EFFECT OF INITIAL BODY WEIGHT OF GROUPS AND FEED QUANTITY ON LAYING PERFORMANCE AND STORAGE TIME ON EGG QUALITY OF JAPANESE QAIL

BY

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ASC/13/0965

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A PROJECT TO THE DEPARTMENT OF ANIMAL PRODUCTION AND HEALTH , FACULTY OF AGRICULTURE IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF AGRICULTURE (B.AGRIC), FEDERAL UNIVERSITY OYE EKITI

FEBRUARY, 2019.

DECLARATION

I hereby declare that this project titled **"EFFECT OF INITIAL BODY WEIGHT OF GROUPS AND FEED QUANTITY ON LAYING PERFORMANCE AND STORAGE TIME ON EGG QUALITY OF JAPANESE QAIL"** is a work done by me under the supervision of Dr. (Mrs) M. Orunmuyi in the Department Of Animal Production And Health, Federal University Oye-Ekiti, Ekiti State. References are provided for all information obtained from any literature and no part of this work has been presented in any previous work for any undergraduate degree in any University.

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13/05/2019

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CERTIFICATION

This is to certify that this project titled **"EFFECT OF INITIAL BODY WEIGHT OF GROUPS AND FEED QUANTITY ON LAYING PERFORMANCE AND STORAGE TIME ON EGG QUALITY OF JAPANESE QAIL"** by Daramola Olusoji Oluseye meets the regulations governing the award of the degree of Bachelor of Agriculture of Federal University Oye-Ekiti, Ekiti State and is approved for its contribution to knowledge and literary presentation. The above declaration is confirmed by:

Supervisor: Dr (Mrs) M. Orunmuyi

Signature and Date

Head of Department: Dr A. Ekeocha

14/3/19

Signature and Date

DEDICATION

This project is dedicated to the God Almighty for seeing me through this work, also to the family of Chief J.O Daramola for their support in every aspect.

ACKNOWLEDGEMENT

I want to express my heartfelt appreciation and gratitude to God almighty for his support and for his favor and love for me during the course of this work and throughout my study period in the University.

I am greatly indebted to my supervisor Dr Mrs Orunmuyi for her guidance and support which brought about the success of this work.

I am grateful to my parents Chief and Mrs Daramola for their support in every aspect. My thanks also goes to my siblings, Oludamola, Olasunkanmi and Oluwatimilehin, for their encouragement and support.

I wish to thank all the academic and non academic staff of the Department of Animal Production and Health, and my department mates.

I sincerely thank my project partner, Abolaji Abolade and all my friends, Bodunde Tayo, Ibidapo Clement, Mgbemene Joan, Olatoye Dolapo, Olaleye Tosin, Anglican Student Fellowship for the support I received from individuals and groups when I needed them.

To all family friends numerous to mention, I am indeed grateful.

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ABSTRACT

This experiment was conducted to investigate the effects of initial body weight of groups (above 120g and below 120g) and quantity of feed given (25g and 30g) to Japanese quails on egg laying performance at different periods and also egg storage time (7days, 14days and 21days) on egg quality parameters of Japanese quail egg. A total of 120 Japanese quail birds were used at the start of the experiment and were allocated to four groups with respect to their initial body weight at point of lay and feed quantity. A 2X2 Factorial arrangement in a completely randomized design was used. Each treatment had three replicates. Birds were fed layer ration containing 2900 ME/Kcal/kg and 18% Crude Protein.This experiment lasted for one year and was divided into four periods (May-July, August-October, November-January and February-April). Data collected during the experiment were subjected to analysis of variance using the General Linear Model of SAS. In the results, difference in initial body weight shows difference in feed quantity, average egg weight, feed cost per day and egg quantity per hen per week while feed cost per egg, feed conversion ratio, egg number per day and hen day egg production were not significantly different. The effect of feed quantity shows significant difference in feed intake, feed cost per day, feed cost per egg and hen day egg production. Feed conversion ratio, egg weight and egg number were not significantly different. Feed intake per hen per day was not affected throughout the periods but feed conversion ratio, egg weight, egg number, feed cost and hen day egg production were highly significantly different. The effect of interaction between feed quantity and initial body weight were significantly different on feed intake, feed cost per day, egg number, egg weight but did not affect feed conversion ratio, hen day egg production and feed cost per egg. Eggs were also picked randomly and stored for different number of days (7days, 14days and 21days) to determine the egg quality after storage. Result of egg quality after storage for different number of days shows that yolk diameter (27.69, 31.34, 32.33)mm, yolk height (7.78, 6.26, 5.71)mm and yolk index (28.22, 20.22, 17.77)mm for 7days, 14days and 21days respectively were highly significanly different ($P<0.001$), egg final weight (9.26, 9.22, 8.68)g and yolk weight (3.44, 3.44, 3.13)g for 7days, 14days and 21days respectively were significantly different ($P<0.05$). Egg length, egg shape index, Haugh unit, albumen weight and albumen height were not significantly different. It is concluded that the initial body weight of Japanese quail affects egg weight but body weight had no effect on the quantity of egg produced and feed intake per hen per day. Feed quantity affect the feed intake of Japanese quails which makes the feeding cost to be affected as well and the interaction between body weight and feed quantity was observed to affect the egg number produced and the feed intake. Production increased with age and started declining Also, Japanese quail can be stored till 21 days and it will still be suitable for consumption.

