PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF JAPANESE QUAILS (*Coturnix coturnix japonica*) FED VARYING DIETARY ENERGY LEVELS

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DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of Prof. G.S Bawa and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work for this dissertation and the subsequent write-up by (MURTALA ISMAIL UMAR SPS/12/MAS/00011) were carried out under my supervision

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DEDICATION

This research work is dedicated to Almighty Allah for his guidance and sustenance of life. Also, to my late father Alhaji Lawan Mai Kanti Bichi and his family.

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ABSTRACT

Two Experiments were conducted to determine the effect of different dietary energy levels on performance and egg quality characteristics of Japanese quail birds. In experiment 1, a total of 450 quail birds were randomly allotted to five dietary treatment groups in a completely randomized design. The birds were further divided into three replicates per treatment with 30 birds per replicate. Each treatment group was assigned to one of the following test diets, Diet 1: 2800kcal/kg ME, Diet 2: 2900kcal/kg ME, Diet 3: 3000kcal/kg ME, Diet 4: 3100kcal/kg ME and Diet 5: 3200kcal/kg ME respectively for 28 days. Dietary energy levels significantly ($P<0.05$) affect feed intake, daily weight gain, and feed conversion ratio across the dietary energy levels. Live weight, breast weight, back weight, and intestinal length were significantly ($P<0.05$) affected by the energy levels. Haemoglobin, PCV, MCHC, MCV, Albumin and Cholesterol were not significantly ($P>0.05$) affected by the dietary energy levels. RBC, MCH, Globulin and Total protein were however significantly ($P<0.05$) affected by the dietary energy levels. In Experiment 2, a total of two hundred and twenty five (225) 6 weeks old quails birds were randomly allotted to five dietary treatments in a completely randomize design. The birds were further divided into three replicates per treatment with 15 birds per replicate. Each treatment was assigned to one of the following test diets. Diet 1: 2800kcal/kg ME, Diet 2: 2900kcal/kg ME, Diet 3: 3000kcal/kg ME, Diet 4: 3100kcal/kg ME and Diet 5: 3200kcal/kg ME for 56 days. Hen-day egg production, hen-housed egg production, Feed conversion ratio, feed cost per dozen egg, albumin diameter, albumin weight, shell thickness, yolk diameter and yolk weight were significantly ($P<0.05$) affected by the dietary energy level. Therefore, it can be concluded that maximum average weight gain, feed conversion ratio, egg production and egg quality performance in Japanese quails were achieved at 2900 kcal/kg metabolizable energy.

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Poultry production subsector is the major aspect of the livestock industry in Nigeria. This subsector was dominated by the rearing of domestic chickens. However, there are new entrants into the subsector. One of the poultry specie slowly gaining prominence is the Japanese quail *(Coturnix coturnix japonica).*

Japanese quails are suited for commercial rearing, egg and meat production under intensive management system (Egbeyale *et al.,* 2013). This is because of their hardiness and ability to thrive in small cages (Odunsi *et al.,* 2007), the relative short production time and cheaper cost of production (Ojo *et al.,* 2011). Quails have lower feed requirements and require minimal space compared to the chicken.

Successful rearing of quails is a function of feed availability at reasonable cost, quality chicks from reputable organization with good stock records, and proper management. Management seems not to be a problem as such as quails are resistant to most poultry diseases hence, less vaccination is required.

Increasing production of eggs and poultry meat is therefore, the best option to meet the nutrition needs of the growing population in Nigeria. The short generation intervals make quails production well acceptable among the rural and urban communities in Nigeria. Quails production is the fastest means of alleviating the shortage of animal proteins in Africa because it is characterized by the high efficiency of nutrient transformation to high quality animal protein. However, high cost of feed has reduced the expansion rate of the poultry industry resulting in serious animal protein deficiency among Nigerians especially the low income earners leading to malnutrition (Adebajo *et al.,* 2008 and Abu *et al.,* 2009). Similarly, Owen *et al.,*

(2008) reported that growth of the livestock industry in Nigeria has recently fallen below expectation due to rising prices of feed and shortage of feed supplies. Feed is one of the most important inputs in all livestock production systems.

The major constraint therefore, to the rearing of quails and other poultry species in Nigeria is the high cost of feed especially the energy sources such as Maize, Guinea corn, and millet. The reason for the high cost of these feed ingredients is the competition that exists for them between man, the industries and livestock. This makes poultry business very expensive in terms of feeding (Awosanmi, 1999). It is estimated that feeds account for 50-60% of the recurrent expenditure in intensive poultry production and management system (Oluyemi and Roberts, 2000; Ehtesham and Chouwedhury, 2006, Aduku, 2004).

In addition to the feeding problem, prevailing environmental conditions especially temperature in the tropical semi-arid zone of Nigeria has been contributing to the inefficiency of poultry production (Oluyemi and Roberts, 2000; Banerjee, 2007). High ambient temperature and relative humidity cause heat stress which is a major limiting factor in semi-arid zones of the world (Ubosi and Gandu, 1995). The negative influence of heat stress was also reported by Sinkalu and Ayo, (2008). Feed intake is influenced by both environmental parameters and the energy density of the feed, (Leeson and Summers, 2005). The prevailing negative effects of unpredictable weather condition on poultry performance in the semi-arid zone, affect the profitability of poultry products. Inadequate caloric intake, insufficient supply of amino acids in suitable proportions and poor provisions of necessary vitamins and minerals were among the major causes of production failure (Oluyemi and Roberts, 2000).

Generally, birds adjust feed intake to meet their energy requirements (Mac Donald, *et al*., 2007). Therefore, energy is the factor that is first considered during quails ration formulation. Feeding diets containing energy lower than the recommended level to quails result in reduced growth rate, low feed conversion and cessation of lay (Yahaya, 2008). Likewise, energy levels higher than optimum has negative effect on egg production.

Effort by nutritionists to select the optimum dietary energy level for growing and laying phases of quails was stated in Nigerian Industrial Standard (NIS, 2003) under the specification for poultry feeds which focused on ambient temperatures which ranges between 22 to 45^0C for most tropical environments. High dietary energy levels result in optimal egg size, stable production at high temperatures, but at low temperatures, birds over consume calorie and reduce the profitability of the enterprise (David, 2010). Leeson and Summers, (2005), suggested that energy level in diet of layers should be increased during heat period to achieve optimum production. Since feed intake tends to decrease during hot weather, there is need to increase the energy content of the diet to compensate the missing gap.

Therefore, identification of optimum energy level both at growing and laying phases of quail chicken performance in semi-arid environment will be in line with the current trend in specification for poultry feeds and poultry nutrition in Nigeria.

1.2 PROBLEM STATEMENT

Conventional feed ingredients such as maize are more expensive and not readily available to poultry producers due to competing demands for the commodity between man and livestock, adverse climatic conditions and the use of these ingredients in the other industries. This has stimulated the search for alternative feed ingredients particularly energy sources (cassava, millet, sorghum) for poultry (Iji *et al*., 2011).

Generally, inadequate supply of feeds, nutritionally unbalanced rations, adulterated ingredients or stale feeds are some of the factors responsible for low productivity of livestock in Nigeria (Ogundipe *et al*., 2003). In order to address such problems different ingredients are investigated with the aim of replacing all or some of the conventional ingredients.

However, with the alternative feed ingredients, poultry productivity is often poor due to deficiencies in nutrients such as amino acids and minerals, imbalances in energy to protein ratios (Dilger and Baker, 2008) and anti-nutritive factors such as non-starch polysaccharides (NSP), polyphenols or phytic acid (Olukosi *et al*., 2011). Also, there is paucity of information on the nutrient composition of many alternative feed ingredients. Although, producers had strived to improve the quality of alternative feed ingredients through a variety of practices, which include feed processing, sun drying and supplementation with nutrients (Chauynarong, *et al.,* 2009).

1.3 JUSTIFICATION OF THE STUDY

Ahmad, (2009) reported that the energy content of diets is a primary factor controlling the amount of feed birds consume. Poultry producers work towards optimum production with minimum expenditure especially on feed.

However, without developing feeding standard suitable to the semi-arid environment optimum production may remain elusive. Studies by Crampton and Harris, (1969) revealed that most common nutritional cause of poor performance of animals is low energy intake, which is mainly influenced by ambient temperature. Feed intake is closely related to energy intake which has a positive correlation with performance. Therefore, it is important to determine the optimum energy level for best performance both at growing and laying stage of quails birds in the semi-arid zone of the world.

Maize (*Zea mays*) has remained the major source of energy in poultry nutrition and is costly (Abubakar *et al.*, 2006). The high price of maize has resulted in an unprecedented increase in cost of poultry feed production (Oladunjoye *et al.*, 2010). Olewola and Longe, (2001) reported that energy could account for up to 60% of the overall cost of poultry production and the use of wrong energy level adversely affects cost (David, 2010). Thus, determination of optimum energy level required for quails bird raised at ambient temperature range of 22 to 45^{0}C, will reduce cost of production. The current study is designed to evaluate the performance of quail birds fed diets containing different levels of energy, both at growing and laying stages in tropical semi-arid zone of Nigeria.

