EFFECT OF AGE AND EGG SIZE OF JAPANESE QUAIL HENS ON HATCHABILITY AND POST HATCH PERFORMANCE OF QUAIL CHICKS FED DIFFERENT DIETARY PROTEIN LEVELS

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DECLARATION

I hereby declare that this thesis "Effect of Age and Egg size of Japanese Quail Hens on Hatchability and Post-hatch Performance of Quail Chicks fed different Dietary Protein Levels" has been written by me in the Department of Animal Science, Ahmadu Bello University, under the supervision of Prof. G.S Bawa, Dr. T.S Olugbemi and Prof. G.N Akpa. The information derived from the literature has been duly acknowledged in the text and the list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

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Ajide, Solomon Olusoji Date

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CERTIFICATION

This thesis entitled "**EFFECT OF AGE AND EGG SIZE OF JAPANESE QUAIL HENS ON HATCHABILITY AND POST HATCH PERFORMANCE OF QUAIL CHICKS FED DIFFERENT DIETARY PROTEIN LEVELS**" by **AJIDE SOLOMON OLUSOJI** meets the regulations governing the award of the degree of Master of Science in Animal Science of Ahmadu Bello University, Zaria, Nigeria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to the Omnipotent Almighty God for the Grace He bestowed on me in the course of my Masters degree programme and to my dear parents, Chief & Mrs T.S. Ajide and my siblings, Wole, Femi, Funmi and Rotimi for their financial support, incessant prayers, encouragement and moral support.

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ABSTRACT

Two experiments were conducted to determine the effect of age and egg size of Japanese quail hens on hatchability and effect of chick size and protein level on post hatch performance of quail chicks. In the first experiment, the relationship between age with egg size, egg number, hen day production and the subsequent effect of age and egg size on hatchability were determined. Eggs were collected on daily basis for a period of 12 weeks from a total of 211 Japanese quail hens and were marked, weighed with a sensitive electronic scale and sorted into three egg size categories on the basis of small (<9g), medium (9-10g) and large (>10g) to determine the effect of age on egg size, egg number of various sizes and hen day production. Fertile eggs were further collected within the last week of each month when Japanese quail hens were 9, 13, and 17 weeks old to determine the effect of age and egg size on hatchability of the three categories of egg sizes. It was observed that age had significant ($P<0.05$) effects on average egg size, egg number of various sizes and hen day production. There were significant differences ($P<0.05$) in percent fertility, percent hatch, percent dead in shell, percent infertile eggs, chick weight and percent survival. The differences observed for percent hatchability were not statistically ($P> 0.05$) significant, however mean percent hatchability of 69.58% was obtained for medium sized eggs with similar values of 65.95% and 65.74% for large and small sized eggs at the ages of 9, 13 and 17 weeks, respectively. In Experiment 2, the effect of chick size and dietary protein on post hatch performance of Japanese quails was studied. A total of 415 day old unsexed Japanese quail chicks were used for the six weeks growth phase in a completely randomized design of 3 x 3 factorial arrangements. At hatch, quail chicks were grouped according to the various egg sizes of small, medium and large. Chicks from a particular egg weight range constituted a treatment and each

treatment placed on three different dietary protein levels. Birds were assigned into 9 treatment combinations with an average of 45 quail chicks per treatment combination for small, medium, and large sized chicks, respectively. It was observed that, the effect of chick size and dietary protein level had significant ($P<0.05$) effect on the post hatch performance of quail chicks. From this study, the age of Japanese quails had significant ($P<0.05$) effect on egg size, age and egg size subsequently affected percent fertility and hatchability. The final live weights and average daily weight gains were enhanced by the interaction effect of chick size and protein level mostly favouring the large sized chicks and dietary protein level of 28%, while the best feed conversion ratio and cost per gain were obtained in small sized chicks and dietary protein level of 24%. The result of carcass characteristics were not significantly ($P>0.05$) affected by chick size and protein level except for the carcass weight and gizzard that were affected by chick size and liver affected by protein level. A positive correlation exists between egg size and chick hatching weight with subsequent effect on post hatch performance of Japanese quails which were influenced by dietary protein levels.

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CHAPTER ONE

1.0 INTRODUCTION

Commercialization of quail bird production is a recent development in Nigeria. Emphasis has been on other poultry birds, whereas nutritive and economic benefits can also be derived from quail production since the quail is fast growing and resistant to more diseases than the domestic fowl (Oluyemi and Roberts, 2000). The Japanese quail *(Coturnix coturnix japonica*) has the potential to serve as an excellent and cheap source of animal protein for Nigerians (Cooper,1989). According to NRC (1991), quails are precocious and can lay eggs at six weeks old and twenty of them are sufficient to keep an average family on eggs all year round. Other unique characteristics and advantages of the quail over other species of poultry include early attainment of sexual maturity, short generation interval (Robbins, 1981), attaining market weight of 150 – 180grams between 5 - 6 weeks of age and a high rate of egg production of between 180 - 250 eggs per year (Shwartz and Allen, 1981;Garwood and Diehl, 1987). Additionally, quails require less floor space compared to other poultry birds, about 8 -10 adult quails can be reared in a space meant for one adult chicken (Haruna *et al*., 1997). They have less feed requirement and require 20 – 25g of feed per day. Quail meat and egg are of high quality protein with low cholesterol content thereby making it a choice product for hypertension-prone individuals (Haruna *et al.,* 1997 and Olubamiwa *et al.,* 1999).

Little is known about the factors that affect the fertility and hatchability of quail eggs. It has remained for long unresolved the influence of egg size on hatchability and subsequent growth performance of Japanese quail. However, it is expected that many of

the common factors known to influence the incubation success in commercial poultry eggs may likely affect quail egg hatchability (Gonzalez *et al*., 1999).

Nutrition is one of the most important factors required to maintain chicks hatched from different egg sizes. Generally, information on protein requirements of quails in Nigeria is limited. Proteins provide amino acids for tissue growth and egg production. Most of the formulated diets used for feeding quails are based on the NRC recommended allowances meant for temperate regions of the world. Sukerai (1979) reported significant efficiency of feed utilization and egg production when quails were fed 28% to 32% protein level with 3.1 to 3.2 Kcal/g metabolizable energy. Protein values found suitable for raising quails in temperate countries may not be appropriate for quail birds in tropical environments. Also the use of chicken or turkey diets in feeding quails due to lack of adequate information on the nutritional requirements of quails and appropriate diets formulated specifically for quails in the Nigerian livestock feed market is common. The need to generate information on the protein requirement of quail at all phases of growth and production for emerging quail farmers cannot be overemphasized.

In order to improve the performance of these birds, certain base line information/data are needed. This work was therefore aimed at determining the influence of age of Japanese laying quails on egg size, hatchability and post hatching growth of chicks fed varying dietary protein levels.

1.2 Objectives of the study

This study was therefore designed with the following objectives:

1 Determine the relationship between age, egg size and hatchability of egg in Japanese quails.

2 Determine the relationship between egg size, dietary protein levels, post hatch growth of chicks and carcass characteristics of Japanese quails.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Age effects on egg of laying birds

Danilov (2000) observed that egg weight increases with the hen's age, reaching a plateau by the end of the laying cycle. Although egg size and production can be influenced by a number of factors such as improved breeding, increased body weight, composition of feed and nutrition plan, intensity and duration of light, a major factor determining egg size is the age of the bird (Asuquo and Okon, 1993). The average egg weight of a laying flock increases as the birds get older mainly due to physical and physiological changes (Oluyemi and Robert, 1979). The age of hen at lay showed a constant and significant effect on egg weight (Duplessis and Erasmus, 1972). Egahi *et al*. (2011) reported that, the age of the bird had significant effect on weight, length and width of the eggs, similarly haugh unit, yolk, albumen weight and height increased significantly with age of the bird. Joyner *et al*. (2004) reported a close positive relationship between age and egg size while a negative relationship exists between the hens age and egg production. They observed that as the birds advanced in age, the egg production decreased. It is well known that egg mass increases as parental hen flock ages and incubated chick mass gets to its maximum at the end of productive cycle (Barnett *et al.,* 2004; Maiorka *et al*.,2004; Hamidu *et al*., 2007; Sahin *et al.,* 2009).

The egg carrying intensity in Ross hybrid 308 broiler parents was below 50% in the beginning of the productive cycle while the best was obtained between the 29th and 41st week (over 70%) as the birds increased in age (Sreten *et al.*, 2004). Maiorka *et al.* (2004) reported an increase in chick weight of 41.80g and 45.63g in the 30th and 60th week from egg sizes of 53.90g and 65.92g, respectively in hybrid Cobb 500 and Ross 308 broiler

breeder birds as the birds increased in age. All these researches pointed to the fact that, there is a phenotypic correlation between parental flock age in different species of poultry and egg mass as well as with day old chick mass.

Furthermore, hen's age has influence on proportion of yolk, egg white and egg shell in total egg mass (Danilov, 2000; Luquetti *et al.,* 2004). Hen's age also influences chick mass and relative share of chick mass in total egg mass of incubated eggs (Luquetti *et al.,* 2004). Akpa *et al*. (2008) reported an increase in repeatability of egg quality traits with linear increase in age of laying Japanese quails. The age of hens can affect egg solids because egg weight increases with the age of hens (Fletcher *et al.,* 1983). Rossi and Pompei (1995) reported that albumen and yolk average weights and the proportion of yolk in the edible part of the egg increased with hens' age. Akpa *et al*. (2006) reported a general increase in egg traits characteristics with increase in age of Japanese quails.

2.2 Fertility

Fertility is the proportion of eggs that are capable of developing into chicks out of number laid or incubated. Fertility and hatchability performance of eggs depend on genetic, physiological, social and environmental factors (Islam *et al.,* 2002). The fertility of an egg is affected by factors originating from the hen such as her ability to mate successfully, the store of sperm, ovulation rate and availability of a suitable environment for the formation and development of the embryo (Brillard, 2003). Fertility also depends on the cock's ability to mate successfully and the quantity and quality of semen deposited (Brillard, 2003). In all avian species, as well as in other animals in the animal kingdom, increase in age has an adverse effect on reproductive success. The age related decrease in reproduction in the commercial fowl is due, in part, to a decline in egg production,

fertility and hatch ability of fertile eggs. This decline in egg production begins to occur once hens reach their peak in production. The decrease in fertility and hatchability with increasing hen age may be due to a decline in the ability of older hens to retain sperm in special sperm host glands in their oviduct. However, the precise factors that influence or cause the age related decline in reproduction are poorly understood (Bramwell, 2009). These factors which may be from both sexes also seem to be subject to increase in the age of the bird (Hocking and Bernard, 2000; Gumułka and Kapkowska, 2005). A major problem encountered with commercial broiler breeder flocks has been the often dramatic decrease in fertility occuring during the latter part of the laying period, particularly after 50 weeks of age (Kirk *et al.,* 1980; Walsh and Brake, 1997). It has been generally considered that this reduction in fertility was caused by a decline in mating activity that was largely attributable to the heavy weight and poor physical condition of older males (Hocking, 1990).

2.3 Factors affecting fertility

The factors affecting fertility in domestic avian species include:

2.3.1 Mating ratio

Borland (1973) observed that guinea fowl are selective in their choice of breeding partners. They are shy and show reluctance to mate in the presence of human beings. High ratios of females to males results to poor fertility. Mating ratio of fourteen females to one male resulted in 65% fertility compared with 80% when the number was six guinea hens to one male. Gonzalez and Klein (1974) found higher fertility of 92% in flocks where the male to female ratio was 1:5 than in those in which the ratio was 1:3 or

1:7. Oluyemi and Roberts (1979) observed that fertility appeared to depend largely on mating frequency.

2.3.2 Age of birds

Orji and Isu (1983) observed that no fertile eggs were laid in the first 48 hours following the introduction of guinea cocks to the hens, about 50% fertility was obtained on the third day and this rose to a maximum of 100% on the eighth day and was maintained for 30 days. Among the causes of poor fertility and hatchability, Wilson (1993) listed immature males and females, males with abnormal sperm counts and breeding stock more than two years in lay. Many authors (Elibol and Brake 2003 and 2004; Mitrovic *et al*.,2005 and Abiola *et al*.,2008) reported that younger flocks in broiler parents (ages between 29 and 41 weeks) compared with older flocks (ages between 52 and 68 weeks) achieve considerably larger intensity of laying fertilized eggs and thereby larger percentage of new chicks from total number of incubated eggs. A major problem encountered with commercial broiler breeder flocks has been the often dramatic decrease in fertility during the latter part of the laying period, particularly after 50 weeks of age (Kirk *et al.,* 1980; Walsh and Brake, 1997).

2.3.3 Light

Davis *et al*. (1993) reported an increase in egg fertility of breeder Pekin ducks as a consequence of exposure to 16 hours of light daily with a combination of natural day light and artificial light. However, such improvements may not be achieved in countries where there is little seasonal variation in natural day length and without the construction of light- tight houses which require power supply.

2.4 Hatchability

Asuquo and Okon (1993) studied the effects of age in lay and egg size on fertility and hatchability of eggs. The authors observed that egg size within the intermediate range of 45-56g in Anak Broilers would hatch better than small eggs. Gonzalez *et al.* (1999) suggested the setting of eggs of average weight in other to achieve good hatchability. Abiola *et al*. (2008) reported best hatchability result of 96.67% for medium sized eggs. Small chicks are hatched from small eggs while large chicks are hatched from large eggs. Medium sized eggs are preferred in other to obtain good hatchability. Senapati *et al*. (1996) reported positive correlation between egg weight and hatchability. Tullet and Burton (1992) noted that egg weight could be a major determinant of chick weight at hatch. Munir and Mohammed (2010) reported an increase in percent fertility and hatchability of Arbor Acres White and Lohmann Brown hybrid layers between the ages of 24 and 45 weeks followed by a decrease in percent fertility and hatchability when the birds advanced in age between 50-65 weeks.

2.5 Factors affecting hatchability

A number of factors are known to affect the hatchability of domestic avian eggs. These factors include:

2.5.1 Nutrition

Oluyemi and Roberts (1979) listed vitamins B2, B12 and D3 and minerals including calcium, magnesium and iron as being particularly important for good fertility and hatchability. Reduced feed supply however, leads to body weight loss and reduced libido in the male. Deficiencies of vitamins A and E adversely affect spermatogenesis and release of follicle stimulating hormone by the pituitary gland. Embryonic mortality at

days 14 and 15 of incubation was attributed to nutritional defects by Oluyemi and Roberts (1979). Reductions in fertility and hatchability and increased embryonic mortality were reported to be due to mineral imbalance, especially involving manganese (Offiong and Abed, 1980).

2.5.2 Temperature

A constant incubation temperature of 37.8^{o}C is the ideal thermal condition for the chick embryo and gives the best embryo development and hatchability. Mortality is seen if the temperature drops below 35.6^{o}C or rises above 39.4^{o}C for a number of hours. Egg turning during incubation is critical for successful hatching and influences hatchability. No turning of eggs during incubation results in low hatchability and delays hatch by a few days. (King, 2011).

