 to 3.42 from zero to six week of age with protein levels varying from 20.5 to 28.5 per cent and at 24.4 per cent protein the feed efficiency was 3.18.

Weber and Reid (1967) reported feed efficiency values as 4.19 and 3.88 at 24.5 and 28.8 per cent protein respectively

in quails upto five week of age. In the present study at 26 per cent protein level the feed efficiency was better when compared to 24 and 22 per cent protein levels is in agreement with the above report.

Gropp and Zucker (1969) also reported that at lower protein levels the feed efficiency was significantly low.

With higher protein level better feed efficiency obtained in the study is in agreement with those reported by Panda and Srivastava (1978), Panda et al. (1980), Srivastava et al. (1980b), and Srivastava et al. (1981) and Babu et al. (1986).

The statistical analysis of the data (Table 11) revealed that the protein levels in the diet influenced ($P < 0.01$) feed efficiency when computed from initial to five and also from initial to six week of age. Whereas at these periods energy levels in the diet did not exert any significant influence.

Srivastava et al. (1980b) reported that feed efficiency was influenced significantly ($P < 0.05$) both by protein and energy content of the diet of quails from three to five weeks of age. In the present study, feed efficiency upto six weeks of age was influenced mainly by protein alone. Srivastava et al. (1981) also reported that the feed efficiency was not influenced by the treatments upto six week of age of quails.

Comparing the means of feed efficiency at these two periods to decipher the exact variation due to protein it was observed that the feed efficiency was significantly superior

($P \leq 0.01$) with 26 per cent protein. However, the differences between diets containing 22 and 24 per cent protein were statistically similar (Fig.2).

Better feed efficiency with low calorie-protein ratio (1:107) observed in the present study is in agreement with those reported by Srivastava and Panda (1982) and Eliasvila et al. (1985) and Babu et al. (1986).

Processing Data

Yield and losses

The mean carcass yield and losses when the quails were slaughtered at fifth and sixth week of age are presented in tables 12 and 13 and statistical analysis of the data revealed that these factors were not influenced by the dietary treatments. Therefore the present discussion attempts to project values obtained under this experimental condition.

The mean per cent shrinkage of 8.18 and 7.78 at fifth and sixth week of age obtained in the present study is in agreement with Choudhary (1978).

The per cent shrinkage obtained by Pandey et al. (1979) for five week old quails fasted 8, 12 and 16 hours were 4.44, 4.68 and 11.11 respectively. The value obtained in the present study for quails fasted for 12 hours is higher than that reported by the above authors.

A per cent shrink of 8.4 and 8.9 was reported by Singh et al. (1980) for quails of five and six week of age respectively.

The finding of the present study also agrees with the above workers.

Srivastava and Panda (1982) reported that the per cent shrinkage differed between different age groups and between sexes of the group only at five weeks of age. Choudhary and Mahadevan (1983) reported a per cent shrinkage at five and six weeks of age for male and female quails as 8.34 and 4.88; and 7.17 and 4.52 respectively. The values obtained in the present study for quails at five weeks of age is in agreement with those observed by the above authors and the trend of the results that decreased shrinkage per cent with increased age observed in the present study also is in agreement with the above authors.

Per cent shrinkage averaged 9.37 for quails slaughtered at five weeks of age (Anon., 1985). In the present study the values obtained were slightly lower to those reported by the above author.

In the present study the overall mean per cent blood for quails slaughtered at fifth and sixth week of age were 4.58 with a range of 4.14 to 5.08 and 4.51 with a range of 3.70 to 5.37 respectively. This is higher to the value obtained by Pandey et al. (1979) who reported a per cent blood of 2.51 at five weeks of age for quails.

Choudhary and Mahadevan (1983) observed a blood per cent of 8.6 and 4.81 at five and six weeks of age for male quails and 8.55 and 4.93 for female quails of five and six weeks of

age respectively. The values of the present study obtained for quails of six weeks of age is in agreement with the above authors and that for five weeks of age are lower to that reported by the above authors. Decline in blood volume with increased age observed in the study agrees with the reports made by Choudhary and Mahadevan (1983). The authors also reported that difference between the sex was not apparent upto six weeks of age. A blood per cent of 3.95 was obtained for quails of five weeks of age (Anon., 1985). The present results also agree with the above finding.

The per cent feather for quails slaughtered at five and six weeks of age averaged 7.04 and 6.78 in the present study. Pandey et al. (1979) reported a feather per cent of 5.68 for five week old quails. Choudhary and Mahadevan (1983) reported average feather per cent of 5.8 and 10.04 at five and six weeks of age respectively for male quails and 5.79 and 10.26 for female quails. The values reported in the present study is within the range reported by the above authors.

The mean per cent dressed weight of quails ranged from 87.52 to 89.26 with an overall mean of 88.36 at the fifth week and 87.57 to 89.79 with an overall mean of 88.49 at the sixth week of age. The above values are in close agreement with those reported by Pandey et al. (1979); Singh et al. (1980) and Srivastava and Panda (1982). The values obtained in the present study are much higher to those reported by Choudhary and Mahadevan (1983) for per cent dressed yield at both the ages.