CHAPTER ONE

1.0 Introduction

The Japanese quail (*Coturnix coturnix japonica*) is proving to be a promising poultry to the low income rural farmers because of its low starting capital and the requirement for rearing the poultry birds. They have the smallest size among all the avian species and are becoming well known in the commercial poultry sector for purpose of meat and egg production. (Vali *et al.*, 2006). Rearing of Japanese quail is a source of meat and egg for the families with poor resources. The females Japanese quail are high producers of egg and are very prolific due to their ability to start laying eggs on average of six weeks and be able to lay between 250 and 300 eggs a year. In addition, the Japanese quail is a good and an efficient feed converter. For every egg laid by a female Japanese quail it releases an edible package from her body which is 8% of her own body weight unlike the case of chicken which deposit only 3% of her own body weight. (Martin, *et al.*, 2008).

Quails are seen commonly in continents like Asia, Africa and Europe. The female Japanese quails have light tan feathers with black stippling on the throat and upper breast, while male have rusty brown throat and breast feathers which is one the ways of differentiating male and female. The body weight of a live mature female quail is between 120g to 160g, while that of mature male weight is between 110g to 140g (Randall and Bolla, 2008 and Ortlieb, 2013). Japanese quail eggs are characterized by a mottled brown color and are often covered with a light blue chalky material. The average weight of Japanese quail egg is about 10 grams. Japanese quail egg spend 17 to 18days in incubation and the young chicks also weigh between 6 to 7 grams when they are hatched and have brownish colour with yellow stripes. 75 percent of quails eggs are laid around 3 pm to 5 p.m. and 25 percent of their eggs are laid in the night and it takes about 14 to 18hours of light per day for quail to have maximum egg production and fertility. (Randall, 2001).

Some factors such as management practices, farm environment, health of the birds, genetics, nutrition, breeder's age and egg weight before incubation affects the performance of commercial poultry birds. (Corrêa *et al.*, 2011).

The cost of feeding poultry birds takes the highest percentage of the inputs in rearing poultry birds, reducing feed cost will bring more profit to the farmer. Quantitative and qualitative feed restriction are systems that can be employed to improve the feeding plans of poultry to decrease metabolic rate and growth to some extent. The quantity of feed taken in by a poultry bird contributes to most of the physiological functions.

The rearing of Japanese quails in Europe is mainly for commercial production of meat while it is for egg production in Japan, and are often used as dual-purpose poultry in other countries in Asia. (Maiorano *et al.*, 2012). Recently, consumers has been showing interest on quail meat but producers are finding it difficult to get a better quality parent stock. For this reason, especially for the sake of producing fast-growing birds, researchers have been working on Japanese quail parent strains that has a high growth potential. Selection is very important in the genetic improvement of livestock. Individual selection, is important in experiments for selection for body weight in poultry, and the high heritability of body weight provides crucial advantage. (Hussein *et al.*, 2014).

It has been reported that body weight and age of quail have effect on the egg size and the proportion of the components of the egg. (Cummingham., *et al* 2010). One of the very crucial factors in poultry production is egg quality and therefore the success in egg production is very important and must achieved. Usually, when there is a significant increase in the production of egg there is a decrease in egg weight. This is also seen in quails as well, and it is a vital measure for selection for body weight (Alkan *et al.*, 2010; Silva *et al.* 2013).

Differences in body weight within a flock can be due to variation in the genetics and environmental factors that affects individuals. (Ayorinde and Oke, 2009).

The egg laying performance, egg size, egg quality, external appearance, internal composition and the nutritional potential of quail egg which help to promote the growing consumption of quail egg is affected by the functional and phytogenic properties of the feed ingredients given to quail. (Lagana *et al.*, 2012; Saraswati *et al.*, 2013; Saraswati and Tana., 2016).

Hassan (2011) reported the egg weight in Japanese quail at the age of fourteen weeks with three groups (light, medium and heavy) according to their body weight at six weeks were 12.38g, 12.98g and 13.52g respectively.

It was reported that the age and body weight at onset of puberty in poultry birds have a significant effect on most egg production traits (Metin, 2007 and Agaviezor *et al.*, 2008).

Metin, (2007) reported that the age at sexual maturity in chickens and quail influences egg production traits such as egg number, egg size and body weights at sexual maturity. The Japanese quail body weight and their development during the growth phase are factors that influence the weight of the first eggs (Braz *et al.*, 2011). It has been studied that the higher the uniformity of the lot during the period of rearing the higher egg production and the laying persistence during the adult phase will be (Agaviezor *et al.*, 2008).

Difference in the size of egg laid by Japanese quail and the weight greatly depends upon the breed and strain, from one strain to the other and from one individual to another, as a result of this, extensive variation in egg weight may be observed within a flock (Shoukat *et al.*, 1988). It was reported that feed consumed by Japanese quail affects the differences in the body weight of the quails (Nazligül *et al.*,2001).

Feeding time period, sequential feeding, choice feeding, restricted feeding are the different feeding schemes used in poultry industry and also modification of growth pattern by quantitative feed restriction and stimulating compensatory growth is a successful approach in managing the scarcity of feed stuffs (Shariatmadari, 2012).