1.4 THE OBJECTIVES OF THE STUDY

The main objective of the study is to evaluate the performance and egg quality characteristics of Japanese quails fed varying dietary energy levels. While the specific objectives of the study were to determine the:

I. Growth performance of quail birds fed diets containing different energy levels.
II. Effect of different energy levels on egg production and egg quality parameters.
III. Profitability of feeding diets with different levels of energy to Japanese quail birds.
IV. Effect of different dietary energy level on hematology and serum biochemistry of Japanese quails birds.
V. Effect of different energy levels on carcass characteristics of Japanese quails birds.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HISTORY OF JAPANESE QUAIL.

The Japanese quail, also known as Coturnix quail (*Coturnix japonica*) is a species of Old World quail found in East Asia. First considered a sub-species of the Common quail, it was distinguished as its own species in 1983 (Hubrecht and Kirkwood, 2010). The global population size has not been quantified, but the species has been reported to be fairly common (Del Hoyo *et al*., 1994; Fuller *et al*., 2000). Populations of the Japanese quail are known to mainly inhabit East Asia and Russia. This includes India, Korea, Japan, and China (Pappas, 2013). The quail has also been found to reside in many parts of Africa, including Tanzania, Malawi, Kenya, Namibia, Madagascar, and the area of the Nile River Valley extending from Kenya to Egypt (Pappas, 2013). Breeding sites of the Japanese quail are largely localized to East and Central Asia (Barilani *et al*., 2005, Purgcerver *et al*., 2007) in such areas as south eastern Siberia, northern Japan, and the Korean Peninsula. However, it has also been observed to breed in some regions of Europe, as well as Turkey (Pappas, 2013). The earliest records of domesticated Japanese quail populations are from 12th century Japan; however, there is evidence that the species was actually domesticated as early as the 11th century (Hubrecht and Kirkwood, 2010). These birds were originally bred as songbirds, and it is thought that they were regularly used in song contests (Hubrecht and Kirkwood, 2010., Mills *et al*., 1997).

In the early 1900s, Japanese breeders began to selectively breed for increased egg production (Baumgartner, 1994). By 1940, the industry surrounding quail eggs was flourishing. Unfortunately, the events of World War II led to the complete loss of quail lines bred for their song type, as well as almost all of those bred for egg production. After the war, the few enduring quails left were used to rebuild the industry and all current commercial and laboratory lines today are considered to have originated from this population of quail (Mills *et al.,* 1997).

2.2 THE EGG OF JAPANESE QUAILS

During the 17th century, the Chinese pharmacologist Li Shi Chen discovered, in addition to the nutritional value of the eggs and meat of the Japanese quail, their medicinal value as well, other Japanese and Russian scientists and doctors tasted and confirmed this discovery (Lim, 2012). For their extraordinary nutritional and medicinal properties, they are being used with more and more success in Europe and America as well as in the Far East (Dowarah and Sethi, 2014). These eggs are much higher in vitamins and minerals than hen's eggs. They are especially rich in the essential amino acids (methionine, lysine, and phenylalanine) (Lalwani, 2011). Nutritionally, quail eggs contain an average of; protein 13.1 g, fat 11.2 g, minerals 1.1 g, energy (kcal) 158, calcium 59 mg, phosphorus 220 mg, iron 3.8 mg, vitamin A 300 IU, vitamin B_1 0.12 mg, vitamin B_2 0.85 mg, niacin 0.10 mg (per 100 g whole liquid egg). They also contain vitamin B_6, biotin, folic acid and pantothenic acid, and the enzymes peptidase, catalse, glycosidase (Lalwani, 2011).

The average egg weight of a laying flock increases as the birds get older mainly due to physical and physiological changes (Oluyemi and Roberts, 2000). It has been reported that the hen’s age has a constant and significant effect on proportion of egg weight, length and width of the eggs, yolk, egg white and egg shell in total egg mass; similarly yolk and albumen weight and height increased significantly with age of the bird (Rossi and Pompei, 1995; Danilov, 2000; Luquetti *et al.,* 2004; Akpa *et al*., 2006 and Egahi *et al*., 2011). Furthermore there is an increase in repeatability of egg quality traits with linear increase in age of laying Japanese quails (Akpa *et al*., 2008).

2.3 METABOLIZABLE ENERGY REQUIREMENTS OF JAPANESE QUAILS

Energy level is one of the most important components in the formulation of poultry feed, considering that the birds consume feed to meet their energy needs. According to Moura *et al*. (2010), feed intake is regulated by the energy density of the diet and by other nutritional requirements, which consequently affects laying performance and egg quality. Thus according to Bertechini (2006), all nutrients must be related to the energy content of the diet. Excess energy in the diet in the form of carbohydrates, lipids and proteins (disequilibrium in the amino acid profile) causes a reduction in voluntary intake by birds (Baião and Lara, 2005) and fat deposition in the carcass. According to Bertechini (2006) excess fat in the liver and ovary may occur due to the imbalance of energy in the diets of commercial laying hens, promoting a reduction in egg production. The existing recommendations of metabolizable energy for Japanese quails are not widely divergent. So, the NRC (1994) recommended a diet with 2900 kcal/kg metabolizable energy (ME) for Japanese quails at the growth phase and egg production phase, while Silva and Costa (2009) recommended similar values, but differentiate the requirements in three distinct phases, i.e., 2900, 3050, 2800 and 2850 kcal/kg ME for quails from 1 to 21, 22 to 42 days of age and in the first and second egg production phases, respectively. Rostagno *et al*. (2011) recommended a level of 2900 and 2800 kcal / kg ME for Japanese quail first and second growth phases respectively, and in egg production phase, when the quails have, at this stage, a body weight of 177g.

Moura *et al*. (2008) evaluated diets of different energy densities, nutrients ratios constantly in the feeding of Japanese quail and found an increase of 8.9% in feed intake when the energy density decreased from 2900 to 2500 kcal/kg. Freitas *et al*. (2005) also found a linear increase in feed intake by reducing the metabolizable energy level of Japanese quail. Thus, we can infer that the feeding behavior and the feed intake of Japanese quail vary according to the level of dietary metabolizable energy.

Freitas *et al*. (2005) had observed a linear reduction in egg weight and egg mass with increase in metabolizable energy level of the feed. These authors have tested four levels of metabolizable energy (2585, 2685, 2785 and 2885 kcal/kg ME) in diets of Japanese quails and observed a 2.3% reduction in egg weight when compared to the egg weight of quails feed diets containing 2585 and 2885 kcal/kg ME and 7.7% of reduction in the egg mass/hen/ day in these same metabolizable energy levels. Barreto and Luiz, (2007) evaluating metabolizable energy levels (2650, 2750, 2850, 2950 and 3050 kcal/kg ME) in isonitrogenous diets (20% Crude Protein) fed to Japanese quails in the initial phase of egg production observed linear reduction in feed intake, egg weight, yolk weight and albumen weight as the metabolizable energy levels increased. It was however found that the increase in dietary metabolizable energy level did not result in an increase of yolk cholesterol concentration.

The energy density of diets appeared to exert little influence on the formation of the yolk, as Moura *et al*. (2010) evaluated the effect of the reduction in energy density (2900, 2800, 2700, 2600 and 2500 kcal/kg ME), keeping fixed the metabolizable energy: nutrients ratio of the diets on the characteristics of Japanese quail eggs. They found no significant differences in the weight percentage of yolk, albumen and egg shell. Significant differences in weight and yolk percentage were equally not found by Costa *et al*. (2004) when they evaluated diets with levels of 2700, 2800 and 2900 kcal/kg ME and 17.5% crude protein in laying hens. The results related to yolk suggest that Japanese quails and laying hens usually are not influenced by the energy density in yolk formation, in other words, the percentage of egg yolk produced has values near to 30% of the egg weight. Day-old chicks were in a similar body weight range of 7.2 to 7.3 g. The average live weight in quail chicks fed 2700 or 2900 kcal ME kg-1 were similar at 14, 28 and 49 days of age. It is in agreement with the reports of Barque *et al*. (1994) who showed that weight gain of quail chicks was not affected by various levels of energy (2600, 2800 and 3000 kcal ME kg-1).

Gheisari *et al.* (2011) reported that dietary energy levels did not induce any influence on average feed conversion ratio (FCR) at any growth phases which was in contrast with earlier findings of Kaur *et al*. (2008a) and Elangovan et al. (2004) who reported an improvement of FCR in growing quails with increasing dietary energy level.