2.5.3 Storage period

Mani *et al.* (2008) reported that length of pre-incubation storage has detrimental effect on hatchability of quail eggs in the sahel area and that quail eggs for incubation should not be stored at room temperature for more than 9 days, even in the coolest season. Hatchability was generally good in eggs stored for 0 to 4 days, fair for those stored for 5 to 9 days, but dropped sharply after storage for 9 days. No egg hatched following pre-incubation storage of over 11 days. Petek *et al.* (2003) recommended that, storage period for quail eggs should not be more than 3 days. Hatchability of White Rock eggs was found to be significantly affected by storage period and incubation position but not by storage position. However, there was a tendency for eggs stored with the small-end-up to hatch better than those with small-end-horizontal. Maximum hatchability was obtained by combining a four day to six day storage period with the small-end-down incubation

position. Oluyemi and George (1972) reported no significant interaction among storage period, storage position and incubation position.

2.5.4 Strain

Ayorinde and Okaeme (1984) reported marked variations in fertility, hatchability and embryonic mortality in local stocks of ash, black, pearl and white guinea fowl as well as among exotic (Golden Sovereign) varieties of guinea fowl. They observed that the pearl gave higher fertility and hatchability than the other varieties with a lower incidence of dead in shell. The effect of egg storage on fertility and hatchability is most severe in Coturnix quail than in Bobwhite quail (Reynnells *et al.,* 1977).

2.6 Factors affecting egg production

Egg number is the major index of performance of commercial layer. It accounts for about 90% of the income in egg production farm (Oluyemi and Roberts 1979). Egg qualities particularly egg size is another important economic trait, it determines to a large extent the price received in any market and standard range should be between 53 and 63 grams (Obioha, 1992). Oluyemi and Roberts (1979) indicated that egg number and quality are affected by some environmental factors such as nutrition, ambient temperature and humidity.

2.6.1 Temperature and Humidity

The maximum temperature associated with satisfactory laying performance of hens is approximately 30^{o}C at a high relative humidity of 75% (Daghir 1995). Gilbert (1980) observed that temperatures between 13^{o}C and 21^{o} are recommended for optimal egg production, though higher temperatures may lead to increased production figures.

Altitude, gaseous environment, humidity and noise may also affect egg production (Gilbert 1980). Egg production is highest when temperatures are within neutrality range (Smith, 1990). Munir and Mohammed (2010) reported that, ambient temperatures above 30^{o}C are considered to have detrimental effect on the performance of laying hens. The authors observed that ambient temperatures of 21^{o}C and 30^{o}C at a high relative humidity of 75% within the poultry house enhanced egg production compared to birds housed in an ambient temperature of 35^{o}C.

2.6.2 Nutrition

Claudia (2009) reported ricket, caged layer fatigue and fatty liver syndrome as nutritional diseases that affect laying hens and account for a high percentage of the flock mortality. Altering the diet by replacing some of the corn with lower energy feedstuff such as wheat bran can help treat fatty liver syndrome. Sauvuer and Picard (1987) reported a decline in egg production and egg weights to be responsible for reduced feed intake resulting from exposure to high environmental temperatures.

2.6.3 Body weight

Lacin *et al*.(2008) studied the effect of initial body weight on laying performance of groups of 24 weeks old Lohman White layers grouped into light (1400-1500g), medium (1500-1600g) and heavy hens (above 1600g). The author observed higher egg production in the light group than those of other weight groups. Duplessis and Erasmus (1972) indicated that larger hens within a bloodline laid larger eggs than those with smaller body weights.

2.7 Effect of Egg weight on Post-hatch growth

Ayorinde *et al*. (1994) reported that body weight in Guinea fowl keets up to 12 weeks of age differed when eggs were classified into small, medium and large size. Egg weight was significantly and positively correlated with body weight up to 4 weeks of age and egg weight was found to be reliable for estimating body weight up to 4 weeks only. The weight difference between keets from large, medium and small eggs remained significant up to 12 weeks of age. Keets hatched from large sized eggs are superior in body weight over those hatched from small and medium sized eggs. The superiority of keets hatched from large eggs over the keets hatched from small eggs decreased from 36.3% at hatching to 5.2% at 12 weeks of age while those from medium sized eggs were inferior by 27.8% at day old and only 1.4% at 12 weeks of age. The linear regression of egg weight on post hatch body weights were significant up to 4 weeks of age, Thereafter, the effect of egg size was small and hence egg size cannot be reliably used for estimating body weight (Ayorinde *et al*., 1994). Prodfoot and Hulan (1981) were of the opinion that the size of the hatching egg can influence the body weight of chicks up to slaughter. Given the high correlation between egg weight and final body weight, the economic importance of egg weight is apparent (Wilson, 1991). In contrast, Sinclair *et al.,* (1990) and Pinchasov (1991) indicated that there is a decline in the magnitude of correlation between egg weight and chick body weight with advancement of age of the chick. The advantage of initially higher weight attributable to a larger egg diminishes rapidly after hatching while feed intake is the main factor affecting final body weight (Wyatt *et al*.,1985). Tuft and Jenson (1991) studied the effect of egg weight on chick performance and lipid retention and reported that as egg weight increased, feed efficiency and fat retention of hatched chicks were not affected. Abiola *et al*. (1999) observed that large

birds were superior to small and medium birds in terms of dressing percentage and meat/bone ratio, results observed on other parameters of carcass traits did not show a particular trend. However where carcass traits are of special consideration, the large eggs would be preferred for setting (Abiola *et al*.,1999).

2.8 Effect of Dietary Protein on Post-hatch growth

It is well known that dietary protein level influences the body growth and composition of domestic fowl. Feeding low protein diet depressed the growth in pullets (Hussein *et al.,*1996). In female Japanese quail, Hashiguchi *et al.* (1998) reported that feeding low protein diets lowered body weight at sexual maturity. Annaka *et al*.(1993) and Marks (1993) indicated that body weight gain decreased linearly with decreasing dietary protein level in quail. Lilburn and Myera-Miller (1990) suggested that body fat and protein depositions were increased and decreased, respectively, by decreasing dietary protein level in broiler breeder hen. Kirkpinar and Oguz (1995) stated that feeding low protein diets increased carcass fat content and decreased carcass protein content in female quail. Quails perform better on high protein diet for optimum growth and reproduction (Shim and Vohra, 1984). Shrivastav (1983) conducted a series of experiments with particular reference to protein, energy, calcium and phosphorus requirements for different stages of growth and production of quails. He reported that 27% crude protein up to 3 weeks of age and 24% crude protein from 3 weeks onward gave better growth.

2.9 Effect of dietary protein levels on growth parameters of Japanese quails

Baldini *et al*. (1995) studied the protein requirements of bobwhite quail reared in confinement of battery brooders to eight weeks of age. The author used 20%, 25% and 28% levels of protein and observed that 28% protein level gave the best growth and

livability in quail chicks. Akpan and Nsa (2009) reported that final live weight and average weight gain increased as the level of dietary protein increased in the diet up to 25%. However, Bawa *et al*.(2011) reported that increasing concentration of dietary protein up to 28% in the diet of Japanese quails enhanced the final live weight and average weight gain compared to birds fed lower dietary protein levels of 18%, 20%, 22%, 24% and 26%, respectively.

Haruna *et al*. (1997) reported an increase in feed intake as the level of dietary protein increases in the diet of Japanese quail chicks. Bawa *et al*. (2011) also reported significant increases in feed intake in laying Japanese quails fed 28% dietary protein level compared with birds on 18%, 20%, 22%, 24%, 26% crude protein and attributed it to low level of energy in the diet as birds are expected to consume more of low energy diet in an attempt to meet up their energy requirements. However, Murakarni *et al*. (1993) reported no significant effects of dietary protein levels on feed intake.

Akpan and Nsa (2009) fed Japanese quails with 22%, 23%, 24%, 25%, 26% and 27% dietary protein levels and observed the best feed conversion ratio on birds fed 25% crude protein level, an indication that the birds consumed relatively low feed to gain more weight. The authors recommended dietary protein level of 25% and 2500Kcal /Kg of metabolizable energy in diets of growing Japanese quail birds. Exceeding this level will only increase feed cost without any significant positive effect on the cost of feed per Kg weight gain. However Sukerai (1979) reported significant efficiency of feed utilization and egg production when quails were fed 28% to 32% protein level with 3.1 to 3.2 Kcal/g metabolizable energy. Birds on 19% crude protein laid 3.44% more eggs compared to birds on 15% crude protein, while increasing the dietary protein level also improved the

egg weight and feed conversion ratio of the birds (Rashid *et al*., 2004). Feed conversion ratio was slightly improved by decreasing dietary crude protein in broiler birds from 23% to 20% (Kamran *et al*., 2004).

2.10 Nutrient requirements of Japanese quails

The nutrients that comprise quail diet are water, protein, carbohydrate, fat, minerals and vitamins. The requirements of these nutrients in quail diets are as follows:

2.10.1 Protein

According to Oluyemi and Roberts (1988), protein is useful mainly for synthesis of body tissues and also for egg formation. The authors noted that retardation in growth, poor feathering and vice habits can be traced to protein deficiency in the diets. Feedstuffs differ qualitatively and quantitatively in their amino acid composition. Quail diets consist mainly of plant materials. The most commonly used plant products are maize, soyabean meal, 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. Tom (2011) reported dietary protein requirement of 24% crude protein for quail starter and 18% crude protein for quail finisher, breeders and layers, respectively.

2.10.2 Energy

The amount of feed intake depends upon the metabolizable energy (ME) content of the diet, age of the birds, their reproductive status and the ambient temperatures. An energy requirement of 2,600 to 3,000 kcal ME/kg diet for growing quail has been reported for

temperate regions (Farrell *et al*., 1982), whereas, findings under tropic condition indicated an energy requirement of about 2,800 kcal ME/kg for growing quails and 2,550 kcal ME/kg for laying quails (Shim and Lee, 1982). Though raising the dietary energy levels from 2,600 to 2,800 kcal ME/kg did not influence the gain in weight, it affected significantly the efficiency of feed utilization as the feed consumption was reduced significantly (Shrivastav and Panda, 1982). Shrivastav and Johri (1993) reported 2,750 Kcal/kg metabolizable energy adequate for quail layers and breeders. Olubamiwa *et al*. (1999) observed that dietary energy levels of 2,500-2800 Kcal/kg diet supported optimum performance of growing quail in the tropics while Dafwang (2006) suggested a metabolizable energy of 2,700 kcal/kg for both growing and laying quails. Syed *et al*. (2000) reported optimum performance of Japanese quail on 24% crude protein and 2800 Kcal metabolizable energy.

2.10.3 Vitamins

The principal feature of vitamin A is its function in ensuring adequate growth and its role as 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 produce fewer eggs and eggs produced frequently do 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 synthesis (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 (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.

2.10.4 Minerals

Phosphorus is a key component of the bone, along with calcium. 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).

2.10.5 Water

According to Smith (2005), water functions in the body of animal include; regulation of body temperature, transportation of nutrient and taking part in numerous chemical reactions in the body. Furthermore, 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 temperature in hot weather (Dafwang, 1988). Oluyemi and Roberts (1979) reported that, water consumption increases the amount of feed intake by layers which results in increased egg sizes.

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 Experimental site

The study was conducted in Zaria, at the Poultry Unit of the Animal Science Department, Ahmsadu Bello University, Samaru- Zaria.

According to Akpa *et al*. (2002), Zaria is within the Northern Guinea Savannah zone of Nigeria, latitude $11^{o}12^{1}$ N and longitude $7^{o}\ 33^{1}$ E, at an altitude of 610m above sea level. The climate is relatively dry, with a mean annual rainfall of 700-1400mm, occurring between the months of April and September. The dry season begins around the middle of October, with dry cold weather that ends in February. This is followed by relatively hot, dry weather from March to sometime in April, when the rains begin. The mean minimum and maximum daily temperature is from about 14^{o}C to 24^{o}C during the cool season and from about 19^{o}C to 36^{o}C during the hot season. The relative humidity varies between 19% and 35% in dry season and between 63% and 80% in the wet season.

3.2 Source of Experimental birds

Japanese quails (*Coturnix coturnix japonica*) used for the study were obtained from National Veterinary Research Institute (NVRI) Vom, Plateau state.

3.3 Statistical Analysis

The data generated from the study were analysed using the General Linear Model Procedure of SAS (SAS 1993). Pearson correlation was used to determine the relationship between pre-hatch and post hatch parameters. The pre- hatch parameters were percent fertility, percent hatchability and chick weight while the post-hatch

parameters were final live weight, feed intake, feed conversion ratio and dressing percentage. Least significant difference was used to separate the means between the treatment groups where significant differences were observed.

3.4 Experiment 1: Effects of Age and Egg size on Hatchability

3.4.1 Experimental design

The age of quail hens at 9, 13 and 17 weeks together with egg sizes of small, medium and large were subjected to a 3 x 3 factorial experiment in a completely randomized design.

Egg production pattern of Japanese quails

Correlation and regression analysis were used to determine the relationship between egg size (small, medium, large and the overall average) and egg number on age of quail hens. The relationship between age and egg number of small, medium and large sized eggs were illustrated graphically and also the Hen day production of laying Japanese quail hens.

The data collected in this experiment were analyzed using the following models to determine:

i. The effect of Age on Egg size

$Y_{ij} = \mu + A_i + E_{ij}$

ii. The effect of age and egg size on hatchability

$Y_{ijkl} = \mu + A_i + S_j + (AS)_k + E_{ijkl}$

Where: Y_{ij} or Y_{ijkl} = Response variable (egg size or hatchability) as the case were:

μ = Overall mean

A_i = Effect of i_{th} age of quail hens

S_j = Effect of j_{th} egg size

AS_k = Interaction effect of age of quail hens and egg sizes on hatchability

E_{ijkl} = Random error

3.4.2 Experimental Diet for Experiment 1

Two diets (23% crude protein) were formulated for both growing Japanese quails (3-6 weeks) and laying Japanese quails (6-18 weeks). The diets are presented in Table 3.1 and 3.2 respectively. The Proximate Analysis of experimental diet for laying Japanese quails is presented in Table 3.3

3.4.3 Management of Experimental birds and data collection

The effects of age of Japanese quails on egg size as well as age and egg size on hatchability were determined. Fertile eggs from 211 quail hens at point of lay (6 weeks) were collected on a daily basis for a period of 12 weeks (3months) under the same management conditions and feeding regime with a mating ratio of one male to four females. The eggs collected within the last week of each month at the ages of 9, 13 and 17 weeks were numbered, individually weighed and sorted into small, medium and large eggs. The grading of the experimental eggs were as follows: small sized (<9grams), medium sized/normal sized (9 -10grams) and large sized (>10grams). The size of the eggs and age of the quail hens were considered in a 3 X 3 factorial experiment with three replicates. The age of the birds from point of lay, the number of eggs laid per day and mortality were recorded. The hen day production was also determined. The eggs were set in the incubator for 15 days and hatched on the 18^{th} day. On the 15^{th} day of incubation, the eggs were candled. The number of infertile eggs were counted, recorded and removed, while the fertile eggs were transferred to the hatcher. On the day of hatching, the percent hatch, percent dead in shell and percent infertile eggs were calculated.