It was reported by Jin *et al.* (2011) that egg storage temperature and time of storage influences weight loss, albumen pH and haugh unit in poultry birds. Quail eggs are more nutritious when compared to chicken eggs because they contain more essential exogenous amino acids, mineral compounds and elements such as iron, phosphorus, copper and zinc. Quail egg contain high vitamins, especially pro vitamin A, thiamine, riboflavine and cyanocobalamins. Owing to their chemical composition, they are not harmful for people allergic to albumen in chicken eggs. Moreover, quail eggs are characterized by a low cholesterol content (Sinanoglou *et al.* 2011, Genchev 2012).

In order to maintain good quality of quail eggs, various storage methods are employed such as refrigeration retain egg quality by slowing down the ageing process and reducing micro flora activities.(Jones *et al.* 2004). Measuring of the physical and chemical changes taking place in the egg during the time of storage helps to know the level of freshness, and thus its quality and culinary and technological value (Czarniecka-Skubina 2012). The quality of eggs of different bird species varies due to many genetic and environmental factors (Travel *et al.* 2010), the origin (genotype) of birds (Salman and Tabeekh 2011, Gugolek *et al.* 2013), their age and stage of laying period feeding methods, as well as environmental conditions of rearing, such as temperature and humidity, as well as the CO2 content in the room (Raji *et al.* 2009), methods of storing eggs (Dudusola 2009) and conditions of their distribution.

Effect of initial body weight at point of lay has been reported in chicken to affect subsequent laying performance. (Lacin *et al.*, 2008). This experiment is aimed at investigating the effect of initial body weight of groups and quantity of feed given to Japanese quail at different periods of lay on egg laying performance and also the effect of egg storage time on egg quality parameters of Japanese quail egg.

1.1 PROBLEM STATEMENT

Most of the information on the relationship between body weight at onset of lay and subsequent production and egg quality evaluation after storage are based on chicken, only few researches has been done on quail. (Lacin *et al.*, 2008, Braz *et al.*, 2011, Nazligul *et al.*, 2001).

1.2 JUSTIFICATION OF THE STUDY

The factors that influences the weight of the first eggs include the weight of the birds and their development during growth phase (Braz *et al.*, 2011). Selection for higher body weight has negative correlation with production performance, lead to the relatively poor egg production (Nath *et al.*, 2011 and Mielenz *et al.*, 2006). Due to difference in body weight, feed consumption is reported to be affected (Nazligul *et al.*, 2001).

1.3 OBJECTIVES OF THE STUDY

To evaluate the effect of initial body weight of groups on egg laying performance of Japanese quail (below 120g and above 120g).

To evaluate the effect of feed quantity on the laying performance of Japanese quail (25g and 30g).

To evaluate the effect of egg storage length on egg quality parameters of Japanese quail (7 days, 14 days and 21 days).

1.4. HYPOTHESIS

1.4.1. Null hypothesis

H_{o1}: There are no significant differences in egg production of Japanese quail with different initial body weight at sexual maturity.

H_{o2}: There are no significant differences in egg production of Japanese quail with difference in feed quantity.

H_{03}: There are no significant differences in the egg quality parameter of quail eggs stored for different days.

1.4.2. Alternative hypothesis

H_{A1}: There are significant differences in egg production of Japanese quail with different initial body weight at sexual maturity.

H_{A2}: There are significant differences in egg production of Japanese quail with difference in feed quantity.

H_{A3}: There are significant differences in the egg quality parameter of quail eggs stored for different days.

CHAPTER TWO

2.0. LIRERATURE REVIEW

2.1. Geographic Range Of Japanese Quail

In general, quail inhabits parts of Russia (Johnsgard 1988) and eastern Asia, including Japan, Korea and China (Hoffmann 1988) as well as India (Finn 1911). It winters in China, southeast Asia, the extreme northwestern coast of Africa, and a subsaharan band north of Congo and including the Nile River valley from Egypt to Kenya. A small population has been found in Angola. Races of this quail are found in Kenya, Tanzania, Malawi south to South Africa, Mozambique, and Namibia as well as parts of Madagascar. This quail may breed in parts of Europe, Turkey, and central Asia to parts of China (Alderton 1992).

2.2. Habitat

These Japanese quail are seen in grassy fields, on river banks, or in rice fields (Takatsukasa 1941).

Terrestrial Biomes savanna or grassland.

2.3. Physical Description

The Japanese Quail have similar appearance with the European Common Quail, Coturnix coturnix. Japanese quail have dark brown colour with buff mottling above and lighter brown underneath. They also posses a whitish stripe above the eye on the side of the head. Legs are orangish-gray to pinkish-gray as is the beak (Hoffmann 1988). What differentiate female from the males is that the females usually (but not always) lack the rufous coloring on the breast and black flecking or markings on the throat (Johnsgard 1988).

There are differences in plumage color. Some of the birds are whitish to buff with rufous to chestnut mottling above while some others have a very dark brown appearance with little to no mottling. Also, there have been golden-brown varieties bred in captivity (Hoffmann 1988).

Wing sizes in males and females is similar ranging from 92 to 101 mm. Both male and female Japanese quail exhibit similar sized tails ranging from 35-49 mm in length (Johnsgard 1988).

2.4. Reproduction

Quail lays egg at the rate of one per day. (Lambert 1970), with about 7-14 eggs per clutch (Hoffmann 1988). An egg averages 29.8 by 21.5 mm is size and weighs 7.6 g (Johnsgard 1988). Quail eggs incubate for 19-20days. (Lambert 1970), although clutch sizes have been associated with latitude and length of photoperiod. In Japan, clutch size is 5-8 eggs, while in Russia, clutch size is 5-9 eggs (Johnsgard 1988). The chicks are considered to be mature and able to mate after four weeks old (Hoffmann 1988). The breeding season of Japanese quail varies with location they are.