The mean total offal per cent averaged 24.53 and 22.22 at five and six weeks of age respectively which is in agreement with the report of Singh et al. (1980) who observed a value of 26.1 and 23.6 per cent at five and six weeks of age respectively.

The values of the present findings are also lower to the values reported by Srivastava and Panda (1982); Choudhary and Mahadevan (1983) and Anon.(1985). Srivastava and Panda (1982) also reported that the per cent total offal was nearly same upto six weeks of age.

The mean per cent eviscerated yield at five and six weeks of age averaged 67.99 and 70.48 respectively. These values are within the range reported by Pandey et al. (1979), Jones et al. (1979), Singh et al. (1980) and Srivastava and Panda (1982) and Singh and Panda (1985), but, higher to those reported by Choudhary and Mahadevan (1983) and Anon. (1985). Singh et al. (1980) also reported that the evisceration per cent was nearly same in both sexes upto six weeks of age.

The mean giblet per cent were 7.49 and 7.33 at five and six weeks of age respectively which is within the range reported by Pandey et al. (1979), Singh et al. (1980), Srivastava and Panda (1982) and Anon. (1985).

The ready to cook yield averaged 75.47 and 77.78 at five and six weeks of age respectively. This is also in agreement with the reports of Singh et al. (1980), Singh et al. (1981), Panda (1986) and Tsorveni Gousi and Yannakopoulos (1986). The values obtained in the present study were higher to those

reported by Pandey et al. (1979), Srivastava and Panda (1982), Chidananda et al. (1985) and Mohan et al. (1986).

Cut-up-parts

The mean cut-up-parts obtained from quails slaughtered at fifth and sixth week of age are presented in tables 14 and 15 and statistical analysis of the data revealed that none of the cut-up-parts were influenced by the dietary treatments.

The mean per cent breast, thigh, drumstick, wing, neck and back yields at five week of age were 35.41, 13.64, 11.61, 10.51, 6.29 and 22.54 respectively and those for six week of age were 33.55, 12.8, 10.96, 9.41, 6.23 and 25.05 respectively.

The above values are in agreement with the values reported by Pandey et al. (1979).

In the present study breast constituted the highest followed by back, thigh, drumstick, wing and neck among the cut-up-parts and is almost in agreement with Singh et al.(1980) and Panda (1986) who reported that breast was followed by back, thigh, wing, drumstick and neck among the cut-up-parts. Breast and thigh contributed maximum yield in the present study. This observation agrees with the findings of Singh et al. (1981).

Meat-Bone Ratio

The meat-bone ratio of the quails slaughtered at five and six weeks of age presented in tables 16 and 17 revealed that the character was statistically not influenced by the dietary treatments.

The average meat-bone ratio at five and six weeks of age were 1.90 with a range of 1.81 to 2.05 and 1.98 with a range of 1.93 to 2.05 respectively.

Singh et al. (1981) reported a mean meat-bone ratio of 2.4 and 3.4 at five and six week of age respectively for quails.

Sreenivasiah et al. (1985) reported that the meat-bone ratio at six week of age averaged 3.94. Mohan et al. (1986) reported a ratio of 3.57 at six week of age.

Bio-Chemical Parameters

Liver protein

The mean per cent liver protein estimated in quails fed with different levels of protein and energy presented in table 18 indicated an overall mean value of 60.9 at fifth week and 59.3 per cent at sixth week of age.

The statistical analysis of the data revealed that liver protein was influenced ($P < 0.01$) by protein levels in the diet rather than energy levels and interaction is absent.

Further analysis revealed that as protein level in the diet increased there is a significant increase ($P < 0.01$) in the liver protein also. The statistical analysis of the data on sixth week per cent liver protein values also presented the same trend.

Liver lipid

The mean per cent liver lipid of quails at fifth and sixth

week of age presented in table 19 revealed a mean value of 15.46 for fifth week and 15.29 per cent for sixth week of age.

Comparing the effect due to dietary treatments it was observed that energy levels in the diet significantly influenced ($P < 0.01$) liver lipid concentration. The statistical analysis revealed that at both these ages the liver lipid concentration significantly ($P < 0.01$) increased as dietary energy levels increased. However, levels of protein or interaction effect were statistically not significant.

A mean liver lipid content of approximately 25 per cent was observed by Yoshizane Maeda et al. (1986) at second and fourth week of age in both sexes with 18 per cent protein and 3132 KCal ME/kg. Liver lipid content at four week of age averaged 22.5 for female and for male it was 23.6 per cent.

Maximum fat in liver was found with 27 per cent protein at 2800 KCal ME/kg compared to 25 or 23 per cent procein at the same energy level (Anon., 1986a).

Serum protein

The mean serum protein estimated at fifth and sixth week of age (Table 20) presented a mean value of 5.78 and 5.82 g per cent respectively. Analysis of the values obtained for different dietary treatments at both these ages showed that the serum protein was not influenced by the dietary treatments at both these ages.