Table 3.1:Composition of Experimental Diet for Growing Japanese Quails

Feed ingredient (kg)	
Maize	44.45
Soyabean full fat	25.93
Groundnut cake	12.97
Wheat offal	10.00
Fish meal	3.00
Bone meal	2.55
Limestone	0.55
Salt	0.30
Premix	0.25
Methionine	0.20
Lysine	0.10
Total	100

Calculated Analysis	
Metabolizable energy Kcal/kg	2,921
Crude protein (%)	23.00
Fat (%)	8.37
Crude fibre(%)	4.03
Ash (%)	3.99
Calcium (%)	1.11
Phosphorus	0.88
Lysine	1.27
Methionine	0.75

**Bio-mix premix supplied per kg diet-Vitamin A, 10,000 i.u;Vitamin D_3 2,000.00 i.u; Vitamin E 23,000.00mg; Niacin 27.5mg;Vitamin B_1 1,800mg; Vitamin B_2 50mg; Vitamin B_6 30mg; Vitamin B_{12} 0.015mg; Vitamin K_3 2.00mg; Pantothenic Acid 7,500.00mg; Biotin 0.06mg; Folic Acid 0.75mg; Chlorine Chloride 300.00mg; Cobalt 0.2mg; Copper 30mg; Iodine 1.00mg; Iron 200mg; Manganese 0.04mg; Selenium 0.2mg; Zinc 30mg; Antioxidant 1.25mg.*

Table 3.2: Composition of Experimental Diet for Laying Japanese Quails

Feed ingredient (kg)	
Maize	37.13
Soyabean full fat	26.98
Groundnut cake	13.49
Wheat offal	10.00
Fish meal	3.00
Bone meal	2.50
Limestone	6.10
Salt	0.30
Premix	0.25
Methionine	0.15
Lysine	0.10
Total	100

Calculated Analysis	
Metabolizable energy Kcal/kg	2,718
Crude protein (%)	23.00
Fat (%)	8.32
Crude fibre(%)	3.90
Ash (%)	3.98
Calcium (%)	3.39
Phosphorus	0.95
Lysine	1.29
Methionine	0.70

**Bio-mix premix supplied per kg of diet – Vitamin A, 21.250 i.u; Vitamin D3 3750 i.u; Vitamin E 25mg; Vitamin K_3 2.50mg; Vitamin B_1 3.75mg; Vitamin B_2 11.25mg; Niacin 37.5mg; Vitamin B_6 7.5mg; Vitamin B_{12} 0.0375mg, Pantothenic Acid 11.25mg; Biotin 1.25mg; Folic Acid 1.5mg; Chlorine Chloride 437.5mg; Cobalt 0.5mg; Copper 7.5mg; Iodine 2.5mg; Iron 50.0mg; Manganese 100.00mg; Selenium 0.5mg; Zinc 75mg; Antioxidant 3.125mg.*

Table 3.3 Proximate Analysis of Experimental Diet for Laying Japanese Quails

	Diet
Parameters	23%
Dry matter (%)	92.55
Crude protein (%)	23.19
Crude fibre (%)	4.73
Ether extract (%)	4.85
Ash (%)	12.16
Nitrogen free extract (%)	55.07

Percent fertility and hatchability were calculated as follows:

$$\text{Percent Fertility} = \frac{\text{Number of fertile eggs}}{\text{Total Number of eggs set in the incubator}} \times 100$$

$$\text{Percent Hatchability} = \frac{\text{Number of chicks hatched}}{\text{Number of fertile eggs set in the incubator}} \times 100$$

$$\text{Percent Hatch} = \frac{\text{Number of chicks hatched}}{\text{Total Number of eggs set in the incubator}} \times 100$$

$$\text{Percent dead in shell} = \frac{\text{Number of unhatched fertile eggs}}{\text{Total Number of eggs set in the incubator}} \times 100$$

$$\text{Percent infertile} = \frac{\text{Number of non fertile eggs}}{\text{Total Number of eggs set in the incubator}} \times 100$$

3.5 Experiment 2: Relationship Between Chick size and Dietary Protein Level on Post-hatch Performance in Japanese Quails

3.5.1 Experimental Design

A total of four hundred and fifteen day-old quail chicks were used for the study. At hatch, quail chicks were grouped according to the various egg sizes (small, medium and large eggs). Chicks from a particular egg weight range constituted a treatment and each treatment group was placed on different dietary protein levels (24, 26 and 28%). There were 9 treatment combinations with an average of 45 quail chicks per treatment combination with three replicates each in 3 x 3 factorial arrangement in a completely randomized design.

The model used for the analysis of data generated in this study is shown below:

$Y_{ijkl} = \mu + P_i + S_j + (PS)_k + E_{ijkl}$

Where: Y_{ijkl} = Response variables (Post hatch growth of Japanese quail chicks)

μ= Overall mean

P_i = Effect of i_{th} Protein dietary level

S_j = Effect of j_{th} egg size

PS_k = Interaction effect of Protein level and Egg size on post hatch growth of Japanese quail chicks.

E_{ijkl} = Random error

3.5.2 Experimental Diet for Experiment 2

Three diets of 24%, 26% and 28% levels of crude protein respectively were formulated (Table 3.4). The proximate composition of the experimental diets are presented in Table 3.5

3.5.3 Management of Experimental birds and Data collection

Four hundred and fifteen (415) day old Japanese quail chicks were managed in three tier cages partitioned into 27 units for each of the three categories of chick sizes (small, medium and large) fed with 24, 26 and 28% dietary protein levels, respectively. All the chicks were raised under similar management practices (brooding, lighting, feeding and watering) throughout the six week experimental period except for diets offered. The birds were given feed and water *ad-lib* and weighed weekly. The feed intake and body weight changes were monitored on a weekly basis. From the feed intake and weight gain data, feed conversion ratio and cost per unit weight gain were calculated from the feed intake and weight gain data.

Table 3.4: Composition of Experimental Diets Containing Varying Levels of Dietary Protein for Quail Chicks (Day 1-6 weeks)

	Dietary Protein Levels, %		
Ingredients	24	26	28
Maize	41.60	35.43	29.22
Soya beans full-fat	27.96	32.08	36.21
Groundnut cake	13.99	16.04	18.10
Wheat offal	10.00	10.00	10.00
Fishmeal	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00
Limestone	0.60	0.60	0.60
Common salt	0.30	0.30	0.30
Vitamin premix	0.25	0.25	0.25
Methionine	0.20	0.20	0.20
Lysine	0.10	0.10	0.10
Total	100	100	100
Calculated analysis			
Feed cost/Kg ₦	45.99	46.64	47.29
Crude protein %	24.00	26.00	28.00
Metabolizable energy(kcal/kg)	2,916	2,892	2,868
Crude fibre (%)	4.09	4.21	4.33
Ether extract (%)	8.72	9.40	10.08
Ash	3.74	3.97	4.19
Calcium	1.12	1.13	1.15
Phosphorus (%)	0.89	0.90	0.92
Ca: P	1.26	1.26	1.25
Lysine (%)	1.333	1.45	1.57
Methionine +cysteine(%)	0.76	0.78	0.79

**Bio-mix premix supplied per kg diet-Vitamin A, 10,000 i.u;Vitamin D_3 2,000.00 i.u; Vitamin E 23,000.00mg; Niacin 27.5mg;Vitamin B_1 1,800mg; Vitamin B_2 50mg; Vitamin B_6 30mg; Vitamin B_{12} 0.015mg; Vitamin K_3 2.00mg; Pantothenic Acid 7,500.00mg; Biotin 0.06mg; Folic Acid 0.75mg; Chlorine Chloride 300.00mg; Cobalt 0.2mg; Copper 30mg; Iodine 1.00mg; Iron 200mg; Manganese 0.04mg; Selenium 0.2mg; Zinc 30mg; Antioxidant 1.25mg.*

Table 3.5: Proximate Analysis of Experimental Diets of different Protein levels for Quail Chicks

	D I E T S		
Parameters	24	26	28
Dry Matter (%)	92.12	91.90	91.98
Crude Protein (%)	23.12	25.74	26.98
Crude fibre (%)	4.33	5.04	4.19
Ether extract (%)	4.85	4.63	5.98
Ash (%)	8.36	8.99	9.61
Nitrogen free extract (%)	59.34	55.62	53.25

3.6 Carcass Evaluation

At the end of the six weeks study period, three cocks per treatment combination were randomly selected based on the group average weight and were weighed, slaughtered and eviscerated for carcass evaluation. The birds were fasted for 12 hours before slaughtering, bled and the slaughter weight taken. The birds were defeathered manually using hot water and eviscerated. The Live weight and carcass weight were recorded. The dressing percentage was calculated. Organ weights and the major primal carcass parts were expressed as percentages of the dressed weight.

3.7 Pictures of Japanese quails and Hatchery operations

The pictures of quail hens, egg laying, eggs hatchery processes and chicks hatched are presented in plates i-iv.





Plate i - Japanese quail hens and laying process



Plate ii – Classification of eggs into three sizes ie small, medium and large

Small (< 9g), Medium (9-10g) and Large (>10g)



Plate iii – Hatchery processes



Plate iv – Classification of chicks into large, medium and small

CHAPTER FOUR

4.0 RESULTS

4.1 Effect of Age of Japanese Quail hens on Egg size

The range of egg sizes for small, medium, large sized eggs and their averages for the 12 week laying period of Japanese quail hens aged 6 to 17 weeks were 7.69 - 8.58g, 9.39 – 9.59g, 10.33 – 10.80g, respectively. The overall average egg size range of Japanese quails was 9.14 – 9.66g (9.51g). The Pearson correlation between age and egg sizes is presented in Table 4.1. A positive and highly significant ($P< 0.01$) correlation was observed between age of hen on medium and large sized eggs ($r = 0.97$). A significant ($P< 0.05$) and positive correlation was observed between age of hen and small sized eggs ($r = 0.70$). There was a positive and highly significant ($P<0.01$) correlation between the age of Japanese quail hen and the overall averages of small, medium and large sized eggs ($r = 0.87$).

The linear regression relating egg sizes (small, medium, large and their averages) to age of Japanese quail hens are presented in figure 4.1a to 4d. The regression coefficient of egg sizes on age of Japanese quail hens were significant ($P<0.05$), the coefficients of determination for the large and medium sized eggs were high (R^2 =89.60% and 94.40% respectively) while that of small sized eggs that was low (R^2= 49.60%). The coefficient of determination for the overall average of small, medium and large sized eggs was high (R^2 = 75.20%).

The prediction equation of egg sizes from age of hen is presented in Table 4.2. The values obtained for the prediction equation of small, medium, large sized eggs and the

Table 4.1: Pearson Correlation Between Age and Egg Size

	Average size	Small size	Medium size	Large size
Age	0.87**	0.70*	0.97**	0.95**

* - Correlation coefficient is significant at P< 0.05 Level
**- Correlation coefficient is significant at P<0.01 Level

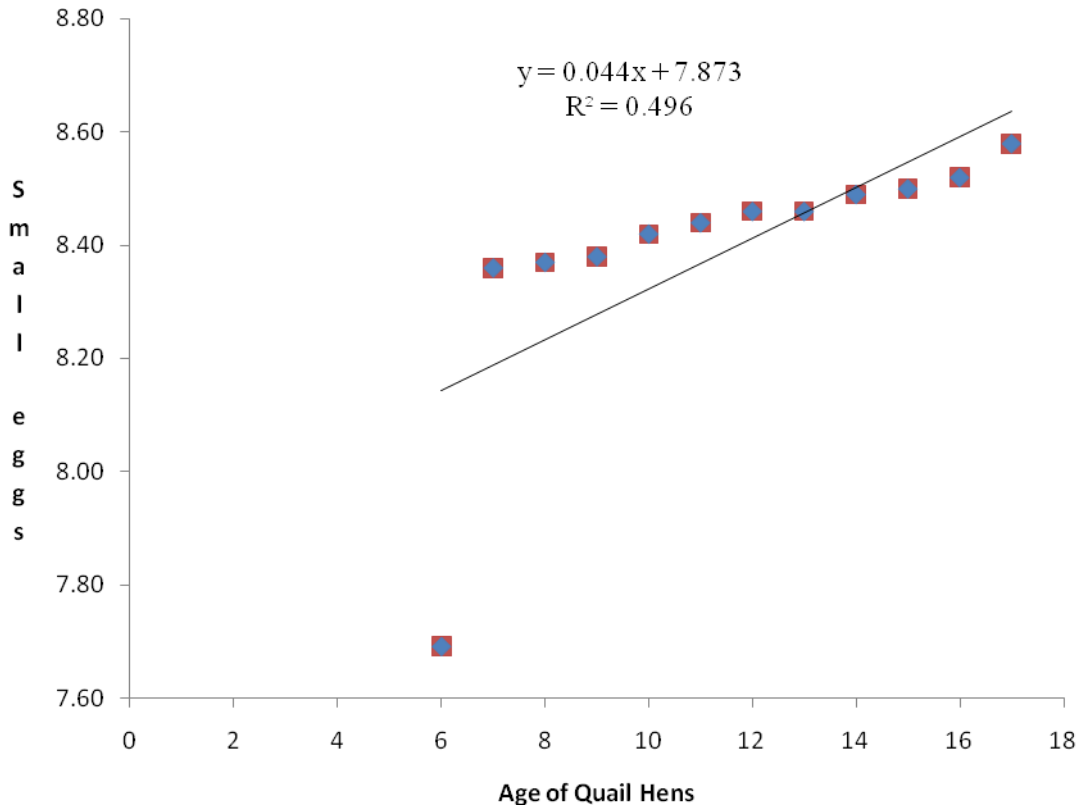


Figure 4.1a: Relationship Between Small sized eggs and Age of Japanese Quail Hens

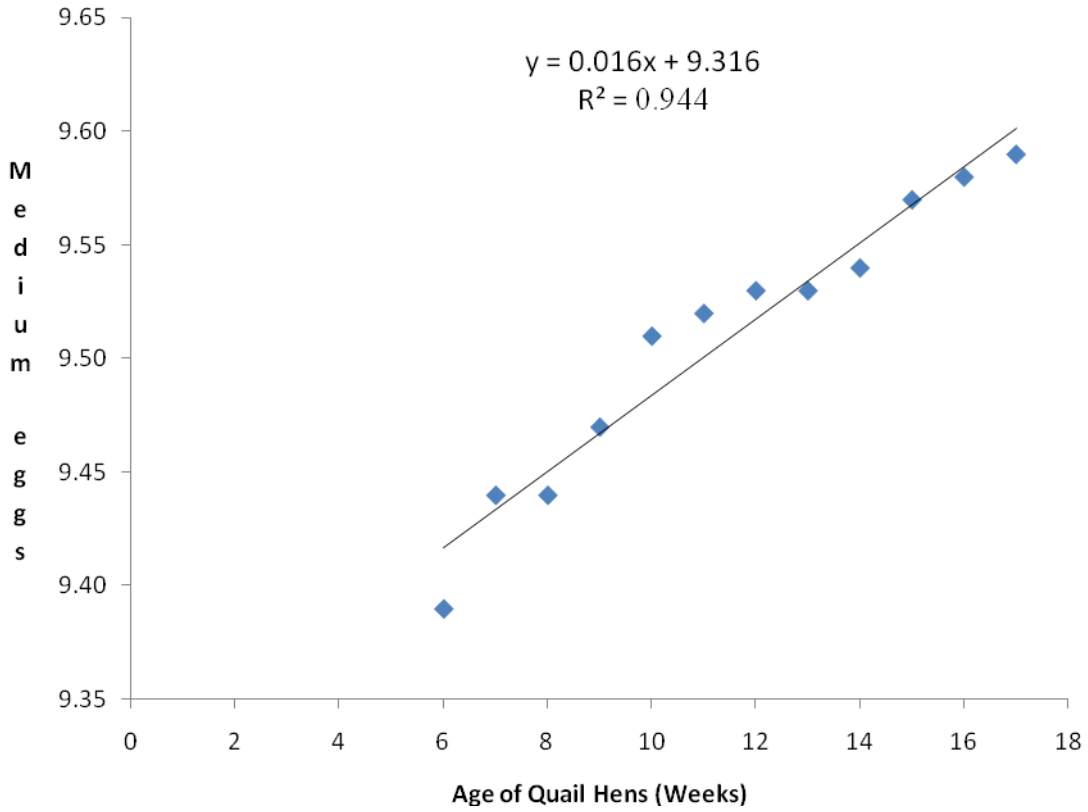


Figure 4.1b: Relationship Between Medium sized eggs and Age of Japanese Quail Hens

