PERFORMANCE OF GROWING JAPANESE QUAILS FED ON ISO-CALORIC DIETS OF DIFFERENT CRUDE PROTEIN LEVELS

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PERFORMANCE OF GROWING JAPANESE QUAILS FED ON ISO-CALORIC DIETS OF DIFFERENT CRUDE PROTEIN LEVELS

BY

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DECLARATION

I Mazuba D.M Francis declare that this report represents my own work and that it has not been previously submitted for a Bachelor degree at any institution. All sources of information have been acknowledged by referencing.

Mazuba Duna Muvwimi Francis

ABSTRACT

A study was conducted to evaluate the effects of feeding Japanese quails (*Coturnix coturnix Japonica*) on iso-caloric diets varying in dietary protein level on the growth performance from 1 to 35 days of age. One hundred and twenty Japanese quails (1-day-old) were used in this experiment following a Completely Randomised Design. The quails were fed with similar level of metabolizable energy (ME) and four levels (D1, D2, D3 and D4) of crude protein (CP), containing 20.10, 21.82, 23.73 and 26.18, respectively. The quails were randomly divided into 12 sub groups of 10 chicks each and there were 3 replicates under each of the four dietary treatments. All the diets were formulated using soya bean meal and maize meal as the main sources of crude protein and energy, respectively. The parameters mortality rate, average body weight (ABW), average feed intake (AFI), and average weight gain (AWG) and feed conversion ratios (FCR) were determined. Differences were significant for ABW; birds fed the D1 diet had the lowest ABW while those fed D3 had the highest. Quails on D1 and D4 had significantly less ABW ($P < 0.05$) compared to those on D2 and D3. Results between D1 and D4 showed insignificant differences ($P < 0.05$). This was the case for quails fed on D2 and D3. During the grower phase, significant differences were observed for AFI; D3 and D4 had significantly higher intakes than D2 and D1, and D2 was significantly higher than D1. The differences were not significant between D3 and D4. D1 had the lowest while D3 had the highest AFI. Crude protein had a significant effect ($P < 0.05$) on AWG; quails fed on D1 recording the lowest value while those fed on D2 had the highest AWG. However, only quails fed on D1 showed significantly lower gains than the rest. Statistically significant differences ($P < 0.05$) were found for FCR; quails fed on D2 had a significantly lower FCR compared to other dietary treatments. Therefore the Japanese quails obtained the best performance when fed D2, 21.82% crude protein.

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ACRONYMS

Acronym	Meaning
AFI	Average feed intake
ABW	Average body weight
AWG	Average weight gain
CP	Crude protein
FCR	Feed conversion ratio

CHAPTER ONE

1.0 INTRODUCTION

1.1.0 GENERAL

Japanese quails (*Coturnix coturnix Japonica*) are a diversified poultry species reared for commercial egg and meat production. It is blessed with the unique characteristics of fast growth, early sexual maturity, high rate of egg production, short generation interval, shorter incubation period, very robust to diseases, no vaccination is required, low space requirement (200 sq cm.), easy to handle, marketing age within 4th week, very high laying intensity- female starts laying at an age of 42 days and reach to peak production by 10-12 weeks of age making it suitable for diversified animal agriculture, also used as experimental animals. Despite these attributes, the quail prefers and requires a high protein diet for optimum growth and reproduction (Sato et al,. 2005). Dietary protein sources are considered the most expensive items in poultry feeding thus requiring more focus on application of low-protein diets in quail feeding. Changes in the life style of people in many countries as well as their growing and diversifying purchase power cause that the consumers start to demand less common poultry products of ostriches, emus, or quails. However, on the other hand, many consumers expect the producers to offer lower prices for food products, which can be achieved by reducing the cost of production. One of the ways leading to reduced cost of feeds is to reduce their protein content. The breeds and varieties of quails farmed presently are characterized by quite a wide range of dietary requirements. The poultry is also able to adapt to lowered supply of nitrogen in the diet through their better management of its compounds.