2.4 PROTEIN REQUIREMENT OF JAPANESE QUAILS

The NRC recommendation for meeting the requirements of quails for dietary protein ranged from 22-24% crude protein. However, Barque *et al*. (1994) reported that dietary protein concentration did not affect average daily feed intake of quails in the first (0-14 days), third (29-49 days) and the whole rearing (0- 49 days) periods, whereas in the second rearing period (15-28 days) the highest daily feed consumption ($P<0.05$) was observed in the group fed high level of protein. These results agreed with the findings of Tarasewicz *et al*. (2007) who reported that a lowered level of protein in fodder did not affect average quail feed intake in the whole rearing period (0-42 days). In a study conducted by Soares (2003) to estimate protein requirements of Japanese quails, crude protein levels of 18, 20, 22, 24 and 26% were used for Trial 1 and 2 (during the laying period) levels used were 16, 18, 20, 22 and 24%. There were no effects ($P<0.05$) of protein levels on feed intake and feed conversion. Protein levels in the experimental diets during rearing had no effect on egg production up to 63 days. However, laying was delayed and variation in body weight was greater ($P<0.05$) in quails fed lower protein levels. In Trial 2, a quadratic effect of protein levels was seen on egg production and feed conversion; and a linear effect was seen on mean egg weight and feed intake. Crude protein levels of 23.08% and 21.95% were estimated by regression equations for rearing and laying, respectively.

An experiment was conducted by Sangilimadan *et al.* (2012) using Japanese quails (Coturnix coturnix japonica) from day old to thirty weeks of age to identify the dietary protein requirement of layer Japanese quail reared in cages under a hot and humid tropical climate. Hen day egg production and hen housed egg production were significantly ($P<0.05$) influenced by dietary protein combinations, the best protein combination was 26/20/22%, Japanese quails aged 11 to 14 weeks had the highest hen day egg production and hen housed egg production. The best feed efficiency per dozen table eggs, ranged from 0.51 to 0.56. Birds aged 11 to 18 weeks recorded significantly the best feed efficiency per dozen table eggs and feed efficiency per kilogram egg mass. Higher grower (22 %) and layer dietary protein levels of 19 and 22 % respectively had significantly influenced egg weight. Heavier eggs of 12.49 and 12.39g were laid by 26/22/22 and 24/22/22% protein combinations, respectively. Livability in layer Japanese quails was not influenced by dietary protein combinations, or by individual protein levels. Dietary protein combination of 24/20/19% recorded the lowest cost of feed per 100 table eggs and the best egg/feed price ratio in layer Japanese quails was recorded in the age group of 11-14 weeks

2.5 ENERGY AND PROTEIN RATIO

Energy and protein are primary nutritional requirements of all classes of animals and for all types of production, including growing quails. These requirements must be met before requirements for other nutrients are addressed. The response of growing Japanese quails to different levels of energy and protein for optimal growth performance, feed utilization efficiency, carcass yield and some blood constituents of Japanese quails, were studied by Mosaad and Iben, (2009). Kaur *et al*. (2008b) in their study concluded that the optimum level of dietary ME is 2700 kcal kg-1 with CP of 25.83% for gain and 3100 kcal kg-1ME with CP of 25.83% for optimum feed conversion during 0-5 weeks of age. Dietary energy levels did not affect average feed intake; (except for days 29-49), body weight and FCR. However, decreasing ME content of finisher diet (29-49 days of age) from 2900 to 2700 kcal kg-1 resulted in an increase in average feed intake from 24 to 25.7 g day-1. It seems that higher feed intake with decreased dietary energy concentration was due mainly to compensate energy intake, partially in finisher phase in which chick energy requirements is relatively higher than starter and grower phases. Kaur *et al*. (2008b) also reported that feed intake of Japanease quails increased linearly with decrease in dietary energy from 3100 to 2900 and 2700 kcal ME kg-1 during 0-3 or 0-5 weeks of age. Barque *et al*. (1994) found that influence of different dietary energy (2600, 2800 and 3000 kcal ME kg-1) on feed intake of Japanese quails were not significant. However, the birds fed on ration containing 3000 kcal ME kg-1 apperantly consumed less feed as compared to those fed diet containing 2800 and 2600 kcal ME kg-1. The high energy content relative to low protein content of the diet, namely, a high metabolizable energy: protein ratio reduces feed intake (Page and Andrews, 1973; Bertechini, 2006), which promotes a lower intake of protein and other essential nutrients, also leading to the accumulation of abdominal fat. Likewise a low metabolizable energy: protein ratio raises the use of protein as an energy source, causing an increased metabolic and of course economic cost, invalidating the efficiency of production. NRC (1994) recommended a metabolizable energy: protein ratio of 120.8 and 145 for initial and egg production phases, respectively. Similarly, Silva and Costa (2009), recommend a ratio of 116, 138.6, 140 and 129.5 for initial phase, growth, egg production I and egg production II. Meanwhile, Rostagno *et al*, (2011) recommended a ratio of 131.8 and 148.9 for growing phase and egg production

2.6 VITAMINS REQUIREMENTS OF JAPANESE QUAILS

The principal role of vitamin A is its function in ensuring adequate growth and a means of assisting in the birds's resistance to disease. Vitamin A is essential for normal vision, egg production, and reproduction. Laying quails receiving insufficient vitamin A produced fewer eggs and those produced frequently did not hatch. For egg production and fertility of females, a level of 2,500 I.U. vitamin A/kg diet was required (Parrish and Al-Hasanbi, 1983). National Research Council (1994) recommended 1650 I.U per kg vitamin A for the starter and grower phase of quails and 3300 I.U per kg for breeding quails. Vitamin D is vital in the absorption and mobilization of calcium during shell formation (North, 1984). Shim *et al*. (1983) reported that, deficiency of vitamin E in semi-purified diets containing isolated soybean protein and starch did not affect the body weight, feed consumption, or egg production of Japanese quail. However, it caused sterility in males, which was overcome by restoring 40 I.U. vitamin E/kg to the diet after 2 weeks.

The fertility and hatchability of quail eggs were severely depressed after the birds were fed a conventional diet containing glucose and soybean meal, but deficient in vitamin E for 20 weeks. Prolonged deficiencies of Vitamin A and E adversely affect spermatogenesis and storage of the follicle stimulating hormone in the pituitary gland which in turn affects fertility and hatchability (Gaby and Singh, 1990). Vitamin C alleviates the negative effects of stress such as cold stress-related depression in poultry performance (McDowell, 1989). Ahmadu (2008) reported best percent hatchability by dipping Shika brown eggs in 5 % sterile concentration of ascorbic acid concentration for a period of 3 minutes prior to incubation and no pip chicks were recorded compared to 2.5, 7.5 and 10% ascorbic acid concentration.

2.7 MINERALS REQUIREMENTS OF JAPANESE QUAILS

Calcium is a key component of the bone, along with phosphorus. High levels of phosphorus in the blood will inhibit mobilization of calcium from the bone. Manganese interferes with the metabolism of calcium and causes poor shell quality, if it is in excess in the diet. Excess calcium causes reduced feed intake which affects shell quality as well as production (North, 1984). Selenium deficiency in the chicken, especially in combination with low vitamin E supply, is responsible for the development of a range of diseases including exudative diathesis (Barthomew *et al*., 1998) and nutritional encephalomalacia (Combs and Hardy, 1991). Nutritional pancreatic atrophy in chicks may be overcome by feeding vitamin E at 15-20 times the levels normally regarded as nutritionally adequate (Whitacre *et al*., 1987). Selenium supplementation can also decrease the incidence of nutritional muscular dystrophy in the chick (Jonsson, 1993). An experiment was conducted by Sibel, *et al.* (2009) to determine the threonine requirement of laying Japanese quails. Increasing threonine level in the diets increased feed conversion efficiency, total egg production (g/bird/63 days), egg weight (g/bird/day) and number of eggs (bird/63 days). However, there were no significant differences among the groups (p>0.05). About 1.04% threonine level in the diet increased egg production by 9.79% and number of eggs 9.30% compared with the basal diet (0.74% threonine). The result suggested that the current NRC recommendation of 0.74% threonine for laying quails is not adequate to support comparable laying performance. NRC (1994) suggested that quails fed diets containing 2900 kcal kg-1 of diet should receive a total dietary threonine level of 0.74%. Parlat *et al*. (2003) were performed to determine the effects on threonine addition to diets containing high protein on performance traits of laying Japanese quail. Baylan *et al*. (2006) found that threonine supplementation in the diet did not affect growth performance and edible carcass parts (P>0.05), assuming that birds can make metabolic adaptation to current dietary threonine supplementations. In some studies, positive influences of supplemental threonine at the levels of 0.53% on egg production, egg weight, egg mass and feed intake were observed in laying hens. Body weights were not significantly different among hens that received diets containing 0.45-0.53% threonine (Faria *et al*., 2002). Ishibashi *et al.* (1998) found that dietary threonine exceeded the requirement level, egg mass and feed conversion ratio decreased with increasing dietary threonine levels. Zollitsch *et al.* (1993) did not observe improvements in feed conversion ratio resulting from increased threonine. Sohail *et al*. (2002) reported that laying hens responded to the inclusion or removal of supplemental threonine, lysine, isoleucine, tryptophan and sulfur amino acids within 1-2 weeks. A study was conducted by Cruz and Fernandez to evaluate the effect of dietary inclusion of the organic trace minerals selenium and zinc on the performance, internal and external egg quality of Japanese quails subjected to heat stress. Results showed no differences ($p > 0.05$) in egg production (%), egg mass (g/hen/ day), feed conversion per egg mass (kg/kg), feed conversion per dozen eggs (kg/dz), average egg weight (g), egg specific gravity, eggshell thickness (mm) and weight (g), Haugh Unit, yolk index, albumen index and mortality (%). However, quails fed the combination of Se and Zn had higher ($p < 0.05$) feed intake (28.73g/hen/day). Those fed only organic selenium had higher average daily egg production (30.17 eggs/day), and those fed the diet only supplemented with zinc had higher mortality ($p < 0.05$).