Leveille and Sanberlick (1961) reported that the stage

of nutrition influenced the plasma protein levels.

The present finding agrees with Atwal et al. (1964) who reported that the plasma protein levels varied from 3.3 to 6.1 g per 100 ml at 50 days old quails of both sexes.

Nirmalan and Robinson (1971) reported that in adult quails plasma protein varied from 3.1 to 3.7 g/100 ml.

Serum lipid

The mean serum lipid estimated at fifth and sixth weeks of age (Table 21) was 2.36 and 2.28 g per cent respectively. Estimating the possible difference, if any, among dietary treatments employing statistical analysis revealed that the serum lipid was significantly ($P < 0.01$) influenced by the energy levels, effect being a progressive increase as the dietary energy levels increased. The protein levels in the diet had little influence on this parameter. The trend of the result was similar at both five and six week of age.

Plasma lipid increased with increase in protein levels in the diet (Anon., 1986a). The present result agrees with the above finding.

Nirmalan and George (1972) observed a mean total lipid value of 1.80 and 1.97 g/100 ml for male and female whole blood respectively.

Haemoglobin

The mean haemoglobin values estimated at fifth and sixth

week of age were 9.65 and 9.70 g per cent respectively (Table 22). The statistical analysis of the data revealed that haemoglobin levels were not influenced by the dietary treatments at both these ages.

The values obtained in the present study is in agreement with Deshmukh and Suryawanshi (1982) and Atwal et al. (1964).

Chemical composition of ready to cook meat

The mean chemical composition of the ready to cook meat of quails slaughtered at five and six weeks of age presented in table 23 revealed that only the percentage ether extractive was influenced ($P < 0.01$) by the dietary treatments. At both these ages the ether extractives were more with higher energy levels in the diet. Likewise the protein content in the diet also influenced the ether extractives in a fashion similar to that of energy but lesser in magnitude. The interaction effect was absent.

The overall mean per cent values obtained for moisture, protein, fat and ash at five and six weeks of age were almost in agreement with those reported by Srivastava and Panda (1982), Anon. (1985) and Choudhary and Mahadevan (1986).

The mean moisture per cent obtained in the study is slightly lesser to those reported by Srivastava and Panda (1982), Anon. (1985) and Choudhary and Mahadevan (1986).

The mean protein per cent obtained is in agreement with Srivastava and Panda (1982) and Anon. (1985).

The mean fat values obtained were higher to those reported by Srivastava and Panda (1982) and Anon. (1985).

The mean ash per cent obtained is in agreement with Anon. (1985) and slightly higher to that reported by Srivastava and Panda (1982).

The present study revealed that the percentages of protein, ash and moisture in the meat did not differ statistically at fifth and sixth week of age. Amon et al. (1970) reported that proximate composition was not influenced by age or sex.

In the present study there was a gradual increase in meat protein per cent with decrease in level of calorie-protein ratio in the diet. The increase in meat protein was significantly ($P < 0.01$) different in the study conducted by Srivastava and Panda (1982).

The present study showed that the dietary treatments influenced the fat percentages significantly ($P < 0.01$) at fifth and sixth week of age which agrees with the findings of Srivastava and Panda (1982).

At sixth week of age the fat per cent was found to be significantly ($P < 0.01$) lowest with the diet containing lowest calorie-protein ratio which also agrees with the reports made by the above author.

The fat content in the quails increased with diets containing high calorie-protein ratio and this is in agreement with Edward (1981).

Nitrogen Retention

Nitrogen retention is an indication of protein adequacy in the diet for various physiological purposes. The positive nitrogen balance observed in the study (Table 24) for all dietary combinations indicated that the diets employed in this study supplied sufficient protein and energy for normal physiological function. The trend of the result is in agreement with Farrell et al. (1982).

Mortality

The mortality among quails observed during the period of experimentation presented in table 25 is within normal range and the cause of death even among those that died did not reveal anything suggestive to be linked with the protein or energy levels in the diet. The overall mortality per cent (6.28) obtained in the study is in agreement with Baldini et al. (1953a) and Panda and Srivastava (1978).

Summary

SUMMARY

A 3 x 3 factorial experiment designed to study the dietary requirements of protein and energy for meat type Japanese quails (Coturnix coturnix japonica) for growth, under the climatic condition of Kerala is reported in this thesis.

Three hundred and twenty-four quail chicks of seven days of age were selected for the experiment. The quail chicks were randomly alloted to nine dietary protein-energy combination groups with each treatment having six replicates and each replicate having six chicks. The dietary protein levels employed were 22, 24 and 26 per cent and that of energy levels were 2700, 2900 and 3100 KCal ME/kg diet.

The quail chicks for the experiment were obtained in three batches at three weeks interval between batches. Each batch of experiment lasted for six weeks. The quail chicks for the whole experimentation were obtained from the same source in order to keep the genetic make up constant. The quail chicks were reared upto one week of age on common diet and common brooding and were alloted to different dietary treatments at the end of one-week of age.