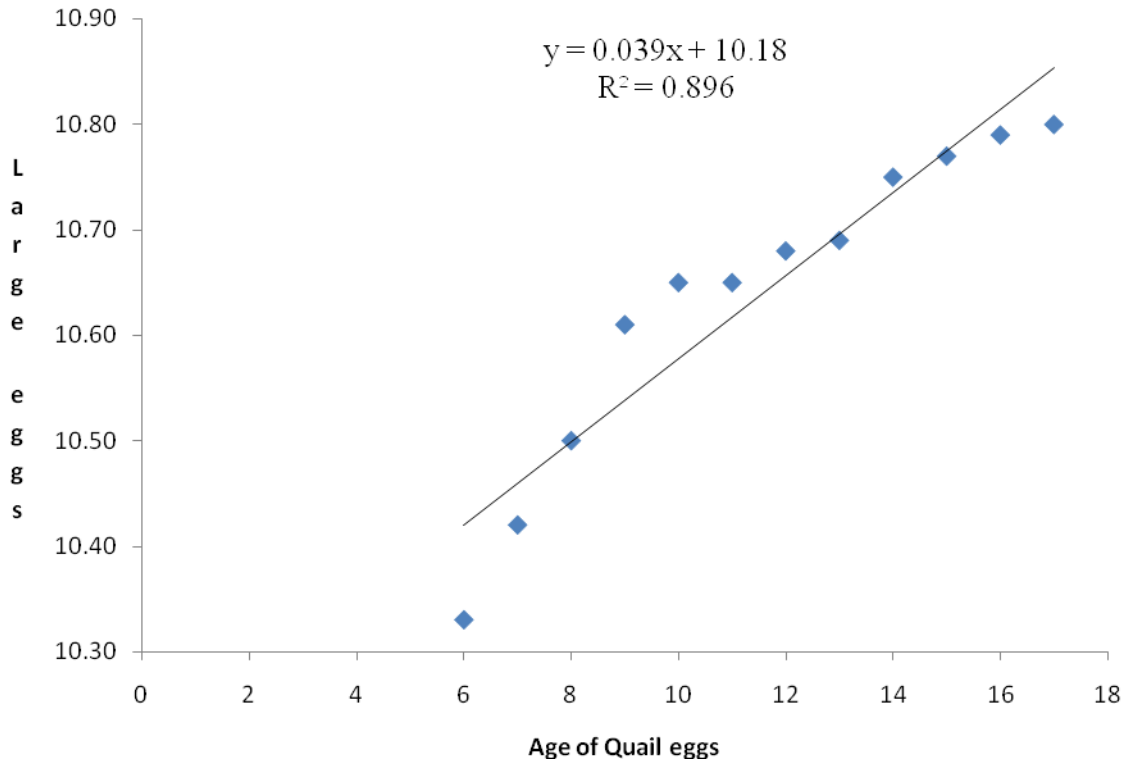


Figure 4.1c: Relationship Between Large sized eggs and Age of Japanese Quail Hens

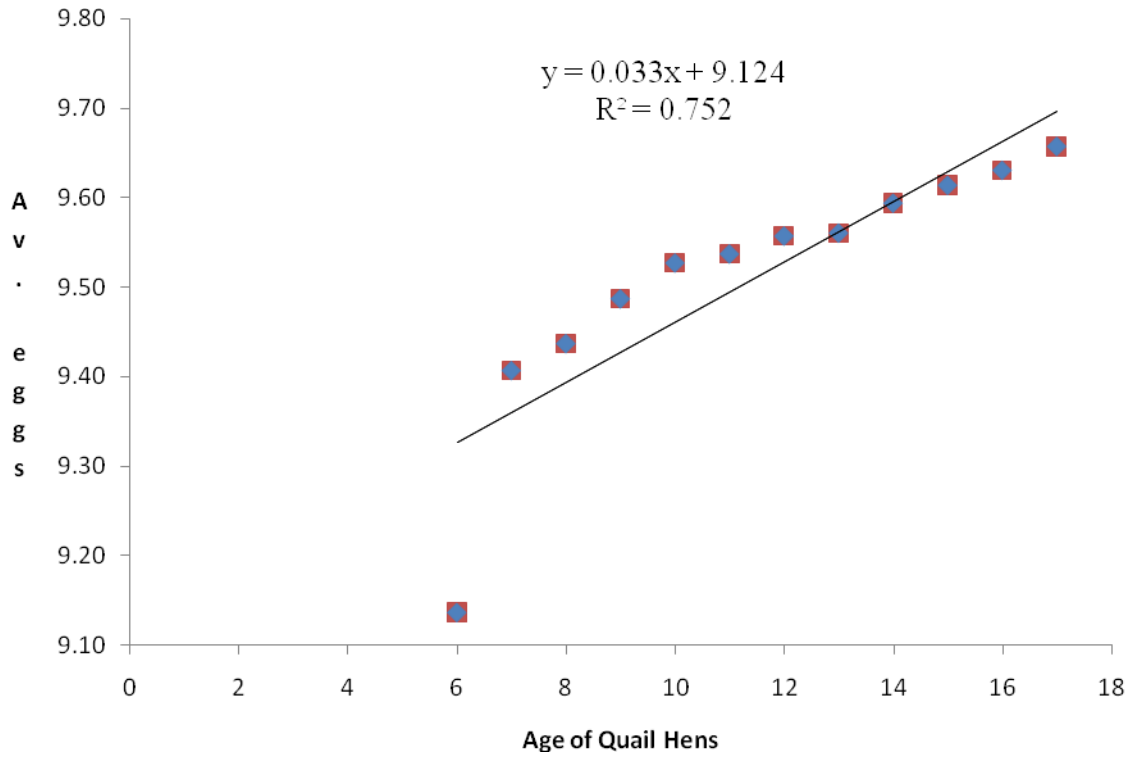


Figure 4.1d: Relationship Between Average egg size and Age of Japanese Quail Hens

Av.: Average

Table 4.2: Prediction Equation of Egg Sizes from Age of Hens

Egg sizes	Prediction Equation	r^2
Large	10.18 + 0.040x	89.60
Medium	9.316 + 0.016x	94.40
Small	7.873 + 0.044x	49.60
Average	9.124 + 0.033x	75.20

x= Age of bird at any week
r^2- Coefficient of determination;
Significance of r^2 ($P<0.05$)

overall averages were 7.8733 + 0.04486x, 9.3166 + 0.0167x, 10.1847 + 0.03364x and 9.1249 + 0.04486x with good prediction estimators (0.496, 0.944, 0.896 and 0.752), respectively.

4.2 Effect of age on egg number and hen day production

The effect of age on the weekly numbers of small, medium and large eggs of Japanese quail hens are presented in figure 4.2. The quail hens attained point of lay at 6 weeks, the initial number of small, medium and large eggs were 33, 21 and 3, respectively. At 7 weeks, the number of small eggs increased to 153 compared to 126 and 36 for medium and large sized eggs. As the birds increased in age at 8 weeks, there was a marked decrease in proportion of small eggs (437) relative to medium eggs (453) which values were higher than large sized eggs (169) and at 9 weeks, the medium and large sized eggs were 632 and 441, respectively, both higher in number than the small sized eggs (241). A peak in egg production was attained when quail hens were 11-15 weeks old and it was expected that as the birds increased in age, the number of small sized eggs would decrease consistently, while the medium and large sized eggs would increase consistently as well. However, there were irregularities in the weekly proportion of small, medium and large sized eggs. At the peak period, the values observed for small sized eggs from 11-15 weeks were 127, 263, 270, 360 and 377, for medium sized eggs were 452, 537, 524, 565 and 564, while for large sized eggs, the numbers were 811, 593, 599, 468 and 452. As the birds aged from 16 to 17 weeks, there was a general decline in the production of all egg sizes. At this age the number of small sized eggs declined from 411 to 274 and 519 to 445 for medium sized eggs. The number of large sized eggs rather increased slightly from 348 to 360. However, the flock averages for the study period were 3,101 (small), 5,352 (medium) and 4,987 (large) eggs.

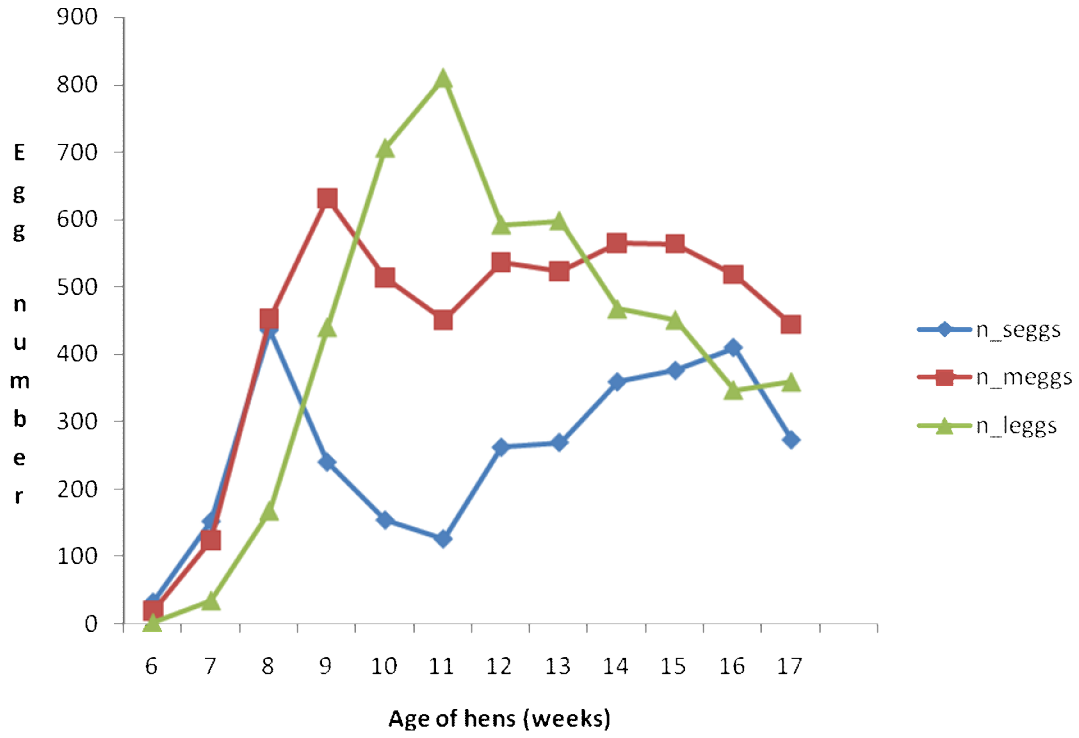


Figure 4.2: The effect of age of hens on proportion of egg sizes of Japanese quails.

n_seggs=number of small sized eggs
n_meggs=number of medium sized eggs
n_leggs=number of large sized eggs

The effect of age on hen day production of Japanese quail hens is presented in figure 4.3. There was an initial hen day production of 3.86% at the 1st week of lay but at the 3rd and 4th week of lay, the hens had attained 72.04% and 89.39% hen day production, respectively. Quail hens reached their peak production 6 weeks after the point of lay with a hen day production of 94.76%. This was maintained up to the 10th week of lay between the age of 11 to 15weeks, thereafter, the hen day production declined to 86.94% and 73.40% at the 11th and 12th week respectively, of lay at the age of 16 and 17 weeks.

The Pearson correlation between age and number of egg sizes and between age and hen day production are presented in Table 4.3. A positive and significant ($P \leq 0.05$) correlation was observed between age of quail hen and number of small sized eggs ($r = 0.57$), the correlation between age and medium sized eggs was significant ($P < 0.05$) and positive ($r = 0.60$), while the correlation between age and number of large sized eggs was not significant ($P > 0.05$) but positive ($r = 0.42$). A significant ($P < 0.05$) and positive correlation was observed between age of hen and hen day production ($r = 0.63$).

4.3 Effect of Age and Egg size on Pre-hatch Performance of Japanese Quails

The effect of age and egg size of Japanese quails on percent hatch, dead in shell, infertile and survival are presented in Table 4.4. Egg size had significant ($P<0.05$) effect on percent hatch, whereas age and the interaction effect of age and egg size had no significant ($P>0.05$) effect on percent hatch. The values observed for effect of age on percent hatch at 9, 13 and 17 weeks were 61.18%, 59.85% and 56.81%, respectively. The values observed for effect of egg size on percent hatch of small, medium and large eggs were 56.44%, 63.14% and 56.81%, respectively. The highest percent hatch was observed for the medium sized eggs followed by the large and small sized eggs that were similar.