2.8 WATER REQUIREMENTS OF JAPANESE QUAILS

According to Smith *et al*, (2006), functions of water in the body of animal include; regulation of body temperature, transportation of nutrient and taking part in numerous chemical reactions in the body. Water requirement of poultry are often crudely estimated by multiplying the amount of feed eaten by two. However, under hot conditions, animals drink substantially more water. Water controls the ability of the birds to regulate their body temperature in hot weather (Dafwang, 1988). Oluyemi and Roberts, (2000) reported that, water consumption increases the amount of feed intake by layers which results in increased egg sizes.

Quails will die more rapidly from water deprivation than from food deprivation and that restricting drinking water or limiting drinking time leads to reduced feed intake that is directly proportional to the amount of water being consumed. Maertens, (1992) reported that water and feed consumption varies with changes in environmental temperature and humidity. As the temperature of the environment rises above 20^0C day and night, feed intake tends to drop while water consumption increases. At high environmental temperatures (30^{oC} and above), feed and water intakes decline, affecting the performance of growing and laying quails (Fernandez-Carmona, *et al.,* Cervera and Blas, 1996). According to Pond *et al.* (1995) water plays an essential role in a number of functions vital to the animal such as digestion, nutrient transport, waste excretion and temperature regulation. One of the most important properties of water in nutrition is its remarkable ability to dissolve substances (Pond *et al.,* 1995). Animals need more water to serve as a medium for transporting substances contained in feed round the body and to dissolve substances that cannot be spontaneously adsorbed by the body of birds (Siregar, 1994).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITE

The study was conducted at Murtala Poultry Farms, Bichi Local Government, Kano State, Nigeria from March to May 2016. Kano state is located between latitudes $9^0$30' and $12^0$30' North and longitude $9^0$30' and $8^0$42' east. The area is characterized by tropical wet and dry seasons (Olofin, 1987). The wet season starts from May and ends in September while the dry season commences from October and ends in April. The meanannual rainfall and temperature ranges between 888.6 and 960mm and 21 and 46^0C, respectively. The humidity range between 40% (dry season) and 60-80% (wet season) Kano state Agricultural and Rural Development Authority (KNARDA, 2006).

3.2 SOURCE OF THE EXPERIMENTAL BIRDS

Experimental birds (Two weeks old) for the study were sourced from the National Veterinary Research Institute (NVRI) Vom, Plateau State.

3.3 SOURCE OF EXPERIMENTAL FEED INGREDIENTS

The feed ingredients used for feed formulation which include maize, soybean meal, limestone, wheat offal, fish meal, bone meal, lysine, methionine and vitamins/mineral premixes were purchased from Phed Agro Vet services, Kano. Some of the ingredients were milled in Bichi-town where the experiment was conducted.

Experiment I: Effects of Varying Dietary Levels on Performance of Japanese Quail from 2-6 Weeks (Chick Phase).

3.4 EXPERIMENTAL DIETS

Diet 1 contained 2800 kcal/kg M.E, Diet 2 contained 2900 kcal/kg M.E, Diet 3 contained 3000 kcal/kg M.E, Diet 4 contained 3100 kcal/kg M.E, and Diet 5 contained 3200 kcal/kg M.E. The crude protein contentment of all the diets ranged from 24.09 to 24.37. The compositions of the experimental diets formulated are shown in Table 3.1.

Proximate composition of experimental diets for growing phase

The proximate composition of the experimental diet for the growing phase are shown in Table 3.2

The metabolizable energy (kcal/kg) content of the diets ranged from 2807.05 in diet 1 to 3195.21 in diet 5. Dry matter (DM) content ranged from 92.28 in diet 4 to 93.87 (%) in diet 5, while the crude protein content of the diet ranged from 24.09 in diet 4 to 24.37 (%) in diet 2. Content of crude fibre ranged from 2.75 in diet 5 to 4.21 (%) in diet 1, while the ether extract percentage ranged from 3.15 in diet 2 to 3.71 in diet 5.

Table 3.1: Composition of the Experimental Diets for Chick-Phase (2-6 Weeks)

	Diets (%)				
Ingredients	1	2	3	4	5
Maize	43.00	52.00	52.20	55.00	55.00
Fishmeal	3.00	4.00	4.00	5.00	7.50
Soybean Meal	19.00	19.00	19.50	17.00	15.50
Groundnut Cake	15.00	15.00	15.00	15.30	13.00
Wheat Bran	6.50	4.50	2.00	0.00	0.00
Limestone	3.25	3.25	3.25	3.25	3.25
Maize Bran	7.50	0.00	0.00	0.00	0.00
Salt	0.30	0.30	0.3	0.30	0.30
Broiler Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.2	0.20	0.20
Methionine	0.20	0.20	0.2	0.20	0.20
Di calcium Phosphate	1.50	1.50	1.5	1.50	1.50
Vegetable Oil	0.00	0.00	1.0	1.70	3.00
Toxin Binder	0.10	0.10	0.1	0.10	0.10
Enzymes	0.05	0.05	0.05	0.05	0.05
Acidifier	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated Analysis (% unless otherwise stated)					
Crude Protein	24.20	24.37	24.27	24.09	24.20
Fat	3.31	3.20	4.03	4.63	5.91
Crude Fibre	4.21	3.35	3.15	2.95	2.75
Ash	7.38	6.39	6.79	6.5	6.56
Calcium	1.34	1.17	1.32	1.31	1.50
Phosphorus	0.38	0.38	0.37	0,36	0.46
Salt	0.38	0.38	0.38	0.39	0.46
Methionine	0.55	0.55	0.55	0.55	0.57
Lysine	1.41	1.41	1.41	1.41	1.47
ME (kcal/kg)	2807.02	2905.65	2998.97	3085.64	3195.21
Cost/kg diet ₦	96.27	99.87	102.09	103.99	105.65

*Vitamin/Minerals premix contained per kg of diet: Vitamin A, 1200 I.U; Vitamin D3, 2500 I.U; Vitamin E, 50mg; Vitamin K_3, 2.5mg; Vitamin B_6, 6.0mg; Niacin, 40.0mg; Calcium pantothenate, 10.0mg; Biotin, 0.8mg; Vitamin B_{12}, 0.25mg; Folic acid, 1.0mg; Choline chloride, 300mg; Iron, 100mg; Zinc, 50mg; Iodine, 1.55 I.U; Selenium, 0.1mg.

Table 3.2: Proximate Composition of Experimental Diets for Growing Phase

	Diets				
Parameters (%)	1	2	3	4	5
Metabolizable energy (kcal/kg)	2807.05	2905.65	2998.64	3085.64	3195.21
Dry matter	93.48	93.06	93.40	92.28	93.87
Crude protein	24.20	24.37	24.27	24.09	24.20
Crude fibre	4.21	3.35	3.15	2.95	2.75
Ether extract	3.16	3.15	3.26	3.32	3.71
Ash	7.38	6.39	6.76	6.5	6.56
Nitrogen free extract	61.05	62.74	62.56	63.14	62.78

3.5 EXPERIMENTAL DESIGN

Four hundred and fifty (450) two weeks old Japanese quail birds were randomly allotted to five dietary treatments in a completely randomized design. The birds were further divided such that each treatment group of 90 birds had three replicates. Each replicate was housed in a different cage. Each replicate had 30 birds. The treatment groups were assigned to the following diets; thus: Diet 1: 2800kcal/kg Diet 2: 2900kcal/kg Diet 3: 3000kcal/kg; Diet 4: 3100kcal/kg and Diet 5: 3200kcal/kg for the treatment groups 1,2,3,4 and 5, respectively. The experimental diets were fed to the quails at 2-6 weeks of age, so, the feeding trial lasted for four weeks.

3.6 MANAGEMENT OF EXPERIMENTAL BIRDS

A total of Four hundred and fifty (450) two weeks old quails with initial weight of 41.66g/bird were used in experiment 1. The quail chicks were housed in cage system equipped with feeders and drinkers. Heat and light were provided using 100 Watts electric bulbs. Feed were supplied in chick trays and fountain water drinkers were used to supply water. Feed and water were supplied *ad-libitum* throughout the experimental period. Water intake was measured and was served in the morning hours at about 8-9am. The leftover was measured the following morning and the differences between served and leftover were calculated as water intake. Daily feed supplied were weighed and the left over was measured to determine the average daily feed intake of the birds. The birds were weighed on weekly basis and the following parameters were calculated; daily feed intake, daily weight gain, feed conversion ratio and mortality.