Feed and water were provided ad libitum. The routine managemental practices were followed throughout the experimental period. The general observations were made for three, six week periods.

Weekly body weights of individual quail chick were recorded and from this data body weight gain was arrived at. Feed intake was recorded at every week replicatewise and feed efficiency (feed/weight gain) was calculated.

Data on slaughter characteristics such as yield and losses, cut-up-parts and meat-bone ratio at fifth and sixth week were recorded.

The biochemical parameters such as serum protein, serum lipid, liver protein, liver lipid and haemoglobin were estimated during the course of the experiment to assess the physiological status of the quails.

The proximate compositions of the ready to cook yield in quails slaughtered at fifth and sixth week of age were also estimated.

The absolute nitrogen retention and abdominal fat per cent were also estimated.

The quail chick mortality was recorded during the experimental period for assessing the livability in each treatment group.

The temperature and relative humidity of the region, where the experiment was conducted were recorded monthly.

The following observations were made from this investigation.

1. The body weight at fifth and sixth week of age was not influenced by the dietary levels of protein or energy used in the study.

2. Body weights at earlier ages were influenced ($P < 0.01$) by the dietary treatments. Higher dietary protein level of 24 and 26 per cent resulted in significantly ($P < 0.01$) heavier body weight. It was also observed that body weight tend to decrease with increase in energy level in the diet.

3. The weight gains were not influenced by the dietary treatments except at the second week of age. The overall weight gain from 1 to 5 and 1 to 6 weeks of age revealed that both protein and energy influenced the character significantly ($P < 0.01$). The gain was superior with 26 per cent protein and 2700 KCal ME/kg energy at both these ages.

4. The feed consumption data reiterated the already established findings that feed intake is regulated more by the energy level rather than protein levels in the diet. The overall feed consumption from 1 to 5 and 1 to 6 weeks of age revealed that protein levels did not influence feed consumption whereas energy levels influenced. The feed consumption decreased with increased energy levels in the diet.

5. The feed efficiency in earlier ages was significantly ($P < 0.01$) better with higher protein diet but at fourth week of age it was inconsistent. However, the overall feed efficiency from 1 to 5 weeks of age as well as from 1 to 6 weeks of age indicated statistically superior ($P < 0.01$) feed efficiency with higher protein levels, energy having no effect.

6. The processing data were not influenced by the level of the protein, energy or both employed in the study. The ready to cook yield averaged 75.47 and 77.78 at five and six weeks of age respectively and the mean total offal averaged 24.53 and 22.22 per cent at five and six weeks of age respectively.

7. The yields of different cut-up-parts at fifth and sixth week of age were not seem to be influenced by the dietary treatments. Breast constituted the highest cut followed by back, thigh, drumstick, wing and neck. The mean per cent breast, thigh, drumstick, wing, neck and back yields at five week of age were 35.41, 13.64, 11.61, 10.51, 6.29 and 22.54 respectively and those for six week of age were 35.55, 12.8, 10.96, 9.41, 6.23 and 25.05 per cent respectively.

8. The dietary treatments did not influence significantly the meat to bone ratio either during fifth or sixth week of age. The meat-bone ratio averaged 1.90 and 1.98 at fifth and sixth week of age respectively.

9. The data recorded for biochemical observations were within the normal range for healthy quails.

10. The liver protein progressively increased with increase in protein content of the diet.

11. The liver lipid at fifth and sixth week of age also progressively increased with increase in energy levels in the diet.

12. The serum protein levels increased with increase in the protein content in the ration at both fifth and sixth week of age.

13. The serum lipid values were influenced by the dietary energy levels. The values were significantly ($P < 0.01$) highest at highest energy level in the diet.

14. Haemoglobin values were not influenced by the dietary treatments.

15. The composition such as moisture, protein and total ash of the ready to cook meat at fifth and sixth week of age of quails were not influenced by the dietary treatments. Whereas the ether extractive was influenced ($P < 0.01$) by the dietary treatments at both these ages. The carcass lipid content increased with increase in the energy levels in the diet during both the ages.

16. All the birds showed a positive nitrogen balance irrespective of the protein or energy levels in the diet.

17. Extremely poor abdominal fat deposition was observed.

18. Though the mortality of birds among certain dietary protein-energy combinations were on the higher side, the autopsy of birds did not show any findings suggestive of the protein and/or energy combinations as a cause for mortality.

Eventhough the results of weekly body weight and weight gain tend to suggest a two stage requirement namely one from one week of age to third week of age and the other on fourth

week of age down, the absence of any significant influence by either protein or energy levels in the diet on body weight at fifth and sixth week does not provide sufficient rationale for such a suggestion. But the overall feed efficiency from initial to either fifth or sixth week did show significant influence ($P < 0.01$) of dietary protein levels, higher level of 26 per cent being superior over other levels. Thus, it appears more reasonable to set the energy and protein requirement at 2700 KCal ME/kg and 26 per cent respectively. The better feed efficiency at fifth week of age when compared to sixth week of age and also the absence of any statistically significant difference in slaughter characteristics between fifth and sixth week of age tend to suggest fifth week of age as ideal age of slaughter.