Poultry production in Zambia has become one of the biggest practices in the agriculture industries and its improvement is one of the main objectives of both private and public sectors. Moreover, feeding cost for poultry is usually considered the most expensive item, especially dietary protein sources. Efforts to reduce dietary protein level have been the subject of numerous investigations. Abd-Elsamee et al. (2001); Hammouda et al. (2001); Abd-Elsamee (2002); Sterling et al. (2002); and Abdel-Gawad et al. (2004) concluded that lowering crude protein (CP) level lowered broiler chicks performance. Hence, it is expected that great efforts will be directed to maximize the utilization of low protein diets.

Several reports indicated that starter diets for quail should contain protein content of 24% this may become 20% at several weeks later (Shim and Vòhra, 1984). Panda and Shrivastav (1994) indicated slightly higher dietary requirements of 27% protein for starting quail, a content that may be reduced to 24% after three weeks of age (Shrivastav et al., 1994). Generally the crude protein content in diets of growing quails ranges from 24 to 27 % (NRC, 1994; Shrivastava and Panda, 1994; Baldini et al., 1995; Weber and Ried, 1967).

It is reasonable to suppose that amino acid inadequacy and stress caused by the environmental temperature could explain the increased requirement.

Low-protein diet feeding reduces the amount of nitrogen discharged into the environment in manure (Szczurek and PisulewskI, 1996). Jamroz et al. (1984) as well as Leclercq and Tesserand (1993) have not observed any negative influence of moderately reduced level of crude protein in the diet, on the performance or slaughter value of chicken broilers. Similar results for quails were reported by Daszkiewicz et al. (1988). Zelenka et al. (1984), who applied feeding with varied crude protein level, did not demonstrate significant differences in the breast muscle content or carcass fat content in quails. Conversely, limited feeding, as opposed to *ad libitum* feeding, resulted in differences in the composition of body tissues and in slightly delayed laying.

The meat production performance of Japanese quails has also been improved during recent years due to genetic selection. Therefore, there is a need of updating optimal nutritional requirements of Japanese quails to exploit production potentiality through precise nutrient supply to reduce on the cost of feed, wastage of nutrients, environmental pollution, and bad aroma in poultry house, and thus improves animal welfare.

The aim of this study was to investigate the performance of growing Japanese quails fed on iso-caloric diets of different crude protein level.

1.2.0 PROBLEM STATEMENT

The production of poultry in Zambia has been hit by a crisis of prohibitive cost of feed more especially among small scale farmers. This in turn has resulted in increased cost of poultry production making it difficulty for small scale farmers to undertake the activity thus depriving them of a reliable source of income (Saeli et al. 2007).

Feeding cost for poultry is usually considered the most expensive item, especially dietary protein sources of which soya beans is the main source. Soya bean meal prices are increasing greatly in recent years. It is therefore important to formulate diets to efficiently meet the needs of animals at a lower cost without compromising the quality of the feed. This may be achieved through restriction or qualitative reduction of protein in the diets leading to rations containing the correct amount of Crude Protein (CP) for optimum performance. Normally, the producing performance is increasing with the dietary CP increase (Tasaki and Okumura, 1969).

The energy and protein requirements as well as the efficiency of feed utilization are still poorly documented, especially for quails. Generally, the energy and protein requirement for this category of poultry were considered to be similar to those farm poultry, especially hens (Parvu et al,. 2010).

Among diet nutrients, protein has the highest heat increment; thus, during many years, diets with low protein level were recommended in order to reduce heat production in broiler chickens under heat stress. However, reports have shown that low protein diets have negative effects on broiler performance when environmental temperature is high, because during heat stress, low food intakes associated to a low diet protein induce amino acid deficiencies (Furlan et al,. 2004).