3.7 CARCASS EVALUATION

At the end of the feeding trial, (4^{th} week) three (3) birds from each replicate (9 birds per treatment) were selected, weighed and starved over night so as to allow for the emptying of the crop and gut. The birds were weighed, slaughtered and defeathered.

Each carcass was weighed, cut into different parts and the following parameters were calculated; dressing percentage, breast weight, thigh weight, liver, gizzard, back muscle, and leg weights.

3.8 HEAMATOLOGICAL AND SERUM BIOCHEMISTRY ANALYSIS

Two quails from each replicate (6 birds per treatment) were selected and bled via jugular vein. Blood sample (2ml) was collected from each bird using a sterile syringe in to a tube containing anticoagulant, sodium salt of Ethylene diamine tetra acetic acid (EDTA) for the determination of heamatological parameters. Blood sample (2ml) was also collected from the quails in a plain bottle for the determination of serum biochemistry as described by Oyewale, (1992).

Experiment II: Effects of varying dietary energy levels on the performance of Japanese quail hens from 7-14 weeks (laying phase)

3. 9 EXPERIMENTAL DIETS

The experimental diets were formulated to contain different levels of energy as shown in Table 3.3. Diet 1 contained 2800 kcal/kg M.E, Diet 2 contained2900 kcal/kg M.E, Diet 3 contained 3000 kcal/kg M.E, Diet 4 contained 3100 kcal/kg M.E, and Diet 5 contain 3200 kcal/kg M. E

<u>Proximate composition of experimental diets for laying phase</u>

The proximate composition of experimental diets for laying phase is presented in Table 3.4.

The metabolizable energy (ME kcal/kg) of the diets ranged from 2807.05 in diet 1 to 3195.21 in diet 5. Dry matter (DM) ranged from 92.40% in diet 3 to 94.87 in diet 5. The crude protein content of the diet ranged from 22.02 in diet 3 to 22.23 in diet 5. The crude fibre content ranged from 2.35 in diet 5 to 3.06 in diet 1 while ether extract ranged from 3.46 in diet 1 to 5.26 in diet 3. The ash percentage ranged from 11.05 in diet 5 to 11.81 in diets 1 and 2, respectively.

Table 3.3: Composition of Experimental Diets for Laying Phase (7-14 Weeks)

	Diets (%)				
Ingredients	1	2	3	4	5
Maize	51.00	52.50	53.00	53.00	53.30
Fishmeal	5.00	6.50	6.50	7.00	9.00
Soybean Meal	15.00	15.00	15.00	15.00	14.00
Groundnut Cake	12.00	10.50	10.50	10.50	9.00
Wheat Bran	5.50	3.00	1.30	0.00	0.00
Limestone	8.55	8.55	8.55	8.25	8.25
Salt	0.30	0.30	0.30	0.30	0.30
Layer Premix*	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.05	0.05	0.05	0.05	0.05
Di calcium phosphate	1.50	1.50	1.50	1.50	1.50
Vegetable Oil	0.50	1.50	2.50	3.80	5.00
Toxin Binder	0.10	0.10	0.10	0.10	0.10
Enzymes.	0.05	0.05	0.05	0.05	0.05
Acidifier	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Calculated Analysis (% unless otherwise stated)					
Crude Protein	22.20	22.20	22.02	22.16	22.23
Fat	3.46	4.41	5.26	6.4	7.48
Crude Fibre	3.06	2.78	2.65	2.52	2.35
Ash	11.81	11.81	11.72	11.16	11.05
Calcium	2.97	3.09	3.08	2.96	3.03
Phosphorus	0.36	0.42	0.41	0.43	0.46
Salt	0.36	0.40	0.40	0.41	0.45
Methionine	0.37	0.39	0.39	0.39	0.40
Lysine	1.29	1.30	1.29	1.30	1.33
ME (kcal/kg)	2807.05	2905.65	2998.97	3085.64	3195.21
Cost/kg diet (₦)	97.29	99.67	101.41	104.34	107.13

*Vitamin/Minerals premix contained per kg of diet: Vitamin A, 1200 I.U; Vitamin D3, 2500 I.U; Vitamin E, 50mg; Vitamin K_3, 2.5mg; Vitamin B_6, 6.0mg; Niacin, 40.0mg; Calcium pantothenate, 10.0mg; Biotin, 0.8mg; Vitamin B_{12}, 0.25mg; Folic acid, 1.0mg; Choline chloride, 300mg; Iron, 100mg; Zinc, 50mg; Iodine, 1.55 I.U; Selenium, 0.1mg.

Table 3.4: Proximate Composition of Experimental Diets for Laying Phase.

	Diets				
Parameters (%)	1	2	3	4	5
Metabolizable energy (kcal/kg)	2807.05	2905.65	2998.64	3085.64	3195.21
Dry matter	92.48	93.86	92.40	93.28	94.87
Crude protein	22.20	22.20	22.02	22.16	22.23
Crude fibre	3.06	2.78	2.68	2.52	2.35
Ether extract	3.46	4.41	5.26	3.71	3.65
Ash	11.81	11.81	11.72	11.16	11.05
Nitrogen free extract	59.47	58.80	58.32	60.45	60.72

3.10 EXPERIMENTAL DESIGN

A total of two hundred and twenty five (225) seven weeks old quail birds were used in Experiment 2, in a completely randomized design (CRD). The quails were divided into three replicates per treatment such that there were 15 hens per replicate with a total of 45 hens per treatment. Each treatment group was assigned to one of the following diets. Diet1: 2800kcal/kg, Diet 2: 2900kcal/kg, Diet 3: 3000kcal/kg, Diet 4: 3100kcal/kg and Diet 5: 3200kcal/kg ME as treatment 1,2,3,4 and 5 respectively. The crude protein content of the diets ranged from 22.02 to 22.23.

3.11 MANAGEMENT OF EXPERIMENTAL BIRDS

Two hundred and twenty five 225 hens were housed in cages equipped with feeders and drinkers. Feed and water were provided *ad libitum* throughout the experimental period which lasted for 8 weeks. Daily feed supplied were weighed and the left over was measured to determine the average daily feed intake of the birds and the following parameters were measured; daily feed intake, daily weight gain, feed conversion ratio, Hen-day egg production, Hen-housed egg production and mortality.

3.12 DATA COLLECTION

Data was collected on mean feed and water intake, while feed conversion ratio, hens-day egg production, hen-housed egg production and efficiency were calculated as follows:

Hen-day egg production (HDEP) on daily basis was calculated by adopting the formula given by North (1984).

$$\text{HDEP} = \frac{\text{Number of eggs produced on daily basis}}{\text{Number of birds available in the flock on that day}}$$

Hen-day egg production for the whole laying period was worked out by summing up the daily Hen-day egg production of the flock

Hen-housed egg production (HHEP) was calculated using the following formula given by North (1984).

$$HHEP = \frac{\text{Total number of eggs produced by a flock} \times 100}{\text{Total number of hens housed}}$$

$$\text{Feed conversion ratio} = \frac{\text{kg of feed consumed}}{\text{kg of egg produced}}$$

3.13 DETERMINATION OF EGG QUALITY PARAMETERS

At the 12th and 13th week of the egg production phase, 5 eggs were randomly picked from each replicate to determine the egg quality parameters. The eggs were weighed using sensitive electronic scale to the nearest 0.01g. Egg length and width was measured using Vernier caliper and the values were used to calculate egg shape index using the formula described by Sauveur (1988).

ESI = EW/EL

Where ESI = Egg shape index

EW = Egg width (mm)

EL = Egg length (mm)

Each egg was broken around the equator; but care was taken to keep the yolk intact. The weight of the egg albumen and yolk were taken with the aid of a sensitive scale. Albumen width was taken with the aid of Vernier caliper and the values obtained was used with egg weight to calculate Haugh unit values for each egg according to the formula outlined by Haugh (1937)

$HU = 100 \log (H - 1.7W^{0.37} + 7.6)$

Where HU = Haugh unit

H = albumen height (mm)

W = Egg Weight (g)

Each egg shell was weight and dried in an oven and weighed to determine the shell weight, which was used to calculate the egg shell index (I) using the formula described by Iposu *et al*. (1994).

$$I = 100SW/5$$

Where SW = shell weight (g)

S = Surface area (cm)

S = K.EW 2/3

Where K has value of 4.67 for egg weigh less than 60g and EW has egg weight.