References

REFERENCES

Amon, N., York, L., Kulencamp, C., Coleman, T.H. and Dawson, L.E. (1970). Yield, composition and acceptability of meat from Bobwhite quail. Poult. Sci., 49(5): 1363-1364.

Anon. (1983). Annual Scientific Report on Improvement of Quail for Meat and Egg Production for 1983. Department of Technology Transfer, Central Avian Research Institute, Izatnagar, U.P. 243122, Publication No.7/84, pp. 11-14.

Anon. (1985). Annual Report For 1985. Central Avian Research Institute, Izatnagar, U.P. 243122, pp. 16-23.

Anon. (1986a). Annual Scientific Report on Improvement of Quail for Meat Production for 1986. Division of Technology Transfer, Central Avian Research Institute, Izatnagar, U.P. 243122. Publication No.1/1987, pp. 22-28.

Anon. (1986b). Indian Poultry Industry Year Book 1986. ed. S.P. Gupta, New Rohtak Road, New Delhi, 8th Ed. pp.5.

Andrews, T.L., Harms, R.H. and Wilson, H.R. (1973). Protein requirement of the Bobwhite chick. Poult. Sci., 52(4): 2199-2201.

A.O.A.C. (1970). Official Methods of Analysis. Association of Official Agricultural Chemists, 11th Ed. Washington D.C.

Atwal, O.S., McFarland, L.Z. and Wilson, W.O. (1964). Hematology of coturnix from birth to maturity. Poult. Sci., 43(6): 1392-1401.

Axuan, N.G.O. and Young, R.J. (1976). Protein, energy and amino acid requirement and the utilization of diammonium citrate by growing quail. Poult. Sci., 55(5): 2070-2071.

Babu, M., Prakaman, R. and Sundararasu, V. (1986). Protein requirement of Japanese quails. Indian J. Poult. Sci., 21(4): 272-274.

Baldini, J.T., Roberts, R.E. and Kirkpatrick, C.M. (1953a). Antibiotic and vitamin B_{12} supplements as related to crude protein level of Bobwhite quail diets. Poult. Sci., 32(4): 563-567.

Baldini, J.T., Roberts, R.E. and Kirkpatrick, C.M. (1953b). Low protein rations for the Bobwhite quail. Poult. Sci., 32(6): 945-949.

Baranovska, M., Snejdarkova, M., Illesova, D. and Gazo, M.L. (1983). Some principal characters of muscles and internal organs in Japanese quail (Coturnix coturnix japonica). Poult. Abstr., 9(1): 102.

Becker, W.A., Fagerlie, D.L. and Mirosh, L.W. (1985a). Heritability of live weight and abdominal fat weights in Coturnix quails. Poult. Sci., 64(7): 1397-1398.

Becker, W.A., Worden, S. and Mirosh, L.W. (1985b). Body and abdominal fat weight reduction upon feed withdrawal in Coturnix quail. Poult. Sci., 64(3) 597-599.

Benjamin, M.M. (1979). Outline of Veterinary Clinical Pathology. The Iowa State University Press, Ames, Iowa, U.S.A. 3rd Ed. pp. 60-64.

Carpenter, K.J. and Clegg, K.M. (1956). The metabolisable energy of poultry feeding stuffs in relation to their chemical composition. J. Sci. Fd. Agric., 7: 45-51.

Chidananda, B.L., Prathapkumar, K.S., Sreenivasiah, P.V., Lokanath, G.R. and Ramappa, B.S. (1985). Comparative performance of Japanese quail reared in cages and deep litter. (1) Body weight, feed efficiency and mortality. Indian J. Poult. Sci., 20(3): 162-164.

Choudhary, M.K. (1978). Studies on dressing of quail at various temperatures and different times and their effect on subsequent preservation. M.V.Sc. Thesis submitted to Rohilkhand University, Bareilly.

Choudhary, M.K. and Mahadevan, T.D. (1983). Studies on the effect of age and sex on slaughter characteristics of quail (Coturnix coturnix japonica). Indian J. Poult. Sci., 18(1): 33-36.

Choudhary, M.K. and Mahadevan, T.D. (1986). Influence of age, storage and type of cuts on the composition of quail meat. Indian J. Poult. Sci., 21(3): 252-254.

Clegg, K.M. (1956). The application of the anthrone reagent to the estimation of starch in cereals. J. Sci. Fd. Agric., 7: 40-44.

Darden, J.R. and Marks, H.L. (1985). The influence of dietary salt on water consumption and carcass lipids in Japanese quail. Poult. Sci., 64(7): 1269-1278.

Dawson, L.E., York, L.R., Amon, N., Kulencamp, C. and Coleman, J.H. (1971). Processing and yield charactoristics of Bobwhite quail. Poult. Sci., 50(5): 1346-1349.