1.3.0 JUSTIFICATION

During the recent years quail production has shown increasing importance because there is an increase in demand of animal protein complemented with the ever growing world population. In addition, quails have early sexual maturity, rapid growth rate and small body size, which results in lower necessity of housing space and feed. Japanese quails are bred for eggs and meat production. Few studies have been published on egg production (Vali, 2008) but, reports on quail growth and body composition are numerous (Yalcin., 1995). However, both protein and energy in poultry ration are considered the most expensive items in the cost of a complete feed, both representing approximately 85% of total feed cost (Gunawardana et al., 2008).

Hence, it is to be expected that many programs be made to reduce their use in the rations without lowering performance. Many of these restriction programs involve low protein and energy feeding regimes. Lee et al. (1997) indicated that the method of feed restriction classified as a) limiting the bird's time of access to feed, b) quantitative feed restriction, c) the use of low energy diets and d) dietary protein restriction. In study reported by Moran (1979) indicated that one method of qualitative feed restriction is use of low protein diets.

Further from the economical standpoint of view, currently there is a critical need to increase efforts of reducing feed cost without compromising the final productivity. One possible nutritional strategy of reducing feed cost without detrimental effect on performance is to restrict protein intake. In this respect, with the commercial industry facing high feed cost, low protein consumption by reducing feed expenses could help to reduce costs. Step-down protein and energy feeding regimes are still the norm for the egg industry (Anderson, 2007).

1.4.0 OBJECTIVES

1.4.1 Overall objectives

The main objective of the research was to evaluate the performance of growing Japanese quails fed on iso-caloric diets of different crude protein levels.

1.4.2 Specific objectives

- To determine the feed intake of quails fed on iso-caloric diet of different crude protein levels.
- To determine the weight gain of quails fed on iso-caloric diet of different crude protein levels.
- To determine feed conversion efficiencies of quails fed on iso-caloric diet of different crude protein levels.

1.5.0 RESEARCH HYPOTHESIS

- Ho: Varying crude protein levels in a diet has no effect on the quail feed intake.
  HA: Varying crude protein levels in a diet effects the feed intake of quails.
- Ho: Feeding quails on diets varying in crude protein levels has no effect on their weight gain.
  HA: Feeding quails on diets varying in crude protein levels has an effect on the weight gain
- Ho: Different crude protein levels in quails' diets have no effect on feed conversion ratios.
  HA: Different crude protein levels in diets effects quails' feed conversion ratios.

CHAPTER TWO

2.0 LITERETURE REVIEW

Japanese quails are bred for eggs and meat production. Few studies have been published on egg production (Vali, 2008) but, reports on quail growth and body composition are numerous (Yalcin et al., 1995). However it's well known that both protein and energy in poultry ration are considered the most expensive items in the cost of a complete feed where they both represent approximately 85% of total feed cost (Gunawardana et al., 2008). Hence, it is to be expected that many programs will be made to reduce their use in the rations without lowering performance.

Many of these restriction programs involve low protein and energy feeding regimes. Lee et al. (1997) indicated that method of feed restriction be classified as a) limiting the bird's time of access to feed, b) quantitative feed restriction, c) the use of low energy diets and d) dietary protein restriction. In study reported by Moran (1979) indicated that one method of qualitative feed restriction is use of low protein diets.

However, extremely high density of nutrients and energy render more susceptible to various metabolic diseases including ascites, sudden death syndrome and leg abnormalities and subsequently resulted in surging mortality and economic loss (Olkowski et al., 2008). Further from the economical standpoint of view, currently there is a critical need to increase efforts of reducing feed cost without compromising the final productivity. One possible nutritional strategy of reducing feed cost without detrimental effect on performance is to restrict protein intake. In this respect, with the commercial egg industry facing high feed cost, low protein and energy consumption by reducing feed expenses could help to reduce costs. Step-down protein and energy feeding regimes are still the norm for the egg industry (Anderson, 2007). Although, some studies have determined the effects of qualitative and quantitative feed restriction on growth performance of broilers, for bird welfare (Sandilands et al., 2005), carcass quality (James et al., 1992), egg production of broilers (Auckland and Wilson, 1975), ovary morphology and laying traits of turkey (Renema et al., 1995).