Shell thickness was measured using a micrometer screw gauge. Egg yolk height and width was measured with Vernier caliper and the values obtained were used to calculate the yolk index (YI)

$$YI = YW/YH$$

Where YW = yolk width (mm)

YH = yolk height (mm)

While egg specific gravity (ESG) was calculated based on egg weight (EW) and shell weight

$$ESG = EW (0.9680 (EW-SW) + (04921)$$

Where EW = egg weight

SW = shell weight

3.14 STATISTICAL ANALYSIS

Data collected were statistically analyzed using the General Linear Model Procedure of SAS (2002). Differences in means were separated using Least Significant Difference (LSD).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Performance Characteristics of Japanese Quail Fed Varying Dietary Energy Levels (2-6 Weeks)

The result of performance characteristics of Japanese quail fed varying dietary energy levels is presented in Table 4.1. Quails birds fed diets 1 and 2 had significantly (P<0.05) higher feed intake compared to those fed diets 3, 4 and 5, respectively which had similar daily feed intake. Quails fed diets 1 and 2 consumed 15.9 and 14.6g/bird/day while those fed diets 3, 4 and 5 consumed 13.5, 13.7 and 13.2g/bird/day, respectively. However, significant (p< 0.05) differences were observed among the treatment groups for daily weight gain (DWG). The values ranged from 2.58g/bird/day for quails on diet 5 to 2.75g/bird/day for those on diet 1. Daily weight gain (DWG) values were statistically similar for quails on diet 2, 3 and 4 but significantly higher (P<0.05) than those on diet 5. Quails fed diet 1 had the highest daily body weight gain (2.75g/bird/day) compared to others. Dietary energy levels affect Daily feed intake, weight gain and feed conversion ratio. An increase in the metabolizable energy from 2800kcal/kg ME to 3200kcal/kg ME resulted in the linear decrease in feed intake and weight gain across the dietary levels. However, feed gain ratio for quails fed diets 3, 4 and 5 (5.11, 5.17 and 5.10) which were similar, were better than values (5.78, and 5.52) (P<0.05) obtained for quails fed diets 1 and 2, respectively. Quails in these treatment groups showed similar performance in terms of feed gain ratio.

Cost per gain was lower for quails fed diet 3 (1.37 ₦/g), followed by those fed diet 5 (1.40₦/g), those fed diet 4 (1.42 ₦/g), those fed diet 2 (1.46 ₦/g) and those fed the control diet (1.55 ₦/g).

Table 4.1: Effect of Varying Dietary Energy Levels on Growth Performance of Japanese Quail (2-6weeks)

Parameters	Diets					LOS	S.E.M
	1	2	3	4	5		
Initial body weight (g/bird)	41.66	41.66	41.66	41.66	41.66	0.47	0.09
Final body weight (g/bird)	138	134	134	134	132	0.42	0.09
Feed intake (g/bird/day)	15.90[a]	14.58[b]	13.45[c]	13.65[c]	13.19[c]	0.04	9.42
Daily body weight gain (g/bird/day)	2.75[a]	2.64[b]	2.64[b]	2.64[b]	2.58[c]	0.02	10.89
Feed gain ratio	5.78[b]	5.52[b]	5.10[a]	5.17[a]	5.11[a]	0.02	0.40
Feed cost per gain (₦/g)	1.55	1.46	1.37	1.42	1.40	0.24	0.22
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

a,b,c,d,e – mean with similar superscripts are not significantly different ($p>0.05$).

4.1.2 Effect of Varying Dietary Energy Levels on the Heamatological and Serum Biochemistry of Japanese Quails Bird

Haemoglobin concentration (Hb g/dl) and packed cell volume (PCV %) obtained from the blood of quails fed the five dietary treatment did not show any significant different ($p>0.05$). Hb ranged from 23.87 to 36.20 g/dl. Values for PCV ranged from 50.80-54.40 %. However, Red blood cell value (RBC 10^6µl) was lowest for quails fed diet 1 (2.87 10^6µl) while those fed diets 2, 3, 4, and 5 had similar values of 3.53, 3.70, 3.75 and 3.66 (10^6µl), respectively. Mean corpuscular volume (MCV) values were also similar among treatment means. They ranged from 137.70 fl for birds fed diet 3 to 149.90 fl for those fed diet 5.

Mean corpuscular hemoglobin (MCH) of quails fed diet 3 incidentally was the lowest (66.49%) ($P<0.05$) when compared with the values obtained from quails fed diet 1 (71.17%), 4 (73.70%) and 5 (71.83%) respectively. Quails fed diet 2 had similar MCH values (69.85%) with those fed diet 1 and 3 but differed significantly from values obtained for those fed diet 4 and 5 ($P<0.05$). Values obtained for Mean corpuscular hemoglobin concentration (MCHC) from the blood of quails fed diet containing different energy levels did not differ significantly ($P>0.05$). The values ranged from 47.13% for the birds fed diet 1 to 48.23% those fed diet 3.

Table 4.2: Effect of Energy Level on the Haematological and Serum Biochemistry of Japanese Quails Bird

Parameters	Treatments					LOS	SEM
	1	2	3	4	5		
Hb (gm/dl)	23.87	26.30	24.53	36.20	25.43	0.59	1.75
PCV (%)	50.80	54.40	51.00	53.30	53.00	0.90	4.29
RBC(10^6/ul)	2.87^b	3.53^a	3.70^a	3.75^a	3.66^a	0.001	0.10
MCV (fl)	141.01	143.90	137.70	149.70	149.80	0.41	7.19
MCH (%)	71.17^{ab}	69.85^{bc}	66.40^c	73.70^a	71.83^{ab}	0.01	1.64
MCHC (%)	47.13	48.20	48.23	49.20	48.00	0.71	1.44
Albumin	16.67	17.33	17.00	14.67	14.00	0.35	1.90
Globulin	28.70^a	24.00^{ab}	18.70^b	32.00^a	32.00^a	0.02	3.67
Cholesterol	4.47	4.47	5.40	5.93	4.97	0.68	0.22
Total Protein (g/dl)	45.30^{ab}	41.30^b	35.70^c	46.30^a	46.00^a	0.05	4.40

a,b,c,d,e – means with different superscripts on the same row differ significantly ($p<0.05$), LOS = Level of Significance, SEM = Standard Error of Mean Hb = Hemoglobin, PCV = Packed cell volume, RBC = Red Blood Cell, MCV = Mean Corpuscular Volume, MCHC = Mean Corpuscular Hemoglobin Concentration, MCH = Mean Corpuscular Hemoglobin

4.1.3 Effect of Varying Energy Level on Carcass and Organ Characteristics Of Japanese Quails Bird

The effect of the five different dietary energy levels on carcass characteristics and organ weight is shown in table 4.3. Carcass weight of quails fed the experimental diets ranged from 84.90g for those on diets 1, 83.90g for those on diet 2 and 83.00, 79.40 and 78.20g for those on diets 1, 3 and 4, respectively. The values were similar across treatment means. Similarly, dressing percentage for quails fed diet 1 (51.80). Those on diets 2, 3, 4 and 5 had 53.10, 51.60, 49.70 and 47.47, respectively. The values did not differ significantly.

Breast weight of quails fed diet 5 was heaviest 30.99g but similar with those of quails fed diets 1 (28.89g), 4 (27.47g), and 2 (27.30g), respectively. Quails fed 3 had the lowest breast weight (26.38g), thigh weight was similar across treatment means which ranged from 6.87 to 7.76g.

Back weight for quails fed diet 3 (31.70g) was the highest (P<0.05) c0mpared to the back weight of those fed diet 5 (41.30g), 2 (35.40g), 1 (35.60g) and 4 (33.70g) which were statistically similar. Leg weight and wing weights were similar among the quails fed the experimental diets. Values ranged from 2.37 to 2.00g for legs weight and from 6.84 to 7.50g for wing weight.

Only the intestinal length of quails fed diet 2 (48.42mm) was statistically shorter (P<0.05) than the intestinal length of quails fed the other diets, which ranged from 51.83 to 55.78mm which were not significantly different. Although, intestinal weight did not differ significantly (P>0.05) between quails fed the five experimental diets, quails fed diet 4 had 7.07g while those on diets 1, 3, 5 and 2 (6.46, 6.27, 5.60 and 5.38g) respectively.

There was no significant differences (P>0.05) among the values of liver weights, heart weights and gizzard weights respectively. Values of liver weights for quails on the five diets were 3.15, 2.78, 3.86, 2.87 and 2.89g while heart weights 1.39, 1.25, 1.18, 1.28 and 1.37g and gizzard weights values were 4.03, 3.74, 3.77, 3.65 and 3.52g for quails fed diets 1, 2, 3, 4 and 5 respectively.

4.1.4 <u>Effect Varying Dietary Energy Levels on Performance of Japanese Quails Hens During Laying Phase (7-14weeks).</u>

percent charge in body weight of the quails from 7-14 weeks of age (during laying)was 13.09, 13.75, 15.28, 15.35 and 21.98 for quails in treatment groups 3,5,2,4, and 1, respectively the values were not significantly different (P>0.05) between one another. Although values for feed in take varied among quails fed the experimental diets (72.00, 63.30, 53.70, 55.00 and 51.30g/bird/day) for those fed diets 1, 2, 3, 4, and 5, respectively, they were statistically similar. However, better fed conversion ratio (1.93) was obtained for quails fed diet 1 (P<0.05) which significantly differed from values obtained for those fed diet 2 and 3 (2.60 and 2.66) and those fed diet 4 and 5 (2.26 and 2.33). Although FCR values were obtained for quails fed diets 2 and 3 were similar, they differed significantly (P<0.05) from the FCR values obtained for quails fed diets 4 and 5 which were also similar.