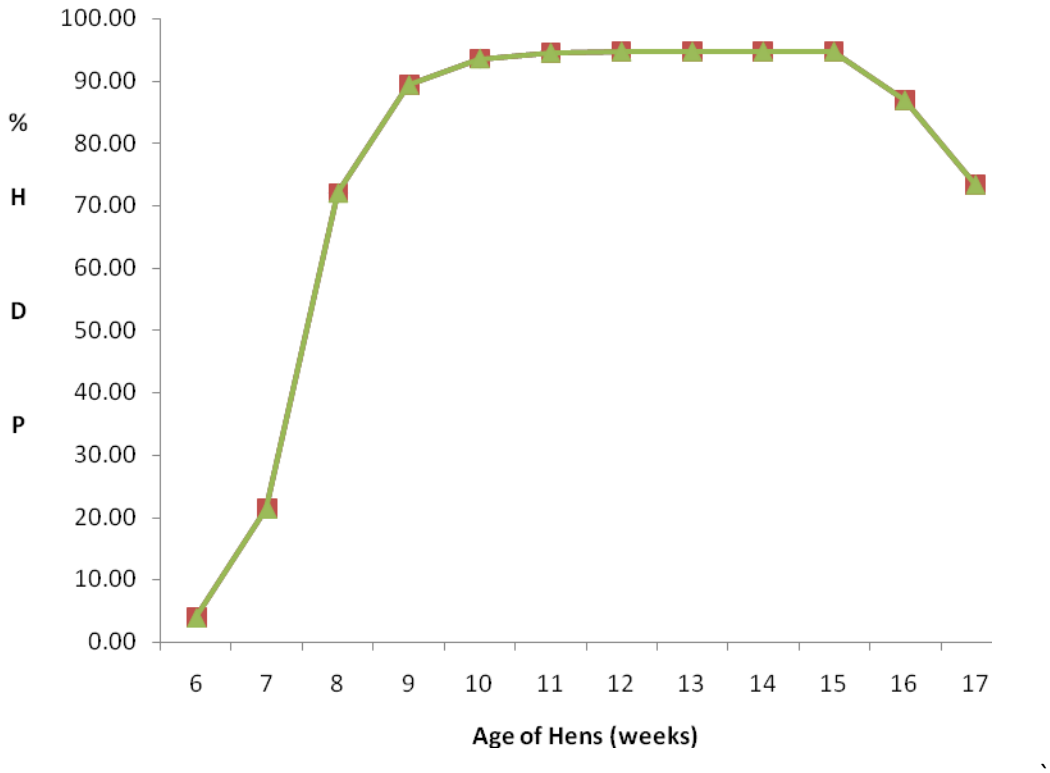


Figure 4.3: Hen Day Production of Japanese Quail Hens

HDP= Hen Day Production

Table 4.3: Pearson Correlation between Age, Egg number and Hen Day Production.

	Small	Medium	Large	HDP
Age	0.57*	0.60*	0.42NS	0.63*

HDP=Hen Day Production
* = Correlation coefficient is significant (P< 0.05)
NS- Correlation coefficient is Non Significant (P>0.05)

Table 4.4: Effect of Age and Egg size size on Percent hatch, Percent dead in shell, Percent infertile and Percent survival of Japanese Quail Hens.

Factor	Percent Hatch	Percent Dead in Shell	Percent Infertile	Percent Survival
Age (weeks)	NS	*	**	**
	LSMeans±SE	LSMeans±SE	LSMeans±SE	LSMeans±SE
9	61.18 ± 1.73	28.74^{b} ± 1.74	10.07^{b} ± 2.07	85.48^{c} ± 0.22
13	59.85 ± 1.73	32.64^{a} ± 1.74	6.91^{b} ± 2.07	88.94^{b} ± 0.22
17	56.81± 1.73	26.11^{b} ± 1.74	17.08^{a} ± 2.07	90.94^{a} ± 0.22
Egg size	*	NS	NS	**
Small	56.44^{b} ± 1.73	29.68 ± 1.74	13.83 ± 2.07	84.33^{c}± 0.22
Medium	63.14^{a} ± 1.73	27.65 ± 1.74	9.15 ± 2.07	86.54^{b} ± 0.22
Large	56.81^{b} ± 1.73	30.16 ± 1.74	11.09 ± 2.07	94.48^{a} ± 0.22
Interaction	LSMeans ± SE	LSMeans ± SE	LSMeans ± SE	LSMeans ± SE
Age X Egg size	NS	NS	NS	**
9 X Small	57.33 ± 3.01	24.89 ± 3.02	17.78 ±3.58	82.17^{e} ± 0.37
9 X Medium	66.22 ± 3.01	27.11 ± 3.02	6.67 ± 3.58	83.89^{d} ± 0.37
9 X Large	60.00± 3.01	34.22 ± 3.02	5.78 ± 3.58	90.37^{b} ± 0.37
13 X Small	57.41 ± 3.01	35.42 ± 3.02	7.04 ± 3.58	85.23^{c} ± 0.37
13 X Medium	63.61± 3.01	29.17 ± 3.02	7.04 ± 3.58	85.54^{c} ± 0.37
13 X Large	58.52± 3.01	33.33 ± 3.02	6.67 ± 3.58	96.06^{a}± 0.37
17 X Small	54.58 ± 3.01	28.75 ± 3.02	16.67 ±3.58	86.25^{c}± 0.37
17 X Medium	59.58 ± 3.01	26.67± 3.02	13.75 ± 3.58	90.20^{c}± 0.37
17 X Large	56.25 ± 3.01	22.92 ± 3.02	20.83± 3.58	97.03^{a} ± 0.37

SE=Standard error;* = P<0.05; ** = P<0.01; ^{a,b,c}Means with different superscript in the column are significantly (P<0.05) different;
NS=Non Significant(P>0.05);%=Percent

The values observed for the interaction effects of age and egg sizes of small, medium and large eggs on percent hatch at the 9th week were; 57.33%, 66.22% and 60.00%, at the 13th week were; 57.41%, 63.61% and 58.52%, while at the 17th week were 54.58%, 59.58% and 56.25%.

Percent dead in shell was significantly ($P<0.05$) affected by age, whereas egg size and the interaction effect of age and egg size had no significant ($P>0.05$) effect on percent dead in shell of Japanese quails. The values observed for effect of age on percent dead in shell at 9, 13 and 17 weeks were 28.74%, 32.64% and 26.11%, respectively. The values observed for effect of egg size on percent dead in shell for small, medium and large sized eggs were 29.68%, 27.65% and 30.16%, respectively. The values observed for the interaction effects of age and egg sizes of small, medium and large eggs on percent dead in shell at the 9th week were; 24.89%, 27.11% and 34.22%, at the 13th week were; 35.42%, 29.17% and 33.33%, while at the 17th week were 28.75%, 26.67% and 22.92%.

Percent infertile was significantly ($P<0.01$) affected by age, whereas egg size and the interaction effect of age and egg size had no significant ($P>0.05$) effect on percent infertile eggs of Japanese quails. The values observed for effect of age on percent infertile at 9, 13 and 17 weeks were 10.07%, 6.91% and 17.08% respectively. The effect of age on percent infertile revealed that percent infertile were lower and similar at the age of 9 and 13 weeks and higher at 17 weeks. The values observed for effect of egg size on percent infertile of small, medium and large sized eggs were 13.83%, 9.15% and 11.09% respectively. The values observed for the interaction effects of age and egg sizes of small, medium and large eggs on percent infertile at the 9th week were; 17.78%, 6.67% and 5.78%, at the 13th week were; 7.04%, 7.04% and 6.67%, while at the 17th week were

16.67%, 13.75% and 20.83%. The pattern in the interaction effect of age and egg size revealed that percent infertile values increased as birds advanced in age.

Percent survival of Japanese quails was highly significantly ($P< 0.01$) affected by egg size, age and the interaction effects of age and egg size. The values observed for effect of age on percent survival at 9, 13 and 17 weeks were 85.48%, 88.94% and 90.94%, respectively. The values observed for effect of egg size on percent survival of small, medium and large sized eggs were 84.33%, 86.54% and 94.48%, respectively. The highest percent survival was obtained in the large sized eggs followed by the medium and small sized eggs, respectively. The values observed for the interaction effects of age and egg sizes of small, medium and large eggs on percent survival at the 9^{th} week were; 82.17%, 83.89% and 90.37%, at the 13^{th} week were; 85.23%, 85.54% and 96.06%, while at the 17^{th} week were 86.25%, 90.20% and 97.03%.

The effect of age and egg size on percent fertility, percent hatchability and chick weight of Japanese quails are presented in Table 4.5. Percent fertility was highly significantly ($P<0.01$) affected by age, whereas egg size and the interaction effect of age and egg size had no significant ($P>0.05$) effect on percent fertility of Japanese quails. The values observed for effect of egg size on percent fertility of small, medium and large sized eggs were 86.13%, 90.79% and 88.83% respectively. The values observed for effect of age on percent fertility at 9, 13 and 17 weeks were 89.93%, 92.90% and 82.92% respectively. The pattern revealed that percent fertility increased, as birds increased in age up to 13 weeks of age and subsequently declined as birds advanced in age, although the values were not significant ($P>0.05$) at the 9^{th} and 13^{th} week, at the 17^{th} week, there was a clear decline in percent fertility. The values obtained for the interaction effects of age and egg

Table 4.5 Effect of Age and Egg size on Percent Fertility, Hatchability and Chick weight of Japanese Quails.

Factor	Fertility %	Hatchability %	Chick weight
Age(weeks)	**	NS	*
	LSMeans±SE	LSMeans±SE	LSMeans±SE
9	89.93[a] ± 2.06	68.15 ± 1.56	6.27[b] ± 0.08
13	92.90[a] ± 2.06	64.45± 1.56	6.52[a] ± 0.08
17	82.92b ± 2.06	68.67± 1.56	6.60[a] ± 0.08
Egg size	NS	NS	**
Small	86.13 ± 2.06	65.74± 1.56	5.77[c] ± 0.08
Medium	90.79 ± 2.06	69.58± 1.56	6.18[b] ± 0.08
Large	88.83 ± 2.06	65.95± 1.56	7.45[a] ± 0.08
Interaction	LSMeans ± SE	LSMeans ± SE	LSMeans ± SE
Age X Egg size	NS	NS	NS
9 X Small	82.22 ± 3.57	69.69 ± 2.72	5.68 ± 0.13
9 X Medium	93.33 ± 3.57	70.97 ± 2.72	6.09 ± 0.13
9 X Large	94.22 ± 3.57	63.80 ± 2.72	7.05 ± 0.13
13 X Small	92.82 ± 3.57	61.84 ± 2.72	5.80 ± 0.13
13 X Medium	92.77 ± 3.57	68.65 ± 2.72	6.16 ± 0.13
13 X Large	93.10 ± 3.57	62.84 ± 2.72	7.59 ± 0.13
17 X Small	83.33 ± 3.57	65.68 ± 2.72	5.82 ± 0.13
17 X Medium	86.25 ± 3.57	69.12 ± 2.72	6.29 ± 0.13
17 X Large	79.17 ± 3.57	71.21 ± 2.72	7.69 ± 0.13

SE=Standard error;* = P< 0.05; ** = P< 0.01; [a,b,c]Means with different superscript in the same column are significantly (P<0.05) different; NS=Non Significant(P> 0.05);%=Percent.

sizes of small, medium and large eggs on percent fertility at the 9th week were; 82.22%, 93.33% and 94.22%, at the 13th week were; 92.82%, 92.77% and 93.10%, while at the 17th week, the values were 83.33%, 86.25% and 79.17%. Percent fertility interaction values were apparently lower at the 17th week compared to the interaction effect of age and egg size at 9th and 13th week.

Percent hatchability were not significantly (P>0.05) affected by age, egg size and the interaction effect of age and egg size. The values obtained for effect of egg size on percent hatchability of small, medium and large sized eggs were 65.74%, 69.58% and 65.95%, respectively. The best hatchability was obtained in the medium sized eggs followed by the small and large sized eggs that were similar. The values obtained for the effect of age on percent hatchability at 9, 13 and 17 weeks were 68.15%, 64.45% and 68.67% respectively, there was an irregular pattern in percent hatchability as birds increased in age, the values were higher at the 9th and 17th week compared to the 13th week. The values obtained for the interaction effects of age and egg sizes of small, medium and large eggs on percent hatchability at the 9th week were; 69.69%, 70.97% and 63.80%, at the 13th week were; 61.84%, 68.65% and 62.84%, while at the 17th week, the values were 65.68%, 69.12% and 71.21%. The range in percent hatchability observed was 61.85-71.21%.

Chick weight was highly significantly (P< 0.01) affected by egg size, age had significant (P< 0.05) effect on chick weight and the interaction effects of age and egg size had no significant (P> 0.05) effect on chick weight. The values observed for effect of egg size on chick weight of small, medium and large sized eggs were 5.77g, 6.18g and 7.45g respectively. The highest chick weight was obtained in the large sized eggs followed by

the medium and small sized eggs respectively. The values observed for effect of age on chick weights at 9, 13 and 17 weeks were 6.27g, 6.52g and 6.60g, respectively. The values observed for the interaction effects of age and egg sizes of small, medium and large eggs on chick weights at the 9th week were; 5.68g, 6.09g and 7.05g, at the 13th week were; 5.80g, 6.16g and 7.59g while at the 17th week were 5.82g, 6.29g and 7.69g. The trend in the interaction effect of age and egg size revealed that as the birds advanced in age, the chick weights were enhanced.

4.4 Effect of Chick size and Protein level on Post-hatch Performance of Japanese Quails

The effects of chick size and protein levels on performance of Japanese quails are presented in Table 4.6. The initial live weights for small, medium and large sized chicks were 5.80g, 6.16g and 7.59g, respectively.

The final live weight of Japanese quails were significantly ($P<0.01$) affected by chick size and protein level. The values observed for the effect of chick size on the final live weights of small, medium and large sized chicks were 139.53g, 142.19g and 146.52g, respectively. The pattern revealed that the final live weights of Japanese quail chicks were enhanced with increase in chick size. The values obtained for the effect of dietary protein levels of 24%, 26% and 28% on the final live weights were 138.54g, 139.57g and 150.14g, respectively. The final live weights increased with increasing protein levels in the diet.

The average daily weight gain of Japanese quail chicks were significantly ($P<0.05$) affected by chick size and highly significantly ($P<0.01$) affected by protein level. The values obtained for the effect of chick size on average daily weight gain of small,

Table 4.6: Effect of Chick Sizes and Protein Levels on the Performance of Japanese Quail Chicks (1-6weeks)

Factor	Inwt(g)	Fnwt(g)	Dwtg (g)	Fi(g)	Fcr	Cost/kg(₦)	Mort (%)	Age_lay (days)	Aeggwt (g)
Chick size		**	*	**	*	*	NS	NS	NS
		LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE
Small	5.80±0.00	139.53^{c}±1.17	3.19^{b}±0.04	12.49^{c}±0.20	3.96^{b}±0.08	184.77^{b}±3.61	1.39±0.94	38±0.00	8.44±0.13
Medium	6.16 ±0.00	142.19^{b}±1.17	3.26^{a}±0.04	13.01^{b}±0.20	3.98^{b} ±0.08	185.59^{b}±3.61	1.80±0.94	38±0.00	8.65±0.13
Large	7.59± 0.00	146.52^{a}±1.17	3.34^{a}±0.04	13.83^{a}±0.20	4.24^{a}±0.08	198.07^{a}±3.61	0.00±0.94	38±0.00	8.39±0.13
Protein level,%		**	**	**	**	**	NS	NS	NS
		LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE
24	-	138.54^{b}±1.17	3.14^{b}±0.04	11.77^{c}±0.20	3.78^{b}±0.08	173.98^{c}±3.61	0.65±0.94	38±0.00	8.30±0.13
26	-	139.57^{b}±1.17	3.22^{b}±0.04	13.10^{b}±0.20	4.12^{a}±0.08	192.01^{b}±3.61	1.53±0.94	38±0.00	8.51±0.13
28	-	150.14^{a}±.1.17	3.42^{a}±0.04	14.45^{a}±0.20	4.28^{a}±0.08	202.44^{a}±3.61	1.01±0.94	38±0.00	8.66±0.13

SE=Standard error;* = P< 0.05; ** = P< 0.01; ^{a,b,c}Means with different superscript in the column are significantly (P<0.05) different; NS=Non Significant(P> 0.05);Inwt=Initialweight(g/bird);Fnwt=Finalweight(g/bird);Dwtg=Weightgain(g/bird/day);Fi=Feedintake(g/bird/day);Fcr=Feed conversion ratio;Cost/Kg=Cost per Kg weight gain;Mort=Mortality;Age_lay=Age at 1st day in lay;Aeggwt=Average egg weight at first day in lay.

medium and large sized chicks were 3.19g, 3.26g and 3.34g, respectively. There was a linear increase in average daily weight gain as chick size increased. The values obtained for the effect of dietary protein levels of 24%, 26% and 28% on the average daily weight gain were 3.14g, 3.22g and 3.42g, respectively. The average daily weight gains increased with increasing protein levels in the diet.