There is little or limited information concerning the use of qualitative feed restriction as a nutritional approach to reduce cost of feeds or problems associated with egg production in Japanese quail hens.

During the recent years quail production has shown increasing importance because quails have early sexual maturity, rapid growth rate and small body size, which results in lower necessity of housing space and feed. Protein provides the amino acids for tissue growth and egg production. The dietary protein requirement of quail is influenced by metabolizable energy content and the ingredients used to formulate the diets. A protein source of high quality with adequate amino acid balance is one of the most important nutrients for quail. There are some differences within the nutritional requirements of quails as determined by various authors. According to Larbier and Leclercq (1995) the protein level of a quail feed should vary from 18 to 20% during the laying period, while Vali (2008) recommends the constant level of 21%.

Soares et al,.(2003), evaluated five dietary crude protein levels (16, 18, 20, 22 and 24%) in the rearing period of Japanese quail (*Coturnix coturnix japonica*) and concluded that protein levels had no effects on feed intake and feed conversion ratio. They estimated that CP requirement for rearing period of Japanese quail is 23.08%. Hyankova et al,. (1997), also reported that Japanese quail fed 26 and 21.6% CP had a good performance from 1 to 21 and 22 to 35 day of age, respectively. Thus, their requirements decrease with age, similar to other animal species Shrivastav et al,. (1994).

Generally the CP content in diets of growing quails ranges from 24 to 27% (Panda et al,. 1978). The response of growing quails to dietary levels of essential amino acids at different energy levels on growth and immunity were investigated by Kaur et al,. (2008). They concluded that the optimum level of dietary ME is 2700 kcal kg-1 with CP 25.83% for gain and 3100 kcal kg-1 with CP 25.83% for optimum feed conversion during 0-5 weeks of age.

Several reports indicated that starter diets for quail should contain protein content of 24% this may become 20% at several weeks later Shim et al,. (1984). Panda and Shrivastav et al,. (1984) indicated slightly higher dietary requirements of 27% protein for starting quail, a content that may be reduced to 24% after three weeks of age Shrivastav et al,. (1994). It is reasonable to suppose that amino acid inadequacy and stress caused by the environmental temperature could explain the increased requirement. Also, level of 24 percent of crude protein is recommended for Japanese quails in the rearing period NRC (1994).

Some earlier investigators raised their quail flocks successfully on turkey starter diets containing about 25-28% crude protein. Lee et al. (1997) have shown that a dietary crude protein level of 24% is needed in starter diet for quails and the protein content may be reduced to 20% by 3rd week of age.

Proteins are not alike; they vary according to their origin (animal, vegetable), their amino acid composition (particularly their relative content of essential amino acids), their digestibility and texture. Japanese quails, as such as other poultry, require certain minimal quantities of amino acids from a biologically available source as part of a large protein nitrogen intake. The required amounts of these amino acids vary with age, physiological condition and state of health, Ali et al,. (2009). It is well known that dietary protein level influences the body growth and composition of domestic fowl.

Protein is the most expensive nutrient and must be provided from a high quality source. Protein quality is generally based on the amino acid composition of the feedstuff and the availability of these amino acids from the feedstuff through digestion in the gut of the quail. Amino acids are considered as the building blocks of proteins. Out of 19 total amino acids required by quail, 13 are considered as essential amino acids, because they cannot be produced in the quail's body and must be supplied in the diet, and 6 are considered as nonessential, because they are synthesized by the body and need not be supplied in the diet. Feedstuffs differ qualitatively and quantitatively in their amino acid composition. Quail diets consist mainly of plant materials. The most commonly used plant sources are soya bean meal, maize, sorghum and rice or wheat bran. Methionine and lysine are generally low in plant products. Animal protein products such as fish meal, meat and bone meal etc, are good sources of most of the essential amino acids, but they are usually more expensive than plant protein ingredients. Synthetic methionine and lysine are usually added to the diets to balance the amino acid composition (Shim and Lee, 1984).