2.5. Behavior

According to studies, seven distinct displays and calls were observed in male Japanese quail, where three of the calls were also found in the females (Johnsgard 1988). The call of this quail consists of "deep hollow sounds, several times repeated in quick succession" (Finn 1911). The male's call is typically three notes. The female will utter a long call which will make the male tp be alerted to her receptivity to copulate (Johnsgard 1988). Also, the quails do engage in courtship-feeding. The male will hold a small worm in his beak for the female and utter a soft croaking call and the the female approaches the male and takes the small worm to eat and after that the male then attempts to copulate with the female (Lambert 1970).

This quail and its European counterpart are migratory. Coturnix japonica will migrate to India (Finn 1911), northern Japan and Korea for the summer (Hoffmann 1988). They winter in southeast China, Hainan, Taiwan, and southern Japan. Their migration covers 400-1000 km, which is remarkable for a bird not known for its flying capability (Hoffmann 1988). Overall, their migration route follows a north-south pattern (Johnsgard 1988).

2.6. Food Habits

Japanese quail can consume different kinds of grass seeds, including panicum and white millet. They require more protein in their diet than Painted Quail as these quail will eat more small worms and insect larvae. In the summer, they will especially seek and consume a variety of insects and small invertebrates (Johnsgard 1988). In addition, they eat grit, especially egg-laying females (Lambert 1970).

2.7. FACTORS AFFECTING EGG PRODUCTION

The quantity of egg laid is the major parameter to determine the performance of commercial layer. It takes about 90% of the income in egg production farm (Oluyemi and Roberts 1979). Egg qualities such as egg size is another vital economic trait, it determines to a large extent the price received in any market and standard range of the egg should be between 53 and 63 grams(Obioha, 1992). Oluyemi and Roberts (1979) reported that environmental factors such as nutrition, ambient temperature and humidity affect the quantity of laid and the quality.

2.7.1 Temperature and Humidity

Temperature and humidity affects egg laying performance of quail. The highest temperature required for a good laying performance is approximately 30°C at a high relative humidity of 75% (Daghir 1995). Gilbert (1980) reported that temperatures between the range of 13°C and 21°C are recommended for optimal egg production, even though higher temperatures may lead to increased production figures.

(Gilbert 1980) also reported that the altitude, gaseous environment, humidity and noise may also affect egg production of birds. Highest egg production is seen when temperatures are within neutrality range (Smith, 1990).

2.7.2. Nutrition

Claudia (2009) reported that some diseases such as ricket, caged layer fatigue and fatty liver syndrome are nutritional diseases that affect laying capacity of hens and are responsible for a high percentage of the flock mortality. Improving 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) observed that reduced egg production and egg weights are result of less feed intake resulting from exposure to high environmental temperatures.

2.7.3. Body weight

Lacin *et al.* (2008) studied the effect of initial body weight on laying performance of birds and observed higher egg production in the light group than those of other weight groups. Duplessis and Erasmus (1972) indicated that hens with a larger body weight within a bloodline laid larger eggs than those with smaller body weights.

2.8. EFFECT OF FEED QUANTITY LAYING PERFORMANCE OF JAPANESE QUAIL

Feed restriction is a system of feeding where time of feeding, duration and amount of feed given to birds are limited, and it has an impact on whether a bird is capable of achieving the same body weight as birds that are fed *ad libitum* (Yu & Robinson, 1992). Generally, the common form of feed restriction is the quantitative and qualitative restriction where quantitative involves restricting the quantity of feed given while qualitative involves the restriction of nutrients in diets. (Leeson & Zubair, 1997). A quantitative feed restriction means that a limited amount of a well-balanced diet, with normal nutrient percentage is given to the birds. A simple physical restriction provides a calculated quantity of feed per bird and is one of the most commonly used methods.

The cost of feed cost accounts 60 - 70 % of the cost of producing broilers (Smith, 2001) and this high cost calls for a need to improve the efficiency of the utilization of the feed given to birds. Therefore, there is a serious need to increase efforts of reducing the cost of feeding without causing reduction in the productivity of the hens. One possible strategic way to reduce the feed cost is to restrict feed intake of the birds in the early stage of life. (Attia *et al.*, 1991) reported that feed restriction in early stage of birds has been credited with improved feed efficiency in broiler, (Novel *et al.*, 2009). Quantitative feed restriction have the ability to improve feed efficiency (Nielsen *et al.*, 2003; Hassanabadi, 2008 and Khetani *et al.*, 2009), reduce feed cost (Bouvarel *et al.*, 2008) and reduce total mortality (Lippens *et al.*, 2000 and Rincon & Leeson, 2002) which reflect an increase in economic efficiency.

Also, El-Sagheer & Makled (2005b) reported a better net revenue and economical efficiency when all restricted groups of broiler chicks (3, 6, or 9 hours fasting/day from 2 to 7 weeks of age) compared with ad-libitum control group. Novel *et al.*, (2008 and 2009) also reported that early period 75 % ad- libitum restriction feeding gave an economic advantage over ad-libitum feeding mainly by improving feed utilization and able to attain complete live weight compensation by 42 days of age. Also, Tottori *et al.*, (1997), stated that economic performance of birds with restriction feeding was better than that without restriction as a result of improvements in viability and feed conversion rates. The depression in the cost of diet was mainly due to decreased feed intake with increasing fasting time.