Feed intake per day values were highly significantly ($P<0.01$) affected by chick size and protein level. There was a linear increase in feed intake values per day with higher chick size. The feed intake values per day were 12.49g, 13.01g and 13.83g for small, medium and large sized chicks. There was a linear increase in feed intake per day of Japanese quails as the level of dietary protein increased in the diet. The values obtained for the effect of dietary protein levels of 24%, 26% and 28% on the feed intake of Japanese quails per day were 11.77g, 13.10g and 14.45g, respectively.

The feed conversion ratio of Japanese quails were significantly ($P<0.05$) affected by chick size and highly significantly ($P<0.01$) affected by protein level. The values for feed conversion ratio were higher in the large sized chicks with 4.24 compared with 3.98 and 3.96 obtained for the medium and small sized chicks, respectively. The feed conversion ratio values were 3.78, 4.12 and 4.28 for dietary protein levels of 24%, 26% and 28%, respectively. The feed conversion ratio was better in birds on lower dietary protein (24%) levels.

The cost per kg weight gain of Japanese quails were significantly ($P<0.05$) affected by chick size and highly significantly ($P<0.01$) affected by protein level. The cost per gram weight gain increased with higher chick size and the values were ₦184.77, ₦185.59 and

₦198.07 for small, medium and large sized chicks. There was a linear increase in cost per kg weight gain of Japanese quails as the level of dietary protein increased in the diet. The values obtained for the effect of dietary protein levels of 24%, 26% and 28% on the cost per kg weight gain were ₦173.98, ₦192.01 and ₦202.44, respectively.

Percent mortality in Japanese quails were not significantly (P>0.05) affected by chick size and protein level. The values obtained for effect of chick size on percent mortality of small, medium and large chicks were 1.39%, 1.80% and 0.00%, respectively. The effects of dietary protein levels of 24%, 26% and 28% on percent mortality were 0.65%, 1.53% and 1.01%, respectively.

The age at first day in lay of Japanese quails were neither affected by chick size nor protein level as the birds attained first egg in lay at the age of 38days for small, medium and large sized chicks and the same value obtained for dietary protein level of 24%, 26% and 28%, respectively.

The average egg weight at first lay of Japanese quails were not significantly (P>0.05) affected by chick size and protein level. The values obtained for the effect of chick size on the average egg weight at first lay for small, medium and large sized chicks were 8.44g, 8.65g and 8.39g, respectively. The pattern in the average egg weight of Japanese quail chicks were not enhanced with higher chick size. The effect of dietary protein levels of 24%, 26% and 28% on the average egg weight at lay were 8.30g, 8.51g and 8.66g, respectively, though the effect of protein level on the average egg weight was not statistically significant but the average egg weight were enhanced with increasing concentration of dietary protein in the diet.

The interaction effects of chick sizes and protein levels on the performance of Japanese quail chicks are presented in Table 4.7. The final live weights were significantly ($P<0.01$) affected by the interaction effect of chick size and dietary protein levels.

The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on final live weights were 132.11g, 136.29g and 150.20g. For medium sized chicks, the values were 139.42g, 143.45g and 143.71g, while for large sized chicks, the interaction values were 139.80g, 143.01g and 156.77g, respectively. The pattern revealed that the growth of chicks with small initial size were compensated for by very high protein level while chicks with initial bigger size could tolerate lower protein levels without adverse effect on the final live weights as they maintained relative comparative advantage of their enhanced sizes.

The average daily weight gains were significantly ($P<0.05$) affected by the interaction effect of chick size and dietary protein levels. The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on average daily weight gains were 3.01g, 3.12g and 3.43g. For medium sized chicks, the values were 3.24g, 3.27g and 3.28g, while for large sized chicks, the interaction values were 3.15, 3.32 and 3.55g, respectively. The pattern in the interaction effects of chick size and protein levels on the average daily weight gains of Japanese quail chicks were enhanced with increased chick size and increasing dietary protein levels in the diet.

The feed intake per day values were significantly ($P<0.05$) affected by the interaction effect of chick size and dietary protein levels. The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on feed intake per

Table 4.7: Interaction Effects of Chick Sizes and Protein Levels on the Performance of Japanese Quail Chicks (1-6weeks)

Factor	Inwt(g)	Fnwt(g)	Dwtg (g)	Fi(g)	Fcr	Cost/kg(₦)	Mort (%)	Age_lay (days)	Aeggwt (g)
CS X PL		**	*	*	NS	NS	NS	NS	NS
	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE
Small x 24	5.80±0.00	132.11^{e}±2.02	3.01^{d}±0.06	10.52^{e}±0.34	3.54±0.13	162.95±6.25	0.00±1.62	38±0.00	8.07±0.23
Small x 26	5.80±0.00	136.29^{d}±2.02	3.12^{cd}±0.06	12.44^{c}±0.34	4.14±0.13	193.22±6.25	2.22±1.62	38±0.00	8.75±0.23
Small x 28	5.80±0.00	150.20^{b}±2.02	3.43^{ab}±0.06	14.50^{a}±0.34	4.24±0.13	200.64±6.25	1.96±1.62	38±0.00	8.49±0.23
Medium x 24	6.16 ±0.00	139.42^{cd}±2.02	3.24^{c}±0.06	13.10^{bc}±0.34	4.01±0.13	184.27±6.25	0.00±1.62	38±0.00	8.55±0.23
Medium x 26	6.16 ±0.00	143.45^{c}±2.02	3.27^{c}±0.06	14.01^{ab}±0.34	4.28±0.13	199.52±6.25	2.38±1.62	38±0.00	8.43±0.23
Medium x 28	6.16 ±0.00	143.71^{c}±2.02	3.28^{bc}±0.06	14.38^{a}±0.34	4.45±0.13	210.42±6.25	3.03±1.62	38±0.00	8.96±0.23
Large x 24	7.59±0.00	139.80^{cd}±2.02	3.15^{cd}±0.06	11.70^{d}±0.34	3.80±0.13	174.73±6.25	0.00±1.62	38±0.00	8.30±0.23
Large x 26	7.59±0.00	143.01^{c}±2.02	3.32^{b}±0.06	12.86^{c}±0.34	3.93±0.13	183.32±6.25	0.00±1.62	38±0.00	8.36±0.23
Large x 28	7.59±0.00	156.77^{a}±2.02	3.55^{a}±0.06	14.45^{a}±0.34	4.15±0.13	196.27±6.25	0.00±1.62	38±0.00	8.52±0.23

SE=Standard error;* = P< 0.05; ** = P< 0.01; ^{a,b,c}Means with different superscript in the column are significantly (P< 0.05) different;NS=Non Significant(P> 0.05);CS=Chick size;PL=Protein level;Inwt=Initial weight(g/bird);Fnwt=Final weight(g/bird);Dwtg=Weight gain(g/bird/day);Fi=Feed intake(g/bird/day);Fcr=Feed conversion ratio;Cost/Kg = Cost per Kg weight gain;Mort=Mortality;Age_lay=Ageat 1st day in lay;Aeggwt =Average egg weight at day in lay.

day were 10.52g, 12.44g and 14.50g. For medium sized chicks, the values were 13.10g, 14.01g and 14.38g, while for large sized chicks, the interaction values were 11.70g, 12.86g and 14.45g respectively. The pattern in the interaction effects of chick size and protein levels on the feed intake values of Japanese quail chicks were enhanced with bigger chick size and increasing dietary protein levels in the diet.

The feed conversion ratio was not significantly ($P>0.05$) affected by the interaction effect of chick size and dietary protein levels. The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on feed conversion ratio were 3.54, 4.14 and 4.24. For medium sized chicks, the values were 4.01, 4.28 and 4.45, while for large sized chicks, the interaction values were 3.80, 3.93 and 4.15, respectively. The pattern in the interaction effects of chick size and protein levels on feed conversion ratio of Japanese quail chicks were better with smaller chick size and lower dietary protein levels within a particular chick group and dietary protein levels.

The cost per kg weight gain was not significantly ($P>0.05$) affected by the interaction effect of chick size and dietary protein levels. The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on cost per kg weight gain were ₦162.95, ₦193.22 and ₦200.64. For medium sized chicks, the values were ₦184.27, ₦199.52 and ₦210.42, while for large sized chicks, the interaction values were ₦174.73, ₦183.32 and ₦196.27, respectively. The pattern in the interaction effects of chick size and protein levels on the cost per kg weight gain values of Japanese quail chicks were higher with bigger chick size and increasing concentration of dietary protein levels within a particular chick group.

The percent mortality was not significantly (P>0.05) affected by the interaction effect of chick size and dietary protein levels. The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on percent mortality were 0.00%, 2.22% and 1.96%. For medium sized chicks, the values were 0.00%, 2.38% and 3.03%, while for large sized chicks, the interaction values were 0.00%, 0.00 and 0.00%, respectively. The pattern in the interaction effects of chick size and protein levels on percent mortality did not show any relationship between small, medium and large sized chicks as well as dietary protein levels of 24%, 26% and 28%.

The age at first lay was not significantly (P>0.05) affected by the interaction effects of chick size and dietary protein levels. The age at first lay in this study was 38 days irrespective of small, medium and large sized chicks as well as dietary protein levels of 24%, 26% and 28%.

The average egg weight at first lay was not significantly (P>0.05) affected by the interaction effect of chick size and dietary protein levels. The values for the interaction effects of small sized chicks and dietary protein levels of 24%, 26% and 28% on average egg weight at first lay were 8.07g, 8.75g and 8.49g. For medium sized chicks, the values were 8.55g, 8.43 and 8.96, while for large sized chicks, the interaction values were 8.30g, 8.36g and 8.52g, respectively.

The effect of chick size and protein level on the carcass, organ and major anatomical parts of Japanese quails is presented in Table 4.8. The pattern in the carcass characteristics of Japanese quail chicks were not significantly (P>0.05) affected by chick size and protein levels. However carcass values were enhanced by bigger chick size and

Table 4.8: Effect of Chick size and Protein Level on the Carcass, Organ and Major Anatomical Parts of Japanese Quails (1-6 weeks)

Factor	Lvwt(g)	Carwt(g)	Drssn (%)	Heart (%)	Gizzard (%)	Liver (%)	Small Int(cm)	Thigh (%)	Head (%)	Leg (%)
Chick size	NS	*	NS	NS	*	NS	NS	NS	NS	NS
	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE
Small	120.74^{b}±1.08	87.00^{b}±0.83	72.06±0.54	1.26^{b}±0.01	2.65^{b}±0.21	2.18±0.13	61.11±0.27	15.26±0.21	7.21±0.24	3.03±0.03
Medium	120.71^{b} ±1.08	87.44^{b}±0.83	72.46±0.54	1.29^{a}±0.01	3.01^{b}±0.21	2.20±0.03	61.55±0.27	15.49±0.21	7.31±0.24	3.09±0.03
Large	124.03^{a}± 1.08	90.00^{a}±0.83	72.57±0.54	1.28^{a}±0.01	3.44^{a}±0.21	2.24±0.03	61.17±0.27	15.50±0.21	7.65±0.24	3.08±0.03
Protein level,%	NS	NS	NS	NS	NS	*	NS	NS	NS	NS
	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE	LSMean±SE
24	120.60^{b}±1.08	87.22^{b}±0.83	72.31±0.54	1.26±0.01	2.91^{b}±0.21	2.16^{b}±0.03	61.15±0.27	15.29±0.21	7.22±0.24	3.04±0.03
26	121.21^{b}±1.08	88.11^{a}±0.83	72.69±0.54	1.28±0.01	3.07^{a}±0.21	2.20^{b}±0.03	61.30±0.27	15.34±0.21	7.43±0.24	3.08±0.03
28	123.66^{a}±1.08	89.11^{a}±.083	72.08±0.54	1.29±0.01	3.12^{a}±0.21	2.27^{a}±0.03	61.39±0.27	15.61±0.21	7.51±0.24	3.10±0.03

SE=Standard error;*=P< 0.05;^{a,b,c}Means with different superscript in the same column are significantly (P< 0.05) different;NS=Non Significant(P> 0.05);
Lvwt=Live weight(g/bird);Carwt=Carcass weight(g/bird);Drssn=Dressing percentage;Small Int.=Small intestine length.

increasing dietary protein level except for the liver that was affected by protein level, while the carcass weight and gizzard were affected by chick size.

The interaction effect of chick size and protein level on the carcass characteristics of Japanese quails is presented in Table 4.9. The live weight, carcass weight and dressing percentage were not significantly (P> 0.05) affected by chick size and protein level. The weight of the liver, heart, gizzard, thigh, head, leg expressed as percentage of the carcass weight and intestine length were also not affected by the interaction effect of chick size and protein level.