Progress achieved in genetic improvement of poultry prompts for updating of feeding standards. At present, poultry producers are offered feed mixes with protein and energy contents lower than those stipulated by NRC (National Research Council). Research related to modification of feeding was carried out mostly on chickens (Świerczewska *et al.* 2000), whereas only occasionally on quails (Zelenka *et al.* 1984, Ocak and Erener 2005). A number of experiments performed on quails refer mainly to the influence of restricted feeding on quail growth and reproductive indicators, but the results are frequently inconsistent due to, among others, different methods of limited feeding applied (Zelenka *et al.* 1984. Ocak and Erener 2005). In Poland, popularity of quail increases, but currently the research on its feeding requirements is not carried out.

Most consumers expect from manufacturers not only a wholesome but also a cheap food. Application of the lowered level of total protein in poultry diet may be one of means for reducing production costs as well as for smaller fatness of poultry carcasses. Results of research works with the use of lowered protein level in poultry diet do not give a clear-cut answer, although in general no worsening of production indicators has been stated (Tarasewicz et al., 2006; Daszkiewicz et al., 1988 and Jamroz et al., 1984;), which is a positive phenomenon. In other experiments, a higher body weight of birds fed with low-protein diet was found. In the literature, however, there are also reports where smaller gains were found in birds due to feeding with low-protein (Ocak and Erener, 2005; El Azeem, 2001; Da Silva et al., 2006).

Therefore, there is a need for carrying out further observations that will take into consideration not only a different level of protein but also a composition of feed mix and a production trend, all that against a background of environmental and zoo hygienic conditions.

CHAPTER THREE

3.0 MATERIALS AND METHODS

The details of materials and methods employed in the study are presented hereunder:

3.1.0 Site and location of the experiment

The research trial was conducted in Lusaka in the facilities of the Field Station of the School of Agricultural Sciences at the University of Zambia, in Zambia. It is located at 15° 24 S 28° 20 E, in agro- ecological region II of Zambia receiving an annual rainfall of between 800-1000mm. This trial was conducted for a period of 5 weeks, from April 17 to May 22, 2012 to study effect of varying crude protein content in the growth performance of growing Japanese quails.

3.2.0 Birds and experimental design

One hundred and twenty day-old Japanese quails (*Coturnix coturnix Japonica)* weighing 7.63 g and randomly distributed into 12 groups of 10 chicks each. The experiment was conducted using a completely randomized design (CRD) having four dietary treatments, each with three observations (replicates) housed in battery cages. These treatments had same levels of energy but varying in crude protein content. All birds were kept under similar and standard environmental, hygienic and managerial conditions according to the National Research Council (NRC, 1994) Care Guidelines during the 21 day trial.

3.3.0 Feeding and watering schedule

All the birds were fed their respective experimental diets *ad libitum*, and the feed refusals were weighed once a week throughout the experimental period. Experimental diets had 20.10, 21.82, 23.73 and 26.18% of crude protein and 2774, 2725, 2727, and 2654 kcal/kg of metabolizable energy (ME) respectively. D1 was used to represent 20.10% CP, D2 for 21.82%, D3 for 23.73% while D4 was used for 26.18%. The compositions of the experimental treatments are shown in Table 3.1 below;

Table 3.1: Experimental dietary treatments composition

Ingredient	Dietary treatments			
	Diet 1(D1)	Diet 2 (D2)	Diet 3 (D3)	Diet 4 (D4)
Metabolisable energy (kcal/kg)	2774	2725	2727	2654
Crude protein (%)	20.10	21.82	23.73	26.18
Ingredient (%)				
premix	1	1	1	1
DCP	2.1	2.1	2.2	1.8
Limestone	0.7	0.7	0.8	1
salt	0.25	0.3	0.25	0.25
Maize meal	61.7	56.7	49	42
Soyabean meal	34	39	45	52
Di-methionine	0.2	0.2	0.2	0.28
Fat/oil	-	-	1.55	1.67

Source: Formulated feed values

3.4.0 Housing and brooding

Birds were housed in naturally ventilated house measuring 5m x 3m equipped with cages measuring (120cm x 52cm x44cm) at a density of 30 quails per cage. The birds were weighed as a group at the start of brooding, on the first day of the trial and the average day old weight recorded.