Deshmukh, B.D. and Suryawanshi, S.A. (1982). Effect of gonadal hormones on some haematological parameters in the Rain quail (Coturnix coromendelica). Avian Research, 66(1): 9-11.

Donaldson, W.E., Combs, G.F. and Romoser, G.L. (1956). Studies on energy levels in poultry ration. 1. The effect of calorie-protein ratio of the ration on growth, nutrient utilization and body composition of chicks. Poult. Sci., 35(5): 1100-1105.

Donaldson, W.E., Combs, G.F., Romoser, G.L. and Supplee, W.C. (1957). Studies on energy levels in poultry ration. 2.-Tolerance of growing chicks to dietary fat. Poult. Sci., 36(4): 807-815.

Edward, H.M. Jr. (1981). Carcass composition studies. 3. Influence of age, sex and calorie-protein content of the diet on carcass composition of Japanese quail. Poult. Sci., 60(11): 2506-2512.

Eliasvila, L.L., Manaut,Claret, J. and Verde Lopez, F.J. (1985). Comparative study of different diets for fattening of quails. 1. Comparative study of four levels of energy and protein in growing feeds. Poult. Abstr., 11(12): 2501.

Farrell, D.J., Atmamihardja, S.I. and Pym, R.A.E. (1982). Calorimetric measurements of the energy and nitrogen metabolism of Japanese quail. Br. Poult. Sci., 23: 375-382.

*Gropp, J. and Zucker, H. (1969). Protein requirements of Japanese quail during rearing. Nutr. Abstr. Rev., 39:6089.

Hill, F.W. (1956). Studies of the energy requirements of chickens. 4. Evidence for a linear relationship between dietary productive energy level and the efficiency of egg production. Poult. Sci., 35(1): 59-63.

Inchiosa, M.A. (1964). Total biuret determination of total protein in tissue homogenate. J. Lab. and Can. Med., 63(2): 319-324.

I.S.I. (1973). Indian Standards Institution.- Code for handling, processing, quality evaluation and storage. IS 7049, Manak Bhavan, 9, Bahadurshah Zapar Marg, New Delhi.

Jones, J.E., Hughes, B.L. and Hale, K.K. (1979). Coturnix D_1 carcass yield. Poult. Sci., 58(6): 1647-1648.

Josyln, M.A. (1970). Extraction methods and separation processes in Methods in Food Analysis. ed. M.A. Josyln, Academic Press, New York and London, 2nd Ed., pp. 151-152.

Lawrie, R.A. (1966). Meat Science. Pergamon Press, New York. pp. 270-322.

Lee, T.K., Shim, K.F. and Tan, E.L. (1983). Protein requirement of breeding Japanese quail in the tropics. Poult. Abstr., 9(1): 109.

Lepore, P.D. and Marks, H.L. (1971). Growth rate inheritance in Japanese quail. 5. Protein and energy requirements of lines selected under different nutritional environments. Poult.Sci., 50(5): 1335-1341.

Leveille, G.A. and Sanberlich (1961). Influence of dietary protein levels on serum protein components and cholesterol in the growing chick. J. Nutr., 74: 500.

Marks, H.L. (1971). Selection for four-week body weight in Japanese quail under two nutritional environments. Poult. Sci., 50(3): 931-937.

Marks, H.L. (1978). Compensatory growth in Japanese quail following protein restriction. Poult. Sci., 57(6): 1473-1477.

Mohan, B., Narahari, D., Venkatesan, E.S., Ramamoorthi, R. and Alfred Jayaprasad (1986). Studies on the influence of age and sex on the meat characteristics of Japanese quail (Coturnix coturnix japonica). Kerala J. Vet. Sci., 17(1): 53-57.

Morris, T.R. (1968). The effect of dietary level on the voluntary caloric intake of laying birds. Br. Poult. Sci., 9: 285-295.

Mountney, G.J. (1983). Poultry Products Technology. The AVI Publishing Co., West Port, Connecticut, pp. 82-90.

Narahari, D., Thangavel, A., Prabhakaran, R., Venugopal, K. and Sundararasu, V. (1983). Dressing and cut up yields of Japanese quails as influenced by age and sex. Abstracts: 10th annual poultry symposium of the Indian Poultry Science Association, Madras.

*N.R.C. (1971). Nutrient requirement of Poultry. NAS-NRC, Washington, D.C.

Nirmalan, G.P. (1972). Haematological studies on the Japanese quails. Ph.D. Thesis presented to Faculty of Graduate Studies of the University of Guelph.

Nirmalan, G.P. and George,J.C. (1972). The influence of exogenous oestrogen and androgen on respiratory activity and total lipid of the whole blood of Japanese quail. Camp. Biochem. Physiol., 42(B): 237.

Nirmalan, G.P. and Robinson, G.A. (1971). Haematology of the Japanese quail (Coturnix coturnix japonica). Br. Poult. Sci., 12: 475.

Pani, P.K. (1978). Japanese quail in animal research. Poult. Guide, 15(7): 61-68.