The result of pre-hatch and post-hatch performance correlations of age and egg size of Japanese quail chick is presented in Table 4.10. Very low but positive correlations (P> 0.05) of 0.06, 0.18 and 0.02 were observed between age and percent hatchability, age and chick weight and age and feed conversion ratio, respectively. A high but negative correlation (P> 0.05) of 0.52 was observed between age and percent fertility. There were low but negative correlations (P> 0.05) of 0.41, 0.16 and 0.31 between age and final live weight, feed intake and dressing percentage. A low but positive correlation (P> 0.05) of 0.02 was observed between egg size and percent hatchability, egg size and percent fertility was 0.14 while a low but negative correlation of 0.22 was observed between egg size and dressing percentage, respectively. There was a high but positive correlation (P< 0.01) of 0.94 between egg size and chick weight. A negative and high correlation (P> 0.05) of 0.52 was observed between percent hatchability and percent fertility. There were low and negative correlations (P> 0.05) of 0.07 to 0.32 between percent hatchability and chick weight, final live weight, feed intake, feed conversion ratio and dressing

Table 4.9:Interaction Effects of Chick Size and Protein Levels on the Carcass, Organ and Major Anatomical Parts of Japanese Quail Chicks (1-6weeks)

Factor	Lvwt(g)	Carwt(g)	Drssn (%)	Heart (%)	Gizzard (%)	Liver (%)	Small Int(cm)	Thigh (%)	Head (%)	Leg (%)
CS X PL	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Small X 24	119.33^{b}±1.87	86.33^{c}±1.48	72.35±0.95	1.21^{b}±0.02	2.32^{b}±0.36	2.13^{b}±0.04	61.00±0.48	14.79^{b}±0.36	6.85±0.41	2.89^{b}±0.06
Small X 26	120.78^{b}±1.87	87.67^{bc}±1.48	72.59±0.95	1.28^{a}±0.02	2.78^{ab}±0.36	2.17^{b}±0.04	61.24±0.48	15.27^{ab}±0.36	7.50±0.41	3.09^{a}±0.06
Small X 28	122.11^{b}±1.87	87.00^{bc}±1.48	71.25±0.95	1.29^{a}±0.02	2.86^{ab}±0.36	2.25^{a}±0.04	61.10±0.48	15.70^{a}±0.36	7.29±0.41	3.11^{a}±0.06
Medium X 24	121.36^{b}±1.87	88.00^{bc}±1.48	72.48±0.95	1.28^{a}±0.02	2.99^{ab}±0.36	2.15^{b}±0.04	61.61±0.48	15.73^{a}±0.36	7.57±0.41	3.07^{a}±0.06
Medium X 26	119.11^{b}±1.87	87.33^{bc}±1.48	73.32±0.95	1.29^{a}±0.02	3.00^{ab}±0.36	2.19^{b}±0.04	61.53±0.48	15.37^{ab}±0.36	7.09±0.41	3.12^{a}±0.06
Medium X 28	121.66^{b}±1.87	87.00^{bc}±1.48	71.58±0.95	1.30^{a}±0.02	3.06^{a}±0.36	2.27^{a}±0.04	61.51±0.48	15.38^{ab}±0.36	7.28±0.41	3.09^{a}±0.06
Large X 24	121.11^{b}±1.87	87.33^{bc}±1.48	72.10±0.95	1.28^{a}±0.02	3.42^{a}±0.36	2.19^{b}±0.04	60.83±0.48	15.33^{ab}±0.36	7.25±0.41	3.15^{a}±0.06
Large X 26	123.75^{ab}±1.87	89.33^{b}±1.48	72.18±0.95	1.27^{a}±0.02	3.44^{a}±0.36	2.23^{a}±0.04	61.13±0.48	15.38^{ab}±0.36	7.73±0.41	3.02^{ab}±0.06
Large X 28	127.22^{a}±1.87	93.33^{a}±1.48	73.43±0.95	1.30^{a}±0.02	3.45^{a}±0.36	2.29^{a}±0.04	61.57±0.48	15.78^{a}±0.36	7.99±0.41	3.10^{a}±0.06

CS=Chick size;PL=Protein level;LSM=Least square mean;SE=Standard error;*=P<0.05;^{a,b,c}Means with different superscript in the same column are significantly(P< 0.05)different;NS=Non Significant(P> 0.05);Lvwt=Live weight(g/bird);Carwt=Carcass weight(g/bird);Drssn=Dressing percentage;Small Int.= Small intestine length.

Table 4.10: Pre-hatch and Post-hatch Performance Correlations of Age and Egg size of Japanese Quail Chicks

Parameters	A	ES	PH	PF	CW	FNWT	FI	FCR	DRSSP
Age (A)		0.87^{**}	0.06^{NS}	-0.52^{NS}	0.18^{NS}	-0.41^{NS}	-0.16^{NS}	0.02^{NS}	-0.31^{NS}
Egg size (ES)			0.02^{NS}	0.14^{NS}	0.94^{**}	0.64^{*}	0.81^{**}	0.77^{*}	-0.22^{NS}
Percent Hatchability (PH)				-0.52^{NS}	-0.07^{NS}	-0.15^{NS}	-0.12^{NS}	-0.11^{NS}	-0.32^{NS}
Percent Fertilty (PF)					-0.01^{NS}	0.27^{NS}	0.42^{NS}	0.38^{NS}	0.57^{NS}
Chick Weight (CW)						0.63^{NS}	0.77^{*}	0.73^{*}	-0.43^{NS}
Final Weight (FNWT)							0.78^{*}	0.49^{NS}	0.08^{NS}
Feed Intake (FI)								0.90^{**}	0.01^{NS}
Feed Conversion Ratio (FCR)									-0.06^{NS}
Dressing Percentage (DRSSP)									

NS = Correlation coefficient is not Significant;* =Correlation coefficient is significant at P< 0.05 Level;** = Correlation coefficient is significant at P< 0.01 Level

percentage. There were low and positive correlations (P> 0.05) of 0.27 to 0.57 between percent fertility and final live weight, feed intake, feed conversion ratio and dressing percentage respectively except for the correlation between percent fertility and chick weight that was negative. A positive correlation (P< 0.05) of 0.63 was observed between final live weight and chick weight. Very high and positive correlation (P< 0.05) of 0.77 was observed between chick weight and feed intake and 0.73 was observed between chick weight and feed conversion ratio. A high and positive correlation (P< 0.05) of 0.78 was observed between final live weight and feed intake. Low and positive correlations (P> 0.05) of 0.49 and 0.08 were observed between final live weight and feed conversion ratio, final live weight and dressing percentage, respectively. A highly significant (P< 0.01) correlation of 0.90 was observed between feed intake and feed conversion ratio. The correlation (P> 0.05) between feed conversion ratio and dressing percentage was very low and negative (0.06).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effect of Age of Japanese Quail hens on Egg size

The range of 9.14 - 9.66g for average egg size of Japanese quail observed in this study were similar to the size (9.5g) reported by Babangida and Ubosi (2006).

The significant and positive correlation between age of hen and egg sizes implies that an increase in the age of the bird resulted in increase in egg size. This observation supported by the findings of Olori and Sonaiya (1992) who reported high positive correlation between age of birds, egg weight and egg number. The result also agreed with the findings of Joyner *et al.* (2004) and Ehoche (2010) who reported a close positive relationship between age and egg size. The result shows that age accounted for 87% variation on the average egg size of Japanese quails with only 13% of such variation being attributed to other sources.

The coefficient of determination (R^2) value for the overall average size of small, medium and large quail eggs was 75.20%. The association between age of birds at lay and egg size was high and positive implying that age in lay positively correlated with egg size, hence age of hen could be relied upon as the most important and accurate index for estimating the overall egg size compared to other factors such as feed, environment, temperature, and management of birds which can also influence the size of egg but accounted for 24.80% variation. The University of Florida / Institute of Food Agriculture Science (2003) outlined the factors that may affect egg production in chicken to be age, resistance to disease, light control, quality of feed, temperature, humidity, molting, condition of the laying house and handling. The low coefficient of determination (R^2= 49.60%) observed for small sized eggs compared to R^2 value

of 94.40 and 89.40% observed for medium and large sized eggs respectively, suggest that, most eggs laid by Japanese quail hens fall in the grade of medium and large size as birds advanced in age. Akpa *et al*. (2008) had earlier reported a general increase in egg traits with increase in age of Japanese quail hens. The increase in egg size from small to medium or large as the hens increase in age implies that more income would be realized from the flock. This is in line with the report of Obiora, (1992), that egg qualities particularly egg size is the most important economic trait that determines the market price of eggs.

The prediction equation obtained from the linear regression of egg sizes on age of Japanese quail hens were high, this implies that, the equations are good estimators of the egg sizes of Japanese quails at any given age. This is in line with the findings of Duplessis and Erasmus (1972) that age at lay showed a constant and significant effect on egg weight.

5.2 Effect of age on egg number and hen day production

Higher number of small sized eggs were observed initially at the point of lay compared to medium and large sized eggs. However the number of small sized eggs declined below the number of medium and large sized eggs in the peak period. This was in agreement with the findings of Asuquo and Okon (1993) who reported that as Hyperco white broiler birds advanced in lay, the size of eggs produced increased from small to medium and large. The inconsistency observed in the number of small, medium and large sized eggs at the peak of production could be due to changes in feed and season. The experiment was conducted between the onset (May-June) and peak of the raining season (July-September). Changes in the ambient temperature and relative humidity during the experimental period may have affected the feed intake of birds and caused variation in the proportion of egg sizes. Daghir

(1995) had earlier reported that the maximum temperature associated with satisfactory laying performance of hens is approximately 30^{o}C at a high relative humidity of 75%. It could also be attributed to occasional pause in egg production in an attempt to regain weight by laying birds thereby causing quail hens to lay small, medium or large sized eggs after the resting period. Varyhese (2002) reported that, for quail hens to be under good production, the birds must skip 1-3 days within a week in other to regain body weight.

Flock averages for the study period were 3,101 for small, 5,352 for medium and 4,987 for large sized eggs. The variations observed in the number of small, medium and large eggs were supported by earlier workers (Daspurakayastha,1980 and Kekeocha, 1984). As birds aged in lay, production of small sized eggs significantly ($P< 0.05$) declined, while the proportions of medium and large eggs increased from the 1st to the 6th month in broiler breeders.

The initial hen day production of 3.86% observed in the first week of lay, 72.04% and 89.39% in the 3rd and 4th weeks of lay is contrary to the reports of Kaye (2005) who reported that a week after quail hens started laying, they attained 71% egg production which was maintained to the 10th and 12th week of lay with a peak production of 86%. The peak in hen day production of 94.56% observed six weeks after point of lay in this study is similar to the report of Ehoche (2010), who reported that Japanese quails reached their peak of production 7 weeks from point of lay with 91.86% hen day production. The differences observed for the peak of lay could be as a result of variations in the environments in which the experiments were conducted. The trend in egg production observed in this study followed the egg production curve described by Malau-Aduli *et al*.(2003).

The results showing the correlation between age of quail hen on number of small, medium and large sized eggs showed that age of quail hen is mostly correlated with medium sized eggs compared to small and large sized eggs. The significant ($P< 0.05$) correlation (r value of 0.60) observed between age and medium sized eggs implies that quail hens lay more of medium sized eggs in the flock. The significant ($P \leq 0.05$) correlation (r value of 0.57) observed for small sized eggs, though positive, suggests that the chances of quail hens laying small sized eggs may or may not be continuous in the laying period relative to feed intake, seasonal variations, light duration, body weight and management practices. The low and non significant ($P>0.05$) correlation (r value of 0.42) observed between quail age and large sized eggs implies that good management of laying hens will ensure production of large sized eggs but occurance may not be frequent compared with medium sized eggs.

5.3 Effect of Age and Egg size on Pre-hatch Performance of Japanese Quails

The highest percent hatch observed for the medium sized eggs compared to the large and small sized eggs shows that the medium sized eggs were superior to the small and large sized eggs in percent hatch. This supported the findings of Asuquo and Okon (1993), who reported that egg size within the intermediate range of 45-56g in Anak Broilers would hatch better than small eggs. The effect of age on percent hatch was not significant, this implies that age of quail hens has no relationship with percent hatch and cannot influence it. The highest mean observed in the interaction effect of age and egg size on percent hatch at age 9, 13 and 17 weeks mostly favoured the medium sized eggs (63.13%) followed by the large and small sized eggs with 58.26% and 56.44%, respectively. This implies that percent hatch is only affected by egg size, while age and the interaction effect of age and egg size do not affect percent hatch in birds.

The non significant (P>0.05) effect of egg size on percent dead in shell implies that percent dead in shell is not influenced by egg size, as embryonic mortality, dead germs or dead embryos could occur in eggs without cognizance to the size of the egg and eventually cause death in shell. The observed significant (P<0.05) effect of age on percent dead in shell did not follow any particular trend. The percent dead in shell at the age of 9 and 17 weeks were statistically similar (28.74 and 26.11%) and lower than 32.64% obtained in the 13th week. Although the effect of age on percent dead in shell was significant, it cannot be attributed to age effect as variations in the prevailing weather condition at the time the experiment was conducted might have resulted in dead in shell. Percent dead in shell could also be as a result of eggs deviating from the set positions during turning as force is being exerted on the setting trays, thus preventing the developing embryo from adequate gaseous exchange which could eventually cause death in shell.

The decrease in percent infertile from 10.07% at the 9th week to 6.91% in the 13th week and subsequent increase to 17.08% in the 17th week implies that percent infertile was higher at the onset of sexual maturity, decreases with advancing sexual activity and subsequently increases as birds becomes old. Percent infertile was high in Japanese quails few weeks after the onset of sexual maturity (9 weeks) and as birds increased in age corresponding to the peak in lay (13 weeks), percent infertile declined, probably due to the level of sexual maturity in quails characterized by increased activity of the cocks which enables deposition of adequate number of spermatozoa into the reproductive tract of the female. This may in turn reduce the number of infertile eggs laid. At 17 weeks, sexual activity declines in Japanese quails thus increasing the percent infertile. Wilson (1993) indicated that immature males and females, males with an abnormal sperm count and breeding stock more than two years in lay may be responsible for

low fertility in birds. The precise factors that influence or cause age related decline in reproduction are poorly understood (Bramwell, 2009). The non significant ($P>0.05$) effect of egg size on percent infertile implies that percent infertile is not a function of egg size. The trend in values observed for the interaction effects of age and egg size on percent infertile were not significant. However, percent infertile were apparently high as the birds advanced in age which could be an indication that age of birds is the most important factor that influences percent infertile as it determines the level of sexual activity of the cocks and hens in the flock.

The superiority of percent survival of chicks hatched from large sized eggs compared with medium and small sized eggs could be as a result of better adaptation of the large sized chicks to the environment. The adequate food reserve in the body of the large sized chicks hatched from large eggs could also be due to higher amounts of nutrients that may be available in the larger yolk. This may enhance better viability compared to the medium and small sized chicks. It therefore seems that percent survival is enhanced by increased egg weight. The best result of age effect on percent survival observed at the 17th week followed by the values obtained at the 13^{th} and 9^{th} week respectively implies that an increase in quail age causes an increase in egg weight characterized by supply of more nutrients to the chick's body needed for survival post hatching. The significant ($P<0.05$) effect of age on chick weight may be as a result of the increase in egg size of Japanese quails with increase in age of birds. This agreed with the report of Egahi *et al*.(2011) who indicated significant effect of age of the bird on egg weight. The significant ($P<0.01$) interaction effect of age and egg size on percent survival could be as a result of natural roles of age and egg content on survival of birds. Therefore an increase in the age of quail hens will cause increases in weight of the eggs laid and the resultant chicks thus enhancing adaptability and survival of the chicks post hatching.

The observed significant (P <0.01) effect of age on percent fertility as birds increased in age could be as a result of the increased sexual activity of Japanese quails at the 9th and 13th week while the decrease at the 17th week could be as a result of decreased sexual activity as birds advanced in age. The decrease in percent fertility values observed, as birds advanced in age in the present study is in agreement with the reports of other authors (Kirk *et al.,* 1980; Walsh and Brake, 1997) who in a similar study reported that, the major problem encountered with commercial broiler breeder flocks has been the often dramatic decrease in fertility during the latter part of the laying period, particularly after 50 weeks of age. The pattern observed in percent fertility in this study was also in agreement with the report of Bramwell (2009), that the decrease in fertility and hatchability with increasing hen age may be due to a decline in the ability of older hens to retain sperm in special sperm host glands of the oviduct. They also noted that, in all avian species, as well as in other animals, increasing age has an adverse effect on reproductive performance. The non significant (P>0.05) effect of egg size on percent fertility implies that percent fertility is not influenced by egg size. The non significant (P>0.05) effect of the interaction of age and egg size on percent fertility shows that fertility values were apparently low in all egg sizes as birds advanced in age. This implies that, age of bird may be the important factor that can affect fertility while egg size and the interaction of age and egg size do not influence fertility. In similar studies to buttress the effect of age on fertility, a number of authors (Elibol and Brake 2003 and 2004; Mitrovic *et al*.2005 and Abiola *et al*.2008) reported that younger flocks in broiler parents (aged between 29 and 41 weeks) compared with older flocks (aged between 52 and 68 weeks) achieved considerably higher intensity of laying and produced more fertilized eggs and more chicks from incubated eggs than older hens.