The cages were equipped with drinkers, feeders and an infra-red bulb for electrical brooding for the first 10 days. The infra-red bulb acted as the main source of both light and heat during the brooding period. And an ordinally bulb was used as a source of light at night during the period after brooding. Standard management practices for brooding, and 24 hour light to encourage feed intake were followed. The brooder temperature was maintained at 35°C during the first week of age and gradually reduced to 25°C afterwards.

The day old quails were first weighed and kept in one compartment used as a brooder for 10 days during which the birds were supplied with similar feed and water. The brooding compartment was covered with a black polyethene plastic to protect the quails from predators such as cats and rats.

3.5.0 Purchase of ingredients

Procurement of main energy feed ingredients (maize, soya beans, and cooking oil) were done from Soweto market, Cairo chemist and Spar arcades. The other ingredients were sourced from the animal science section at school of agricultural sciences field station, and these included; vitamin premix, dicalcium phosphate (DCP), limestone, salt, and DL-methionine. Mixing of the diets was done manually at the field station.

3.6.0 Data collection and determinations

The data on average body weight, feed intake and average weight gain were recorded at weekly intervals. Feed conversion (feed, g/g gain) ratios (FCR), for each replication were calculated weekly. The feed conversion ratio (FCR) was calculated on the basis of unit feed consumed to unit body weight gain for each replicate separately. The mortality of birds was recorded as and when it occurred.

3.7.0 Statistical analysis

The data was analysed using GENSTAT discovery edition 14 statistical package and it was then tested for analysis of variance (ANOVA) using F-test ($p<0.05$). The means of different dietary treatments were then separated using Duncan's Multiple Range Test. The results were then interpreted.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The effect of different dietary levels of protein on average body weight, feed intake, average weight gain and feed conversion ratio (FCR) of growing quails were investigated. There was a mortality of 4% resulting from disposal of weak birds during the period of the trial. There were no mortalities which were as a result of clinical illness. The average body weight, average feed intake, average weight gain and feed conversion ratio are discussed below. The results for the four parameters are shown in Table 4.1, 4.2, 4.3 and 4.4 below;

4.1 Average body weights

Table 4.1: Average body weights of quails

Treatments	**Average body weights (g)**
20.10 % CP (D1)	85.62^{a}
21.82% CP (D2)	91.02^{b}
23.73% CP (D3)	92.53^{b}
26.18% CP (D4)	88.20^{a}

NB: Means in the same column followed by different superscripts are significantly different ($p<0.05$).

Mean body weights are given in Table 4.1 above. Differences between D1 and D4 were insignificant ($p<0.05$). This was the case for ABW between D2 and D3 which showed insignificant differences. However, levels of CP significantly affected ABW. Significant differences were only observed between the two pairs, quails on D1 and D4 had significantly less ABW ($P < 0.05$) compared to those on D2 and D3. Quails fed D3 had highest ABW of 92.53g while D1 had the lowest ABW values of 85.62g. From the point of view of body weights, it can be concluded that diets for quail should contain 23.73% CP from 10 to 35 days as observed during the trial. These results agreed with those of Abd El-Gawad et al. (2004) who found that quails fed on optimum level of 24% CP showed significantly higher ABW value during the experimental periods. Also, Ali, et al. (2009); Abd-Elsamee et al. (2001); Hammouda et al. (2001); Abd-Elsamee (2002 and Sterling et al. (2002) found that increasing dietary CP increased significantly ABW values of the Japanese quail or broiler chicks which were fed different levels of CP, however, a substantial increase in body weight was obtained at either two or four weeks of age, by increasing protein level from 20 to 28% (Zeweil et al., 1996). Also, they indicated that increasing the level of protein from 24 to 28% did not exert any additional advantage to growth of quail from 28 to 42 days of age. Data presented in Table 4.1 show that CP levels significantly affected ABW during the period of study.