Furthermore, Hassanien (2012) indicate that all feed restriction regimes have better economic performance than the uncontrolled. This improvement in relative economical efficiency is due to reduced costs of feed. He observed that restriction of feed significantly reduced the quantity of feed consumed by hens and at the same time improved economic efficiency. Also, Jahanpour *et al.*, (2014) concluded that restriction of feed is an effective method of reducing feed cost without reducing the production potential of the birds. Farghly & Hassanien (2012) concluded that despite the increased body weight in ad-libitum feeding system, the effect was less economically efficient. Also, usage of feed restriction regime was associated with no mortalities, reduced feed intake and fat deposition and improves FCR which gave an economic advantage than ad-libitum feeding.

It was proposed by researchers that physical feed restriction at early age of birds for a short period may elicit compensatory growth, improved feed efficiency, reduced abdominal fat pad, and at market age restricted birds performed similar to full fed birds (Ibrahim *et al.*, 2002; Naji *et al.*, 2003).

Some other researchers also found no difference between feed restriction and ad-libitum feeding. Buragohain (2013) observed the same body weight gain between ad libitum and 10% feed restricted groups of Japanese quails. In another report 75 % restriction of ad-libitum feeding exhibited an economic advantage over ad libitum feeding by enhancing feed utilization (Noveli, 2008; 2009).

Hassan *et al.* (2003) reported that feed restriction does not affect hatchability, early age embryonic deaths in Japanese quails, but feed restriction has significant effect on body weight at first egg. Tumova *et al.* (2002), also suggested that physical feed restriction when the bird is still young for a limited period stimulated compensatory growth and its depend on a number of factors such as intensity, time and duration of restriction, sex and strain.

2.8.1. Egg Production

The positivity of restricted feeding over full feeding during the rearing period are usually considered to be greater as the flock is being kept for a longer period. (Robinson *et al.*, 1978). Robinson *et al.* (1978) then reported that the level of feed restriction imposed during the period of laying is more critical than that imposed during the rearing period. Irrespective of the length of the laying period, feed restriction in the rearing period are seen to increase the hen-house production of laying periods. Bruggeman *et al.* (1999) showed that restricted hens during the rearing period (7-15 weeks) produces higher amount of eggs per week than those fed on ad libitum intake throughout the periods showed the lowest egg production per week. The study conducted by Sekoni *et al.* (2002) does not identify any effect of quantitative feed restriction on hen day egg production. According to (Hassan *et al.*, 2003) feed restriction delays onset of egg production by about two days in comparison to full feeding system in quail production. Early feed restriction does not have effect on first egg weight and the number of eggs produced from 6 to 13 weeks of age in quail as reported by Hassan et al. (2003).

According to Crounch et al., (2002a) hens that are raised with restricted feeding (from 3 to 24 weeks and 3 to 16 weeks) had a significantly higher peak egg production than hens on ad libitum feeding from 3 to 24 weeks and 3 to 16 weeks, so also hens that were under feed restriction from 3 to 16 weeks produce significantly more eggs from 1 to 5 weeks of lay than those fed without restriction.

2.8.2. Egg Quality And Weight

The egg quality was not affected by the different feeding regimes in chickens according to (Ukachukwu and Akpan, 2007). Crounch *et al.* (2002a) showed in their experiment on turkey that for the entire lay period, cracked and soft-shelled egg production percentage was greater for the birds that were fed restricted from 3 to 16 weeks of age. There was also no effect of feed restriction treatment on percentage of double yolked and large egg production.

Richards *et al.* (2003) reported that there is low incidences of abnormal eggs in restricted fed hens compared to birds exposed to feeds without restriction. Oyedeji *et al.* (2007) concluded that egg weight is significantly better for hens that were not under restricted feeding over those rationed either once or twice a day. In a study done on quails, Hassan *et al.* (2003) revealed that early feed restriction did not have any impact on the first egg weight, mean egg weight, or number of eggs produced. Egg specific gravity was improved by early feed restriction on Japanese quails in comparison with those on full feeding (Hassan *et al.*, 2003).

2.8.3. Feed Intake And Efficiency

The experiment by Tumova *et al.* (2002) shows that restrictive feeding reduces feed intake which resulted in an improvement of feed efficiency in comparison with a control group fed ad libitum. In the re-alimentation period, female turkeys consumed less feed. Robinson *et al.* (1978) concluded that there is a slight chance for feed restricted birds to over- consume feed. Robinson *et al.* (1978) further indicated that irrespective of the duration of the laying period, the ratio of the quantity of feed (kg) eaten to the quantity of eggs produced decreases with successive increases in laying feed restriction.

Feed restriction treatment does not have impact on the efficiency of feed utilization (Sekoni *et al.*, 2002). The study by Sekoni *et al.* (2002) concluded that quantitative feed restriction did not have any impact on the feed consumed by birds and efficiency of feed for egg production. This same study of feed restriction on Japanese quail showed a non-significant difference in feed conversion efficiency among treatments during feed restriction periods (Hassan et al. 2003). Hassan et al. (2003) explained that an increase in the feed conversion value following feed restriction would probably mean that feed restriction retards growth, and therefore reduces feed efficiency although Plavnik and Hurtzwitz (1985) illustrated that feed restriction induces a higher efficiency of maintenance.