Hen day egg production of quails fed diets 1 and 2 (93.33 and 95.55%) differed significantly for those fed diet 3 (75.55%) which was significantly lower than the values obtained for quails fed diets 4 and 5 (84.44 and 88.88%) which were similar (P>0.05) but differed significantly (P<0.05) from value obtained for quails fed diets 1 and 2.

Cost of feed per dozen eggs was higher for quails fed diet 5 (₦ 102.36) followed by those fed diet 4 (₦ 98.04) followed by those fed diet 2 (₦ 83.52) followed by those fed diet 3 (₦ 81.24). The lowest cost of feed per dozen eggs was obtained from quails fed diet 1 (₦ 77.76).

Table 4.3: Effect of Energy Level on the Carcass Characteristics of Japanese Quails

Parameters	1	2	3	4	5	LOS	SEM
Live weight (g)	160.00^{a}	158.30^{a}	154.20^{b}	158.30^{a}	179.20^{a}	0.02	10.64
Carcass weight (g)	83.00	83.90	79.40	78.20	84.90	0.89	8.04
Dressing %	51.80	53.10	51.60	49.70	47.47	0.79	4.85
Breast weight (g)	28.89^{a}	27.30^{a}	26.38^{b}	27.47^{a}	30.99^{a}	0.02	1.66
Thigh weight (g)	7.56	7.40	6.87	7.26	7.76	0.60	0.56
Back weight (g)	35.60^{a}	35.40^{a}	31.70^{b}	33.70^{a}	41.30^{a}	0.05	3.72
Leg weight (g)	2.30	2.01	2.18	2.00	2.37	0.49	0.25
Wing weight (g)	7.42	7.41	7.48	7.50	6.84	0.94	0.88
Intestinal weight (g)	6.46	5.38	6.27	7.07	5.60	0.56	1.08
Intestinal length mm	51.83^{a}	48.42^{b}	54.08^{a}	55.17^{a}	55.78^{a}	0.04	3.07
Gizzard weight (g)	4.03	3.47	3.77	3.65	3.52	0.63	0.39
Heart weight (g)	1.39	1.25	1.18	1.28	1.37	0.49	0.13
Liver weight (g)	3.15	2.78	3.86	2.87	2.89	0.87	1.86
Hind weight (g)	6.72	7.31	7.33	6.65	7.65	0.74	0.87

LOS = Level of Significance
SEM = Standard Error of Mean
a,b,c,d,e means with different superscripts on the same row differ significantly ($p<0.05$)

Table 4.4: Effect of Varying Dietary Energy Levels on Growth Performance of Japanese Quail (7-14weeks)

Parameters	Diets					LOS	S.E.M
	1	2	3	4	5		
Initial weight (g/bird)	132	134	134	134	138	0.02	452.40
Final weight (g/bird)	169.20	158.30	154.20	158.30	160.0	0.02	10.64
Percentage change in weight	21.98	15.28	13.09	15.35	13.75	0.06	0.46
Feed intake (g/bird/day)	72.00	63.30	53.70	55.00	51.30	0.47	9.42
Feed conversion ratio (Feed:Egg)	1.93[a]	2.60[c]	2.66[c]	2.26[b]	2.33[b]	0.03	0.11
Hen-day egg production (%)	93.33[a]	95.55[a]	75.55[c]	84.44[b]	88.88[b]	0.04	8.42
Hen-House egg production (%)	94.55	96.65	77.25	86.25	89.88	0.48	9.41
Feed cost per dozen egg (₦)	77.76[b]	83.52[b]	81.24[b]	98.04[a]	102.36[a]	0.08	0.23

a,b,c,d,e – mean with different superscripts on the same row differ significantly ($p<0.05$)

4.1.5 Effect of Varying Dietary Energy Level on Egg Quality Parameters of Japanese Quails Hens

The age at which the quails laid their first egg was 50 days those fed diet 5, 48 days for those fed diet 2, 44 days for those fed diet 4 and 42 days for those fed diet 3 and 1, respectively as shown in Table 4.5. The values were not significantly different (P>0.05). Similarly, the number of eggs laid during the period of the study ranged from 34 to 43 for quails on diets 3 and 2, respectively (P>0.05). Weight of first egg also did not differ significantly. The values ranged from 7.2g for egg laid by quails fed diet 2 to 8.6g for those fed diet 5.

Average weight of eggs were 9.15, 9.27, 9.01, 9.15 and 8.28g for quails fed diet 1, 2, 3, 4 and 5, respectively, there were significant differences (P<0.05) between the yolk weight of quails fed diet 5 (3.20g) and those fed the other diets 4.49, 5.57, 5.55 and 5.03g for diets 1, 2, 3 and 4 respectively, which were similar. Yolk diameter showed similar trend. Quails on diet 5 had (2.59mm) which was significantly different (P<0.05) from 3.20, 4.13, 3.98 and 3.92mm obtained for quails on diets 1, 2, 3 and 4 which were similar. However yolk height which ranged from 0.71cm for quails on diet 5 to 0.90cm for those on diet 2. The values were statistically similar. Albumen diameter of eggs laid by quail fed the experimental diets were significantly higher (P<0.05) for those fed 1, 4 and 5 (5.01, 4.05 and 5.54mm, respectively) compared to those fed diets 2, and 3 (3.86 and 3.77mm). Albumen weight also showed some significant differences. Values obtained from eggs of quails fed diets l and 5 (3.91 and 3.79g) which were similar, were higher (P<0.05) than values obtained from quails fed diet 3 (2.85g), this value was similar to those obtained for quails on diets 2, 4 and 5 (2.84, 3.01 and 3.79g), respectively. Albumen height did not differ among treatment means; they ranged from 0.33 cm for birds fed diet 1 to 0.35 cm for those on diet 5.

Egg shell weight and egg shell thickness were statistically similar among the birds fed the five experimental diets. Shell weight values were 0.66, 067, 0.68, 0.65 and 0.64g for quails fed diets 1, 2, 3, 4 and 5, respectively. Egg shell thickness ranged from 0.24 to 0.28mm for quails on diet 4 to those on diet 5.

Haugh unit, percent shell and yolk index of eggs analyzed did not show any variation between birds in the treatment groups (P>0.05). Haugh unit ranged from 61.74 for eggs of quails fed diets 2 to 64.74 for those fed diet 5. Percent shell also ranged from 43 for quails fed diets l and 3 to 48 for those fed diet 5. Yolk index values were 0.22 for quails on diets 2 and 4, 0.21 for those on diet 3, 0.24 for those on diet 4 and 0.27 for those fed diet 5.

Table 4.5: Effect of Energy Level on Egg Quality Parameters of Japanese Quail Hens

Parameters	Treatments					LOS	SEM
	1	2	3	4	5		
Age at first egg (days)		138	132	134	150	0.20	0.17
Weight of first egg (g)	8.4	7.2	7.6	8.4	8.6	0.64	0.21
Number of Eggs	42	43	34	38	40	0.34	0.18
Egg weight (g)	9.15	9.27	9.01	9.15	8.28	0.04	0.12
Yolk weight(g)	4.49[a]	5.57[a]	5.55[a]	5.03[a]	3.20[b]	0.01	0.57
Yolk diameter (mm)	3.20[a]	4.13[a]	3.98[a]	3.92[a]	2.59[b]	0.09	0.56
Yolk width (cm)	0.77	0.90	0.83	0.85	0.71	0.40	0.10
Yolk index (mm)	0.24	0.22	0.21	0.22	0.27	0.06	0.14
Haugh unit (%)	61.99	61.74	63.39	63.36	64.74	1.48	3.50
Albumin weight (g)	3.91[a]	2.84[bc]	2.58[c]	3.01[abc]	3.79[ab]	0.05	0.45
Albumin diameter (mm)	5.01[a]	3.86[b]	3.77[b]	4.05[ab]	5.54[a]	0.04	0.69
Albumin height(cm)	0.33	0.34	0.34	0.34	0.35	0.95	0.02
Shell weight(g)	0.66	0.67	0.68	0.65	0.64	0.91	0.04
Shell thickness(mm)	0.25	0.26	0.25	0.24	0.28	0.11	0.01
Shell (%)	43	46	44	43	48	0.12	0.05

LOS = Level of Significance SEM = Standard Error of Mean.
a,b,c,d,e – mean with different superscripts on the same row differ significantly ($p<0.05$)

4.2 DISCUSSION

4.2.1 Effect of Varying Dietary Energy Levels on Growth Performance of Japanese Quail (2-6weeks)

The feed intake values for Japanese quails in this study were within the range reported by Ekin and Oruwari (2007), when they fed quails corn meal and oil based diet. The higher feed intake by quail birds on diet 1 could be as a result of the low dietary energy content. It would be observed that feed intake values of the birds progressively decrease as the energy density of the diets increased. This justified the fact that poultry generally consume diet to satisfy their energy needs.