Panda, B. (1986). Production and processing of quails in tropics. Poult. Guide, 23(2): 21-31.

Panda, B., Ahuja, S.D., Prakash Babu, M. and Gulati, D.P. (1980). Evaluation of quail line for some important economic traits. Indian J. Anim. Sci., 50(6): 518-520.

*Panda, B. and Srivastava, A.K. (1978). Protein requirement of starter Japanese quail (Coturnix coturnix japonica). XVI World's Poultry Cong. Proc. Rio de Janeiro, Brazil (submitted).

Panda, B., Reddy, V.R. and Sadagopan, V.R. (1977). Nutrient requirements and feeding of Japanese quail. Indian Poult. Gaz., 61(4): 153-172.

Pandey, N.K., Mahapatra, C.M. and Verma, S.S. (1979). Effect of pre-slaughter fasting on slaughter characteristics and cut-up parts of Japanese quail. Indian Poult. Gaz., 63(3): 111-113.

Phogat, S.B. and Chopra, S.K. (1984). Production and management of quails. Poult. Guide, 21(2): 63-67.

Sadjadi, M. and Becker, W.A. (1980). Relationship between fat in breast and thigh muscles and skin with abdominal fat from mated and unmated coturnix quail. Poult. Sci., 59(11): 2462-2466.

Sato, K., Kishi, H. and Ino, T. (1983). Genetic parameters of live weight, eviscerated weight, organ weights and muscle weights in Japanese quail males. Poult. Abstr., 9(7): 1573.

*Scott (1966). The nutrition of pheasants and quails. Proc. Distillers Feed Research Conference, 21: 30-35.

Serafin, J.A. (1982). Influence of protein level and supplemental methionine in practical rations for young endangered masked Bobwhite quail. Poult. Sci., 61(5): 988-990.

Singh, R.P. and Panda, B. (1980). Studies on quail meat pickle. Indian J. Poult. Sci. (Abstr.), XV Supplement (1).

Singh, R.P. and Panda, B. (1985). Studies on the yield and keeping quality of Tandoori quail. Indian J. Poult. Sci., 20(3): 145-149.

Singh, R.P., Srivastava, A.K. and Panda, B. (1980). Studies on slaughter characteristics of Japanese quail (Coturnix coturnix japonica) at different stages of growth. Indian Poult. Gaz., 64(1): 12-17.

Singh, R.P., Srivastava, A.K. and Panda, B. (1981). Meat yield of Japanese quail (Coturnix coturnix japonica) at different stages of growth. Indian J. Poult. Sci., 16(2): 119-125.

Sinha, R.P. and Verma, A.K. (1984). Effect of different levels of dietary protein in Japanese quail (Coturnix coturnix japonica) feeding. Indian J. Anim. Health, 23(1): 77-80.

Snedecor, G.W. and Cochran, W.G. (1967). Statistical Methods. Oxford and I.B.H. Publishing Company, Calcutta, 6th Ed.

Sreenivasiah, P.V., Prathapkumar, K.S. and Ramappa, B.S. (1985). Japanese quail - A new table bird. Poult. Punch., 1(8): 30.

Srivastava, A.K., Ahuja, S.D. and Panda, B. (1981). Use of broiler concentrate in quail rations. Indian Poult. Gaz., 65(3): 89-92.

Srivastava, A.K. and Panda, B. (1982). Effect of increasing calorie-protein ratio during growing period (4-5 weeks) on dressing yield and chemical composition of quail meat. Indian J. Poult. Sci., 17(4): 253-256.

Srivastava, A.K., Panda, B., Singh, R.P. and Agarwal, S.K. (1980a). Studies on slaughter age of quail. Indian J. Poult. Sci. (Abstr.), XV Supplement (1).

Srivastava, A.K., Reddy, V.R. and Panda, B. (1980b). A note on the protein and energy requirements of grower Japanese quail. Indian Poult. Gaz., 64(3): 109-111.

Tserveni Gousi and Yannakopoulos, A.L. (1986). Carcass characteristics of Japanese quail at 42 days of age. Br. Poult. Sci., 27: 123-127.

Ulmek, (1986). Rearing of Japanese quail. Poult. Guide, 23(2): 51-52.

Vogt, H. (1970). Further studies on the protein requirement of young quail during second part of rearing. Nutr. Abstr. Rev., 40: 4245.

Vohra, P. (1971). A review of nutrition of Japanese quail. World Poult. Sci. J., 27: 26-34.

Vohra, P. and Rowdybush, T. (1971). The effect of various levels of dietary protein on the growth and egg production of Coturnix coturnix japonica. Poult. Sci., 50(4): 1081-1084.

Weber, C.W. and Reid, B.L. (1967). Protein requirements of Coturnix quail to five weeks of age. Poult. Sci., 46(5): 1190-1194.

Wells, R.G. (1963). The relationship between dietary energy level, food consumption and growth in broiler chicks. Br. Poult. Sci., 4: 161-168.