2.8.4. Restricted Versus Unrestricted Feeding

Unrestricted feeding in laying hens leads to excess consumption of energy that influences excessive accumulation of abdominal fat predisposing layers to heat stress. Ad libitum feeding also results in increased death rate of laying hens (Oyedeji *et al.*, 2007). Ad-libitum feeding would lead to obesity and thermal discomfort, a high incidence of lameness and high high death rate due to skeletal disorders (Savory and Maros, 1993). Crounch *et al.* (2002a) revealed that quantitative feed restriction reduces body weight and feed consumption and does not reduce egg production.

2.9. EFFECT OF INITIAL BODY WEIGHT ON EGG LAYING PERFORMANCE AND QUALITY

Perez-Bonilla *et al.* (2012) reported that the hens with low or average initial body weight had higher average daily feed intake, egg production and egg weight than the lighter hens. However, none of the egg quality variables studied was affected by the initial body weight of the hens. In the study of Szentirmai *et al.* (2014) it was discovered that the relative difference in the initial body fat content of the hens also maintained to the end of the experiment, namely till 72 weeks of age.

2.9.1. Egg Quantity

According to Jatoi et al., (2013), the difference in body weight of different close-bred flocks of Japanese quails recorded could be due to variation in the genetic makeup of these flocks. Some researchers indicated other factors such as breed, body size, feed, season and breeder age that affect egg production. (North and Bell 1990, Ipek and Sahan 2004). The higher growth-selected strain of broiler breeder exhibited lower egg production than all the other strains (Wolanski *et al.*, 2007).

Milisits *et al.*, (2016) reported that the rate of egg production of the hens with low initial body weight was lower than that of the hens with medium or high initial body weight at 52 and 72 weeks of age and that the initial body weight of the hens affected only the albumen ratio at 32 weeks of age, the yolk ratio at 52 weeks of age and the egg shell ratio at 72 weeks of age significantly. Perez- Bonilla et al. (2012) observed that the initial body weight of the hens has no significant effect on the quality of the eggs.

Jatoi *et al.*, (2013) observed that the highest rate of egg production was recorded in the small weight category and minimum in the heavy size birds. Other researchers also find similar result such as Renden and McDaniel (1984); Leeson *et al.* (1997); in Lohmann•hens, Lacin *et al.*, (2008); in selected strains of broiler breeders Wolanski *et al.*, (2007) and in quails Aboul-Hassan (2001). El-Sagheer and Hassanein (2006) reported differently that the medium and heavy size strains of chicken had significantly ($p<0.05$) higher egg production than those of light strains.

The low egg production in heavy quails in comparison to small quails could be attributed to less number of mature ovarian follicles in heavy quails (Jatoi *et al*, 2013). Similar point of view has been held by Wilson and Cunningham (1984); Palmer and Bahr (1992) who attributed that difference in heavy and older chicken in egg production than the lighter and younger birds has been due to changes physiology leading to slow growth of ovarian follicles.

2.9.2. Egg Weight

Jatoi *et al*, (2013) observed that there is high mean egg weight in the heavy weight category quails and minimum mean egg weight in the small size birds. The similar findings have been reported by Hagger (1994) and Leeson et al. (1997) showing that the increase in egg weight was associated with increase in body weight and age of the breeder. These observations are also thesame with those of El-Sagheer and Hassanein (2006); Kirikci *et al.* (2007) who observed that heavy eggs were gotten from the heavy birds and the light eggs were produced by the small size birds. It has further been indicated that a positive correlation exists between body weight and egg weight (Siegel 1962; Festing and Nordskog 1967; Kinney (1969). Therefore a compromise between body weight reduction and maintenance of acceptable egg weight is needed (Nordskog and Briggs 1968; Hocking *et al.*, 1987).

Lacin *et al.*, (2008) also pointed out thategg weight was lower in the group with low body weight than those of medium and heavy hens, respectively.

2.9.3. Egg Quality

Hassan *et al.*, (2012) reported that body weight have high effect on egg weight, egg length, yolk weight, albumen weight, shell thickness, and egg yolk cholesterol. Female birds with higher body weight have higher egg width and shell weight than other groups. Similar results were reported by Silversides *et al.* (2006) for chicken and by Alkan *et al.* (2010) and Hassan (2011) for Japanese quail.

According to Hassan *et al.*, (2012) there no difference in shape index, yolk index, yolk%, albumen%, shell% and yolk color among the groups of different body weight. Alkan *et al.*, (2010) found decrease in yolk index of female Japanese quail selected to high body weight compared to low line body weight.

2.9.4. Feed Conversion Ratio

Jatoi *et al* (2013) reported that the high mean FCR (g feed/egg) was observed in the heavy weight category and minimum in the small size birds and assumed that the better FCR (g feed/egg) in small size quails during the study could be attributed to less feed requirement of these birds. These findings are accurate with those of Leeson et al. (1997) who observed that the smaller birds consistently consume less feed throughout laying regardless of the strain. Feed consumption increased with increase in body weight due to high feed consumption of the birds with higher body weight. Similar findings reported in Hi-sex brown strain of chicken by El-Sagheer and Hassanein (2006); in Pheasant (Aydin and Bilgehan 2007) and in Lohmann laying hens (Lacin *et al.*, 2008).