Feeding quail chicks on diets containing low (D1) and high (D4) protein levels guarantee to achieve acceptable final body weights which are not significantly different from each other. Though feeding on these levels of CP reduced the ABW. The similarity of ABW could be attributed to more CP getting excreted at higher levels of inclusion in the diet.

4.2 Average feed intake

Table 4.2: Average feed intake of quails

Treatments	Average feed intake (g)
20.10 % CP (D1)	106.15^{a}
21.82% CP (D2)	109.90^{b}
23.73% CP (D3)	116.50^{c}
26.18% CP (D4)	113.72^{c}

NB: Means in the same column followed by different superscripts are significantly different ($p<0.05$).

The data in Table 4.2 indicated that varying CP in growing Japanese quail diets significantly ($P\leq0.05$) affected the AFI of quails. Though D3 and D4 were not significantly different, D1 and D2 were significantly different from each other and significantly different from D3 and D4. Quails fed D1 had the lowest AFI while quails fed D3 had the highest AFI value. Levels of CP (Table 4.2) significantly affected AFI during the period of study. These results disagreed with those of Sandiland et al,. (2000) who found no significant differences in feed consumption among the different dietary treatments (24 or 20%CP) in growing Japanese quail.

Data presented in Table 4.2 show that CP significantly affected FI values, indicating that CP increased appetite so that quails significantly consumed more feed during the experimental periods (10 to 35 days of age). These results agree with those found by Abdel-Azeem (2006) who found that highest daily feed consumption was observed in the group fed high level of protein ($P< 0.05$). These observations are in agreement with the findings of Tarasewicz et al.,(2006).

4.3 Average weight gain

Table 4.3: Average weight gain for quails

Treatments	Average weight gain (g)
20.10 % CP (D1)	32.83[a]
21.82% CP (D2)	37.01[b]
23.73% CP (D3)	36.46[b]
26.18% CP (D4)	35.24[b]

NB: Means in the same column followed by different superscripts are significantly different ($p<0.05$).

Data presented in Table 4.3 showed that there was a significant difference only on one level of CP, in D1. Crude protein levels did not result in significant differences in AWG of quails fed the other diets. As can be seen in Table 4.3, there were no significant differences in AWG between the dietary treatments; D2, D3, and D4. Quails fed D2 had the highest AWG of 37.01g, while the lowest AWG of 32.83g were observed in quails fed D1.

These results are in harmony with those obtained by Tollba (2003) who found a similar trend. Similar results were noticed previously by Abdel-Malak *et al.* (1995) and Ibrahim, *et al.* (1998) in broiler, Ghazalah and Ibrahim (1996) in ducks and Abdel-Latif *et al.* (2004) in Japanese quail who reported that during 10 to 38 days of age quails fed 24 or 21 CP had the same LWG and also were significantly heavier than those fed on lower CP levels with an exception of those fed D2. These results disagreed with Abd El-Gawad et al. (2004) who found that broiler chicks fed on optimum level of 24% CP showed significantly higher LWG value during the experimental periods.

These findings are in agreement with results of other studies of (Bregendahl et al,. 2002; Sterling et al,. 2005 and Tarasewicz et al,. 2005), who found that when lowering crude protein level and maintaining a similar level of lysine and methionine, a lower body weight, by 4.4 - 4.7%, was observed in the quails of 29 to 43 days. The results are in agreement of the findings of Han et al., (1992), who observed that growth depression due to low protein diets may be due to low amino acid profile of such diets. That was the case in quails fed on D1. Excessive protein intake results in higher nitrogen excretion and lower feed efficiency for productive purposes as can be observed in D4 giving a slightly lower ABW as compared to D2.