Wilson, H.R., Douglas, C.R., Harms, R.H. and Edds, G.T. (1975). Reduction of aflatoxin effects on quail. Poult. Sci., 54(3): 923-925.

Wilson, H.R., Douglas, C.R. and Nesbeth, W.G. (1977). Feed consumption and protein efficiency by Bobwhite quail in response to dietary energy levels. Poult. Sci., 56(4): 1127-1129.

Yoshizane Maeda, Shinokamoto and Tsutomu Hashiguchi (1986). Genetic variation on liver lipid content of Coturnix quail. Poult. Sci., 65(2): 205-208.

Zelenka, D.J., Cherry, J.A., Nir, I. and Siegel, P.B. (1984). Body weight and composition of Japanese quail (Coturnix coturnix japonica) at sexual maturity. Growth, 48(1): 16-28.

* Originals not consulted

DIETARY PROTEIN AND ENERGY REQUIREMENTS OF MEAT TYPE JAPANESE QUAIL *(COTURNIX COTURNIX JAPONICA)* FOR GROWTH

By

K. NARAYANANKUTTY

ABSTRACT OF A THESIS

submitted in partial fulfilment of
the requirement for the degree

Doctor of Philosophy

Faculty of Veterinary and Animal Sciences
Kerala Agricultural University

Department of Poultry Science
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
Mannuthy - Trichur

1987

ABSTRACT

A three square factorial experiment designed to study the dietary requirements of protein and energy for meat type Japanese quail (Coturnix coturnix japonica) for growth, under the hot-humid conditions of Kerala is presented in this thesis.

Quail chicks of seven day old age were obtained in three batches at three weeks interval between batches. Each batch consisted of 324 quail chicks and were obtained from the same source in order to keep the genetic make up constant. The birds were randomly allotted to nine dietary protein-energy combination groups. The dietary protein levels employed were 22, 24 and 26 per cent and that of energy level were 2700, 2900 and 3100 KCal ME/kg diet. General observations were made for three, six week periods.

The body weight at fifth and sixth week of age was not influenced by the dietary levels of protein or energy used in the study. Whereas body weights at earlier ages were influenced ($P < 0.01$) by the dietary treatments. Higher dietary protein levels of 24 and 26 per cent resulted in significantly heavier ($P < 0.01$) body weight. The body weight was found to be decreased with increase in energy levels in the diet. The body weight gain were not influenced by the dietary treatments except at the second week of age. The overall weight gain from 1 to 5 and 1 to 6 weeks of age revealed that both protein and energy influenced the character significantly ($P < 0.01$). The feed consumption data reiterated the already

established fact that feed intake is regulated more by the energy level rather than protein levels in the diet. The overall feed consumption from 1 to 5 and 1 to 6 weeks of age revealed that the protein levels did not influence the feed consumption whereas energy levels influenced. The feed efficiency in earlier ages was significantly ($P < 0.01$) better with higher protein diet, but from fourth week of age it was inconsistent. However, the overall feed efficiency from 1 to 5 as well as 1 to 6 weeks of age indicated statistically superior ($P < 0.01$) feed efficiency with higher protein levels, energy having no effect.

The processing data both at fifth and sixth week of age were not influenced by the levels of the protein, energy or both employed in the study. The ready to cook yield and total offal at fifth week of age averaged 75.47 and 24.53 per cent respectively and those at sixth week of age were 77.78 and 22.22 per cent respectively. The breast constituted the highest followed by back, thigh, drumstick, wing and neck among the cut-up-parts at both ages. The meat-bone ratio at fifth and sixth week of age averaged 1.90 with range of 1.81 to 2.05 and 1.98 with a range of 1.93 to 2.05 respectively. The liver protein progressively increased with increase in protein content and liver lipid increased with increase in energy levels in the diet during both five and six weeks of age. Similar trend was observed in the case of serum protein and lipid at both these ages. The haemoglobin levels were not influenced

by the treatments. Eventhough the values obtained on carcass analysis were well within the normal biological limits, the ether extractive per cent at fifth and sixth week of ages were influenced ($P < 0.01$) by the dietary treatments. All the birds showed a positive nitrogen balance irrespective of the protein or energy levels in the diet. Extremely poor deposition of abdominal fat in quails slaughtered at both these ages was observed.

Eventhough the results of weekly body weight and weight gain tend to suggest a two stage requirement namely one from one week to three week of age and the other from four week of age down, the absence of any significant influence by either protoin or energy levels in the diet on body weight at fifth and sixth week of age does not provide sufficient rationale for such suggestion. But the overall feed efficiency from initial to either fifth or sixth week did show significant influence of dietary protein levels, higher level of 26 per cent being superior over other levels. Thus it appears to set the energy and protoin requirement at 2700 KCal ME/kg diet and 26 per cent respectively. The better feed efficiency at fifth week of age when compared to sixth week of ago and also the absence of any statistically significant difference in slaughter characteristics between fifth and sixth week of age tend to suggest fifth week of age as ideal age of slaughter.