2.10. EFFECT OF AGE ON EGG LAYING PERFORMANCE OF QUAIL

The egg quality characteristics of the quail egg change significantly by age in several research studies by (Nowaczewski *et al.*, 2010). It was also reported that yolk and albumen weight increased, whereas yolk and albumen index and Haugh unit decreased as the bird grows older. (SEKER *et al.*, 2005).

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 affects the weight, length and width of the eggs, similarly haugh unit, yolk, albumen weight and height increased significantly as the bird grow older. Joyner *et al.* (2004) reported a close positive relationship between age of hen and the size of egg they lay while a negative relationship exists between the hens age and the quantity of egg produced. They observed that there is reduction in egg production as the age increases. 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).

(Asuquo and Okon, 1993) reported that factors such as improved breeding, increased body weight, composition of feed and nutrition plan, intensity and duration of light can influence egg size and production, a major factor determining egg size is the age of the bird.

Furthermore, age of hen affects the 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 that there is high 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).

2.11. EFFECT OF STORAGE LENGTH ON EGG QUALITY PARAMETERS

Quail eggs quality is divided into external and internal quality parameters (Arpášová et al., 2012). The outer quality features include the weight, the shape of the egg, the quality of the egg shell, the structure of the shell, the strength, the porosity and the color.

Eggs deteriorate in internal quality the longer it is stored and the egg shell and internal content are the determinant factors.(Adeogun *et al.*, 2004). Poor storage conditions may result in deterioration of egg quality and consequently loss and waste of eggs. There are reports which show that loss of water through pores, prevention of microorganism invasion and lower temperature are major considerations of retarding quality degradation (Dudusola, 2009).

In hens, it was found that eggs stored for more than 10 days were characterized by a very low white and yolk indices and lower number of Haugh units, in comparison with those examined on the day of laying (0 days of storage), (Yilmaz and Bozkurt, 2009).

(Demeirel and Kirikci, 2009) conducted an experiment to compare eggs stored after 1-2 days and 9-10 days and found eggs stored for shorter period to have more values of yolk indices and number of Haugh unit.

The quality of the egg is usually given in relation to what the consumers demands and determines the general characteristics which are easily identifiable without breaking the egg, especially the freshness, weight, size, shape and appearance of the eggshell (Sylvie *et al.*, 2018). One of the most important features for the consumer to determine is the weight of the egg, as well as the visual aspect of the egg purity and the integrity of the eggshell. Factors such as breed, the age laying hens, the composition of the feed, and also the storage time and temperature influence the quality of quail egg (Sylvie *et al.*, 2018).

CHAPTER THREE

3.0. MATERIALS AND METHODS

3.1. Poultry House and Experimental Animals

The experiment was carried out at the Federal University Oye Ekiti, Ikole campus' poultry farm. Latitude of 7.7982661°N and longitude of 5.514493°E. It has an annual average temperature of 24.2°C. Wooden cage was used throughout the experiment and the birds were fed once in a day according to the quantity of feed to be given to each animal and early in the morning and availability of adequate water at all time. The window of the poultry and cages are well protected with net to avoid the intrusion of rodents. Wood shavings are used as beddings in the cage to absorb the droppings and are changed every week in other to keep the birds in good health.

3.2. Experimental Birds

This started with two hundred(200) three weeks old male and female Japanese quail birds obtained from National Veterinary Research Institute, Ikire outstation in Osun State, Nigeria. and was divided into four (4) periods, this is the last period which started February 2018 till April 2018.

3.3. Experimental Design

A total of 72 Japanese quail layers was used and were assigned into four(4) experimental groups using the completely randomized design in a factorial arrangement according to their body weight (i.e below 120g and above 120g) and the quantity of feed given to them per day (25g and 30g) and each experimental group consist of three(3) replicate cages.

T1R1	T4R1	T2R1	T3R1	T1R2
T4R2	T1R3	T3R2	T2R2	T4R3

CAGE 1

T3R3	T2R3

CAGE 2

Figure 1. Cage Layout

3.4. Treatments

Treatment 1 (T1): 120g below, diet 1(25g)

Treatment 2 (T2): 120g below, diet 2(30g)

Treatment 3 (T3): above 120g, diet 1(25g)

Treatment 4 (T4): above 120g, diet 2(30g)

The experiment lasted for a year which is in four(4) periods (i.e May-July, August-October, November-January and February-April) . The composition of the experimental diet is as shown in Table 1.

Table 1: **Proximate Composition Of Experimental Diet**

Ingredient	Percentage %
Maize	58.40
Soya bean meal	21.15
Wheat offal	14.25
Limestone	1.50
Dicalcium phosphate	2.00
Fish meal	2.00
Salt	0.25
Layer premix	0.25
Lysine	0.10
Methionine	0.10
Calculated analysis	
M.E. Kcal/kg	2900.00
Crude protein %	18.00
Calcium %	2.50
Phosphorus %	0.60
Crude fibre %	3.78
Lysine %	0.59
Methionine %	0.45

3.5. Experimental Procedure

The birds were divided into groups in which the first group has initial weight above 120g while the other group has initial weight below 120g. These two groups was further divided into another two groups each randomly in which the first group are given 25g feed per day and the other given 30g feed per day which makes us have four treatments.