The results of percent hatchability showed that age, egg size and the interaction effect of age and egg size of Japanese quails had no significant (P>0.05) effect on percent hatchability. The pattern in percent hatchability values were irregular with regard to age and contrary to the report of Munir and Mohammed (2010) that percent hatchability in Arbor Acres White and Lohmann Brown hybrid layers increased between the ages of 24 and 45 weeks followed by a decrease in percent hatchability when the birds advanced in age between 50-65 weeks. In the present study, percent hatchability values were similar and higher at the 9th and 17th week and dropped in the 13th week. This suggests that age did not influence percent hatchability but rather by factors such as genetic, physiological, social and environmental factors. Islam *et al.* (2002) had earlier reported that, fertility and hatchability performance of eggs depend on genetic, physiological, social and environmental factors. These factors could affect hatchability at any age of the bird depending on their magnitude and how they were controlled. The higher percent hatchability obtained in the medium sized eggs compared with the small and large sized eggs imply that percent hatchability is being influenced by the size of an egg. Results obtained on hatchability in the present study conform to earlier findings which recommended the setting of average sized eggs for the purpose of incubation. Gonzalez *et al*. (1999) in a related study suggested the setting of eggs of average weight in order to achieve good hatchability. Abiola *et al.* (2008) reported that up to 96.67% hatchability was obtained for medium eggs while large eggs had the lowest value of 82.88% hatchability in broilers. The interaction effects of age and egg size on percent hatchability did not follow a particular trend. The highest mean observed in the interaction effect of age and egg size on percent hatchability at age 9, 13 and 17 weeks mostly favoured the medium sized eggs (69.58%), while large and small sized eggs had lower values (65.95% and 65.73%), respectively. This implies that

percent hatchability is mainly influenced by egg size, while age and the interaction effects of age and egg size do not influence percent hatchability in birds. The percent hatchability range of 61.85%-71.21% obtained for Japanese quails in this study conformed with the range of 68.80% to 70.50% and 62.63 to 71.19% reported by Erakpotobor *et al*. (2006), Musa *et al*.(2007) and Bawa *et al*. (2011), respectively.

The finding that egg size significantly ($P<0.01$) affected chick weight in Japanese quails corroborates the findings of Ayorinde *et al*., (1994), who reported that, keets hatched from large sized eggs were superior in body weight over those hatched from small and medium sized eggs in guinea fowl. This also agreed with the findings of Abiola *et al*. (2008), who reported that small chicks were hatched from small eggs, medium chicks from medium eggs and large chicks from large eggs. Tullet and Burton (1992) noted that egg weight could be a major determinant of chick weight at hatch. The significant ($P<0.05$) effect of age on chick weight may be as a result of increase in egg size of Japanese quails with increase in age of birds and this agrees with the findings of Danilov (2000), who reported an increase in egg weight as the birds increased in age. The pattern of the interaction effect of age and egg size on the weight of chicks hatched showed that chick weights were enhanced with increase in age of the bird at the 9^{th}, 13^{th} and 17^{th} respectively.

5.4 Effect of Chick size and Protein level on Post-hatch Performance of Japanese Quails

The significant differences ($P<0.05$) in the initial weights of chicks were found to be as a result of differences in sizes of the eggs, from which the chicks were hatched. Tullet and Burton (1992) noted that egg weight could be a major determinant of chick weight at hatch. The superiority in the final body weight of large sized chicks over their medium and small sized

counterparts may be as a result of initial body weight differential. The large sized chicks maintained their comparative size advantage up to the end of the six week study period. This is supported by the findings of Ayorinde *et al*. (1994) that body weight difference between keets from large, medium and small eggs remained significant up to 12 weeks of age. The increased final live weight of keets fed 28% protein level over those fed 26% and 24% protein levels is in line with the findings of Bawa *et al*.,(2011) who reported that increasing the concentration of dietary protein up to 28% had significant effect on final live weight.

The observed significant ($P<0.05$) effect of chick size on average daily weight gains of the birds could be as a result of the increased vigour of large sized chicks and early adaptation at hatch compared to medium and small sized chicks. This enabled them to spend more time eating thereby enhancing their average daily weight gains compared to the medium and small sized chicks. The increased average daily weight gains of chicks fed 28% protein level over those fed 26% and 24% protein levels is in line with the findings of Whyte *et al*.(2000) and Shim (2004) who showed that increasing the levels of crude protein in diets had significant effect on the average weight of quail birds during the growing phase.

The significant ($P<0.05$) effect of chick size on feed intake per day with large sized chicks having higher values compared to the medium and small sized chicks agreed with the findings of Okon *et al*. (2010) that smaller birds have lower nutrient requirement for maintenance and consume lesser amount of feed compared to the large birds. The increased feed intake of chicks fed 28% protein level over those fed 26% and 24% protein levels is in line with the findings of Haruna *et al.* (1997) who reported an increase in feed intake as the level of dietary protein increased in the diet of Japanese quails.

The observed significant ($P<0.05$) effect of chick size on feed conversion ratio among treatment groups was note worthy. There was an indication that small chicks utilized feed more efficiently for growth and maintenance of body size than medium and large chicks. The observed higher feed conversion ratio of birds on 28% protein level over those birds on 26% and 24% protein levels is in line with the findings of Kamran *et al*. (2004) who reported that feed conversion ratio was slightly improved by decreasing dietary crude protein from 23% to 20% in broiler birds. This implies that birds on 24% protein level consumed relatively low feed to gain more weight than birds on high protein levels of 26% and 28%.

The significant ($P<0.05$) effect of chick size on cost per kg weight gain with large sized chicks having higher values compared to the medium and small sized chicks implies that large chicks consumed more feed to gain weight probably as a result of their higher body size compared to the medium and small sized counterparts. The highest cost per kg weight gain was recorded for birds on 28% protein level compared to birds on 26% and 24% protein levels. This could be as a result of the higher proportion of the protein sources (soyabean and groundnut cakes) used in formulating the 28% crude protein diet. It was observed that as their inclusion level increased the cost of the diets increased.

The low percent mortality values obtained for chick size and protein levels effect showed that, there was no apparent relationship between chick size or protein level and mortality. The observed generally low mortality during the experimental period (1-6 weeks) in this study supported the earlier report that quails are hardy and perhaps less disease-prone than other poultry birds (Maurice and Gerry, 2006).

The non significant (P>0.05) effect of chick size or protein levels age at first lay suggests that when Japanese hens attain sexual maturity between 5-6 weeks, they can start laying eggs irrespective of the chick size and protein level in the diet. The age at first lay of 38 days recorded in the present study is in agreement with the findings of Bawa *et al*. (2011) who reported the range of 25-37 days as age at first lay in the quail. However, the present study with respect to dietary protein levels influencing age at first lay is contrary to the report of Bawa *et al*. (2011), who reported that birds on 26% and 28% crude protein had their first eggs at 35 days of age, whereas birds on 18, 20, 22 and 24% CP had theirs 2 – 3 days later. The uniformity of age at first lay observed in this present study compared with the previous study could be due to differences in the environments and seasonal variations in which the experiments were conducted.

The average egg weight at first lay was not significantly (P>0.05) affected by chick size and protein level. However the observed increase in egg weight as the level of dietary protein increased in the diet corroborated the findings of Bawa *et al.*(2011). The values obtained for the effect of chick size did not follow a particular pattern as medium sized chicks laid bigger eggs followed by small and then large sized chicks. Lacin *et al*. (2008) had earlier reported higher egg production in the light group (1400-1500g) Lohman White layers compared to the medium (1500-1600g) and heavy hens (above 1600g).

The result of the interaction effect of chick size and protein level on the growth performance showed that feed intake, final live weights and average daily weight gains of Japanese quail chicks were enhanced probably as a result of increasing protein levels in the diet. This may have influenced the initial weight differential of the chicks. However low initial weight was compensated for in the medium and small sized chicks on high protein diet (28%CP). The

feed intake values, final live weights and average daily weight gains were lower in medium and small sized chicks on low protein diet compared with the large sized chicks. This is in line with the findings of Ayorinde *et al*. (1994) that keets hatched from large sized eggs were superior over those hatched from small and medium sized eggs. The reports of Bawa *et al*. (2011) that feed intake, final live weights and average daily weight gains increased as concentration of protein level increased in the diet agreed with the findings of this study. However the interaction effect of chick size and protein level on feed conversion ratio, cost per kg weight gain, mortality, age at first lay and average egg weight at first lay were not complementary on these parameters.

Carcass characteristics were not significantly ($P>0.05$) affected by chick size and protein levels. This suggests that small, medium and large birds and dietary protein levels of 24, 26 and 28% produced similar influence on these carcass and organ traits. The results obtained in this study agreed with Abiola *et al*. (2008) who reported that broiler chicks maintained their size categories up to the end of the starter phase from the various egg size categories in which they were hatched. This could be responsible for the significant ($P<0.05$) effect of chick size on the carcass weight and gizzard weight of Japanese quails. The report of Bawa *et al*. (2011) on the non significant ($P>0.05$) effect of protein level on the carcass characteristics of Japanese quail chicks supports the findings of this study. However the observed significant ($P<0.05$) effect of protein level on the liver weight could be as a result of increased detoxification by the liver as the level of dietary protein increased in the diet.

The interaction effect of chick size and protein levels on the carcass characteristics were not statistically significant ($P>0.05$). However carcass characteristics were enhanced in large sized chicks coupled with increased protein level in diet. Carcass characteristics were better in

chicks with disadvantaged initial weight (small and medium) as protein level increased in the diet while carcass characteristics of quails were poor with low protein level in the diet.

The low and positive correlation between age and hatchability implies that the relationship between age and hatchability is poor and this could be as a result of genetic, physiological, social and environmental factors. This is in line with the findings of Islam *et al.* (2002) who reported that genetic, physiological, social and environmental factors affect hatchability of quail eggs. The high and negative correlation between age and percent fertility implies that as Japanese quails advanced in age, fertility decreased. Kirk *et al*. (1980) and Walsh and Brake (1997) in a similar study reported that the major problem encountered with commercial broiler breeder flocks has been the often dramatic decrease in fertility during the latter part of the laying period, particularly after 50 weeks of age. The low and negative correlation betweeon age and post-hatch performance parameters imply that, the age of birds has no influence on the post hatch parameters of chicks. The low but positive correlation obtained between egg size and percent hatchability suggests that size of eggs could influence hatchability of eggs. Senapati *et al*.(1996) had earlier reported positive correlation between egg weight and hatchability. The high and positive correlation observed between egg size and chick weight clearly indicates that egg size influences the size of resultant chicks at hatch. Abiola (1999) had earlier reported close correlation between egg size and chick hatching weights. The high and positive correlation between egg size and post- hatch parameters (final live weight, feed intake, feed conversion ratio) except for the dressing percentage that was low and negative implies that the larger the egg size, the better the post-hatch performance. This conformed with the findings of Abiola *et al*.(2008) in a similar study with broiler finishers which were found to maintain the advantage of their initially higher egg weight, with respect to the final average

live weight. Prodfoot and Hulan (1981) were of the opinion that, the size of the hatching egg can influence the body weight of chicks up to slaughter. The reports of Ayorinde *et al*. (1994) that egg weight was significantly and positively correlated with body weight up to 4 weeks of age and that egg weight was found to be reliable for estimating body weight up to 4 weeks of age were in agreement with the findings of this study.

CHAPTER SIX

6.0 SUMMARY, CONCLUSIONS AND RECOMMEDATIONS

6.1 Summary

This study was undertaken to determine the effect of age and egg size on fertility and hatchability. It was also aimed at determining the effects of chick size and protein level on post- hatch performance of Japanese quail chicks. The results revealed that age had significant effect on egg size with a high and positive correlation (r value = 0.63) occurring between the two traits. The effect of age and egg size on percent fertility and hatchability revealed that age had significant effect on percent fertility. Percent fertility decreased as birds advanced in age. Although the effect of age and egg size interaction on hatchability was not statistically significant, percent hatchability was influenced by egg size and favours the medium sized eggs compared to the large and small sized eggs. The results of growth performance was significantly affected by chick size and protein level. The interaction effect of chick size and protein level on growth performance were complementary, mostly favouring large sized chicks on high dietary protein level while the low initial weights of medium and small sized chicks were enhanced with high dietary protein level. The results on the effect of chick size and protein level on the carcass characteristics were not statistically significant, however primal cuts and carcass traits were enhanced by the interaction effect of chick size and protein level. The correlation between egg size and growth parameters (final live weight, feed intake, feed conversion ratio) were high and positive except for the dressing percentage that was low and negative.

6.2 Conclusions

The following conclusions were drawn based on the results of this study:

Medium sized quail eggs (9-10g) should be used during hatching to obtain optimum hatchability.

Dietary protein of 24% should be given to large and medium sized chicks for optimum growth performance, while 28% crude protein diet should be fed as starter diet to small chicks.

Higher percent fertility and hatchability were obtained when the breeding quails were between the age of 9-17 weeks of age.

Quail hens attain peak production between 12-15 weeks and hen day production declines at the age of 16 weeks. It is therefore advisable that quail farmers make preparation to re-stock their farm at this point before birds get to the point where it is uneconomical justifiable to retain hens in the farm.

6.3 Recommendation

In further studies, the quails should be sexed at 3 weeks old to determine the growth performance and carcass characteristics of the females and males separately, since the hens are usually heavier than the cocks.

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Appendix A: Effect of Age on Egg sizes of Japanese Quail Hens.

Age(Weeks)	Small sized eggs (g)	Medium sized eggs (g)	Large sized eggs (g)	Average of egg sizes (g)
6	7.69	9.39	10.33	9.14
7	8.36	9.44	10.42	9.41
8	8.37	9.44	10.50	9.44
9	8.38	9.47	10.61	9.49
10	8.42	9.51	10.65	9.53
11	8.44	9.52	10.65	9.54
12	8.46	9.53	10.68	9.56
13	8.46	9.53	10.69	9.56
14	8.49	9.54	10.75	9.59
15	8.50	9.57	10.77	9.61
16	8.52	9.58	10.79	9.63
17	8.58	9.59	10.80	9.66

Appendix B: Effect of Age on Egg number of Japanese Quail Hens and Hen Day Production.

Age(Week)	N0.Small Eggs	N0. Medium Eggs	N0. Large Eggs	Total N0. Eggs	N0. Birds
6	33	21	3	57	211
7	153	126	36	315	211
8	437	453	169	1059	210
9	241	632	441	1314	210
10	155	514	707	1376	210
11	127	452	811	1390	210
12	263	537	593	1393	210
13	270	524	599	1393	210
14	360	565	468	1393	210
15	377	564	452	1393	210
16	411	519	348	1278	210
17	274	445	360	1079	210
Total	3,101	5,352	4,987	13,440	210

HDP=Hen day Production;N0.=Number;%=Percent