Daily weight gain during this period ranged from 2.64 to 2.75g/day/quail. This is in disagreement with the value of 4.9g/day/quail reported by Ozbey *et al*. (2006). Quail birds fed diet 1 had higher body weight. This agreed with the finding of Umoren and Ojo, (2007), who confirmed that maize was the best energy source with diet of growing rabbits in their study with cassava, cocoyam and jacinia naanni. Earlier, Petersen, (1969) had reported that maize promoted better growth rate than guinea corn, oats or barley.

4.2.2 Effect of Varying Dietary Energy Level on the Heamatological and Serum Biochemistryof Japanese Quails

Heamoglobin, pack cell volume (PVC), mean corpuscular heamoglobin concentration (MCHC), mean corpuscular volume (MCV), albumen and cholesterol were not significantly affected by the energy level. Red blood cell (RBC), mean corpuscular heamoglobin (MCH), globulin and total protein were however affected by energy levels. This is in conformity with the report of Adamu *et al.* (2006) who observed that nutrition had significant effect on heamatological values like packed cell volume (PCV) heamoglobin (Hb) and red blood cell (RBC). Campbell (1988) reported Hb value of 12.0 to 15.2gm/dl and PCV (3.8 to 5.5 x 10^6/ul) for healthy quails, this is not in agreement with the Hb value of birds fed all the dietary treatment which fell above the normal range since the diets did not contain such factors the parameters could be greater.

Higher value for RBC count in this trial could be attributed to the fast growth rate of quails, this agreed with the finding of Bayyari *et al.* (1997) and Maxwell, (1993) who reported significant increase in RBC in turkey and fast growing chickens, respectively. While Brown *et al.* (2000) opined that increased RBC values are associated with high quality dietary protein and with disease free animals. The MCV value recorded across the dietary treatment ranged (78 to 101fl) as reported by Campbell, (1988), that the significant increase in the value of MCV observed may be due to accelerated erythropoiesis that significantly increased the demand for iron during heamoglobin formation (Oluwasanmi and Temitayo, 2014).

4.2.3 Effect of Varying Dietary Energy Levels on Carcass and Organs Characteristics of Japanese Quails

Live weight, breast weight, back weight and intestinal length were significantly affected by the energy level. The live weight values in diet support the report of Garba (2005), that high dietary energy level significantly increase live weight; birds fed diet 5 had heavier live weight than those fed diet 3. The same conclusion was reached by Oluyemi and Roberts (2000), who stated that French guinea fowl broilers fed 3100 and 3150kcal/kg ME diet exhibited significantly greater live weight gained than those fed 3050kcal/kg ME.

The value obtained for dressing percentage in this study were statistically similar (47.43 to 53.10%) and were lower than (65.43 to 70.43%) reported by Adesiji *et al.* (2012). This could be due to slaughter differences. The result of live weight and carcass weight is in agreement with the finding of Hazim *et al.* (2011) who observed effect of different fat on carcass traits of Japanese quails.

This is in agreement with the finding of Rao *et al.* (2005) who study performance, serum lipid profile and immune competence of broiler fed granded levels of finger millet and found significant difference for kidney, gizzard and spleen weight. This is also agreed with the finding of Rama Rao *et al.* (2004) who reported significant difference in relative weight of spleen weight as influenced by variations in different energy sources.

Dressing percentage, liver weight and heart weight were not significantly influenced by the dietary treatment, this is in conformity with the result of Bai, (2012) who reported no significant in carcass yield and abdominal fat percentage of broiler when normal maize was replaced by quality protein maize, this is also in conformity with the finding of the Rama Rao *et al*. (2004) who reported that the relative weight and length of intestine were not significantly affected by variation in dietary energy levels.

4.2.4 Effect of Varying Dietary Energy Levels on Performance of Japanese Quails Hen (7-14weeks)

All birds on the varying dietary energy levels started to lay by the 6^{th} week of age, which confirmed the reports of Martins, (1987). There were no significant ($p > 0.05$) differences in feed intake across the dietary levels. This may be attributed to the ability of quails to adjust feed intake with time over a wide range of dietary energy content (Olubamiwa *et al*., 1999). Daily feed intake in this study which ranged from 51.30 – 72g/day/quail was in contrast with the finding of Ani *et al*. (2009) who reported an average daily feed intake of 20 – 25g/day for Japanese quails. Animal feed intake varies with many factors such as their age (Almeida *et al*., 2002), feed chemical composition (Verdelhan, 2006) and the ambient temperature (Lebas, 2004).

Varying dietary energy level had significant effect on Hen-day egg and Hen-housed egg production among the treatment groups. Hen-day Egg production showed that quail birds fed diet 2 performed best while those fed diets 1, 4 and 5 performed better than those on diet 3. The hen day production value ranged between 75.55 -95.55 percent which is considerable higher than the value reported by Olubamiwa *et al.* (1999). The observed improvement in hen-day egg production and hen-housed egg production for quails on diet 2 could be attributed to the enhanced quality of diet. It has been postulated that there is an inverse relationship between egg weight and egg number, the longer the egg size, the lower the egg number (Odunsi *et al.,* 2002).

4.2.5 Effect of Varying Dietary Energy Levels on Internal and External Egg Quality Characteristics of Japanese Quails

Statistical analysis revealed that there were no significant ($p< 0.05$) differences between the diets with respect to egg weight, albumen height, and egg shell thickness. Bawa *et al.* (2011) reported that egg mass or weight can be used as a criterion in assessment of nutritional status, especially if they are obtained from birds of the same age, breed and health status. Akinwunmi *et al.* (2011) reported that weight of initial egg of quails ranged from 9.3 to 10.2g/egg. This result is similar to the average egg weight of this study but differed from that reported by Bawa *et al.* (2011) which is about 10g. About 8% of the body weight of quail hen also differs from the report of Elnaga and Abd-Elhady, (2009), who reported an average body weight of about 10.8g. The low egg weight in this study may be due to environmental factors and parental average body weight (Yakubu *et al.*, 2008). Higher values were observed for shell thickness than those (0.18 – 0.19mm) reported by Odunsi *et al.* (2007) there were no significant ($p>0.05$) differences in shell thickness across the dietary treatments while higher mineral content in maize impacted positively on shell thickness and shell weight.

Hough unit percentage in this study ranged from 61.74 to 64.74 percentages which is lower than the minimum of 75 percent recommended for excellent quality egg, Babangida and Ubosi, (2006). The lower haugh percentage across the dietary treatment could be attributed to be finding of Panigrahi *et al.* (1989), who reported that parameters for measuring quality traits of all egg are at maximum when the egg are freshly laid and decrease with increased storage time.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

Two Experiments were conducted to determine the effects of different energy levels on performance and egg quality characteristics of Japanese quail birds. In experiment 1, a total of four hundred and fifty quail birds were randomly allotted to five dietary treatments in a completely randomized arrangement. The birds were further divided into three replicates per treatment with 30 birds per replicate. Each treatment was assigned to one of the following test diets, diet 1: 2800kcal/kg ME, diet 2: 2900kcal/kg ME, diet 3: 3000kcal/kg ME, diet 4: 3100kcal/kg ME and diet 5: 3200kcal/kg ME, respectively. The Total feed intake of birds fed diet 1 was significantly ($P < 0.05$) higher than birds fed other diets. Birds fed diets 3, 4 and 5 were statistically ($P > 0.05$) similar. Dietary energy levels did not affect final weight of the birds across the treatment groups. The haemoglobin, PCV, MCHC, MCV, Albumin and Cholesterol were not significantly ($P > 0.05$) affected by the energy level. RBC, MCH, Globulin and Total protein were significantly ($P < 0.05$) affected by energy level. In Experiment 2, a total of two hundred and twenty five (225) 6 week old quails birds were randomly allotted to five dietary treatments in a completely randomize arrangement and fed the same energy content as in experiment one. Albumin diameter, albumin weight, shell thickness, yolk diameter and yolk weight were significantly ($P < 0.05$) affected by the energy level. The higher final weight recorded for birds fed higher energy level in the first experiment and the effect observed on egg quality parameters in the second experiment indicated that there was no clear difference in pattern of feed consumption with energy level in the diets, since the weight gain of the birds were not equally affected, therefore, it can be concluded that maximum average gain and feed conversion in Japanese quails were achieved at 2900 kcal/kg metabolizable energy.

5.2 CONCLUSION

It was concluded that performance and egg quality were better at 2900kcal/kg ME layer birds gain more weight at higher dietary energy level. Therefore, diet 2 had the best performance among the 5 dietary energy levels in the study area.

5.3 RECOMMENDATION

From the study the following recommendations were made:

1. Dietary energy level of 2900kcal/ME is recommended to achieve maximum weight gain and feed conversion ratio in Japanese quails
2. Energy level of 2900kcal/ME is recommended for maximum egg production and egg quality performance.
3. Further studies under different season of the year should be conducted.

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