4.4 Feed conversion ratio (FCR)

Table 4.4: Feed conversion ratios of quails

Treatments	**Feed conversion ratios**
20.10 % CP (D1)	3.237[a]
21.82% CP (D2)	2.967[b]
23.73% CP (D3)	3.205[a]
26.18% CP (D4)	3.232[a]

NB: Means in the same column followed by different superscripts are significantly different ($p<0.05$).

Results presented in Table 4.4 indicated that varying CP in diets significantly ($P<0.05$) affected FCR. It can be observed that quails fed D2 had the lowest FCR value of 2.967 while the highest FCR was observed in quails fed D1 with 3.237. A statistically significant difference was found in the feed conversion ratio ($P < 0.05$) of the birds fed D2 compared to other treatments whose differences were not significantly different. The birds fed with D2 had a lower feed conversion ratio making it better than the other treatments. The FCR of quails fed on D1, D3 and D4 remained statistically similar but were poorer ($P<0.05$).

Dietary levels of protein had an influence on FCR. The improved FCR in D2 might be due to the ability of Japanese quails to retain more energy as fat in their body tissues.

CHAPTER FIVE

5.0 CONCLUSION

The findings of the research indicated that it was possible to feed quails on dietary rations with reduced levels of CP in relation to the standard feed mixtures of the nutritional value recommended by NRC (1994) , without inducing a negative influence on most growth performance parameters (body weight, feed intake, weight gain, feed conversion ratio). It has been demonstrated that varying protein levels resulted in significant variations among average body weight, average feed intake, and average weight gain and feed conversion ratios among the four dietary treatments. The findings of this study suggested that the levels of 21.82% of crude protein in the diet of Japanese quails performed better than other treatments during the period as seen in the lowest FCR.

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APPENDICES

Appendix 1. Analysis of variance for Average Body Weight.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	168.989	56.330	9.18	<.001
DOC	1	7654.796	7654.796	1247.40	<.001
TRT.DOC	3	6.050	2.017	0.33	0.805
Residual	16	98.186	6.137		
Total	23	7928.021			

Least significant differences of means (5% level) = 3.032

Coefficient of variation (%) = 2.8

Appendix 2. Analysis of variance for Average Feed Intake.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	366.817	122.272	19.95	<.001
DOC	1	1748.480	1748.480	285.27	<.001
TRT.DOC	3	100.615	33.538	5.47	0.009
Residual	16	98.067	6.129		
Total	23	2313.980			

Least significant differences of means (5% level) = 3.030

Coefficient of variation (%) = 2.2

Appendix 3. Analysis of variance for Average Weight Gain.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	61.902	20.634	6.78	0.004
DOC	1	13.485	13.485	4.43	0.051
TRT.DOC	3	48.610	16.203	5.32	0.010
Residual	16	48.702	3.044		
Total	23	172.699			

Least significant differences of means (5% level) = 2.135

Coefficient of variation (%) = 4.9

Appendix 4. Analysis of variance for Feed Conversion Ratios.

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
TRT	3	0.30250	0.10083	2.98	0.063
DOC	1	0.75615	0.75615	22.34	<.001
TRT.DOC	3	0.24482	0.08161	2.41	0.105
Residual	16	0.54153	0.03385		
Total	23	1.84500			

Least significant differences of means (5% level) = 0.2252

Coefficient of variation (%) = 5.8

Appendix 5: Table of means

Treatments	Average body weights (g)	Average feed intake (g)	Average weight gain (g)	Feed conversion ratios (FCR)
20.10 % CP	85.62[a]	106.15[a]	32.83[a]	3.237[a]
21.82% CP	91.02[b]	109.90[b]	37.01[b]	2.967[b]
23.73% CP	92.53[b]	116.50[c]	36.46[b]	3.205[a]
26.18% CP	88.20[a]	113.72[c]	35.24[b]	3.232[a]

NB: Figures in the same column followed by the same superscript indicates no significant differences ($p<0.05$).