Feeds are given to each animal according to the quantity of feed to be given to the treatment they belong to and the feed are measured with a sensitive scale (Camry, 0.01). Productive performance was evaluated by counting the number of eggs in a cage (treatment) and weighing the eggs laid by each treatment every day. Feed intake was measured by measuring the feed remaining in the feeding through at the end of every week and subtracting it from the total quantity of feed given for the whole week. Feeding, egg collection and recording was done once daily in the morning. Egg production and weight was also recorded daily. Feed was weighed at feeding time, usually every day, and then the feed left in the feeder at the end of the week will be weighed and subtracted from the total amount supplied during the week. This will give the total feed intake per 1 week, and from this the total feed intake per bird will be calculated.

For the egg storage, eggs was picked randomly twice every week from each treatment and was marked by numbering them in other to identify each eggs so as to make accurate observation and to avoid mixing of the eggs up after storage. Each eggs are then weighed and the weight are recorded with the number written on the eggs and are then grouped randomly into three groups where the first group was stored for 7 days when the egg quality parameters will be analyzed, the second group stored for 14days while the third group for 21days and the egg quality parameters of the three groups were analyzed and recorded. The egg quality parameters are; egg weight after storage, egg length, egg breadth, yolk height, albumen height, yolk diameter, yolk weight, albumen weight, yolk color, shell weight and shell diameter.

3.6. MEASUREMENT

Instruments used are vernier caliper, micrometer screw guage, yolk color fan, petri dish, scooping spoon, sensitive scale.

Before each experiment, the eggs are weighed again to know their weight after storage to know the amount of weight loss after storage.

Egg height: A digital vernier caliper was used to measure the yolk height by making sure the top and bottom of the egg are touching the vernier caliper and the value is recorded.

Egg diameter: Digital vernier caliper was also used to measure the egg diameter. The egg is put between the vernier caliper with the sides touching the vernier caliper and the value is recorded.

Yolk diameter: To measure the yolk diameter, the egg was broken gently and the albumen and yolk were gently poured in a petri dish of a known weight for measurement and the shell placed closed to the window for it to dry. The digital vernier caliper is the inserted with the vernier caliper touching the yolk at two edges and the value is recoreded.

Yolk height: The yolk height is measured by using the digital vernial caliper. The vernier caliper is dipped in the center of the yolk horizontally and the value is recorded.

Albumen height: Albumen height is also measured by using the vernier caliper. The vernier caliper is inserted horizontally in the albumen very close to the yolk and repeated at another point that is also close to the yolk and the two values are recorded and the average is used as the albumen height.

Yolk weight: A scooping spoon is used to gently remove the yolk out of the albumen and put in another petri dish. The weight of the petri dish has already been known before putting the yolk and then a sensitive scale is used to measure the yolk and the weight of the petri dish is subtracted from the value gotten as recorded as the yolk weigh.

Albumen weight: The albumen left in the first petri dish is weighed and the weight of the petri dish is subtracted from the value gotten and is recorded as the albumen weight.

Shell diameter: After drying the shell, the diameter is measured by using a micrometer screw guage and three different part of the shell were measured (i.e the top, the middle and bottom) and the average was used as the shell diameter.

Yolk color: The yolk color was determined by using the yolk color fan according to the CIE standard calorimetric system (Yolk Colour Fan, the CIE standard, calorimetric system, F. Hoffman-La Roche Ltd., Basel, Switzerland) . The yolk color fan is placed close to the yolk and colors are compared and the color that matches the yolk color is recorded.

3.7. Data collection

Egg production performance and egg quality parameters were calculated as follow;

Feed intake/week = Feed offered – left over feed

Feed intake/day = Feed intake/week ÷ number of days

Feed intake/day/hen = Feed intake/day ÷ number of birds in the cage

Feed cost = Feed intake/day × Price of 1kg of the feed

Feed cost/egg = Feed cost ÷ Quantity of egg laid/day

Feed cost/dozen = Feed cost/egg × 12

Egg number/hen/day = Quantity of eggs laid/day ÷ Number of birds in the cage

Egg shape index (%) = Egg diameter ÷ Egg height × 100

Yolk index (%) = Yolk height ÷ Yolk diameter ×100

Haugh Unit = $100 \times \log (AH + 7.57 - 1.7 \times EW^{0.37})$

Where AH = Albumen height (mm) and EW = Egg weight (g)

3.8. Data Analysis

All data collected were subjected to the analysis of variance (ANOVA) using the General Linear Model (GLM) of SAS (2008) and means of the treatment were separated using Duncan.

3.9. STATISTICAL MODEL BODY WEIGHT AND FEED QUANTITY

$$Y_{ijklm} = \mu + b_i + t_j + p_k + bt_{(ij)} + pb_{(ik)} + pt_{(jk)} + e_{ijklm}$$

Y_{ijklm} = Individual observation m on the treatments

μ = Common mean

b_i = The effect of body weight at sexual maturity

t_j = The effect of feed quantity on Japanese quail

p_k = The effect of the periods on laying performance

$bt_{(ij)}$ = The effect of the interaction between body weight and feed quantity

$pb_{(ik)}$ = The effect of the interaction between body weight and the periods

$pt_{(jk)}$ = The effect of the interaction between feed quantity and the periods

e_{ijklm} = Random error

STATISTICAL MODEL FOR EGG STORAGE

$Y_{ij} = \mu + b_i + e_{ij}$

Y_{ij} = Individual observation j on the treatments

b_i= Effect of storage on egg quality

μ = Common mean

e_{ij} = Random error

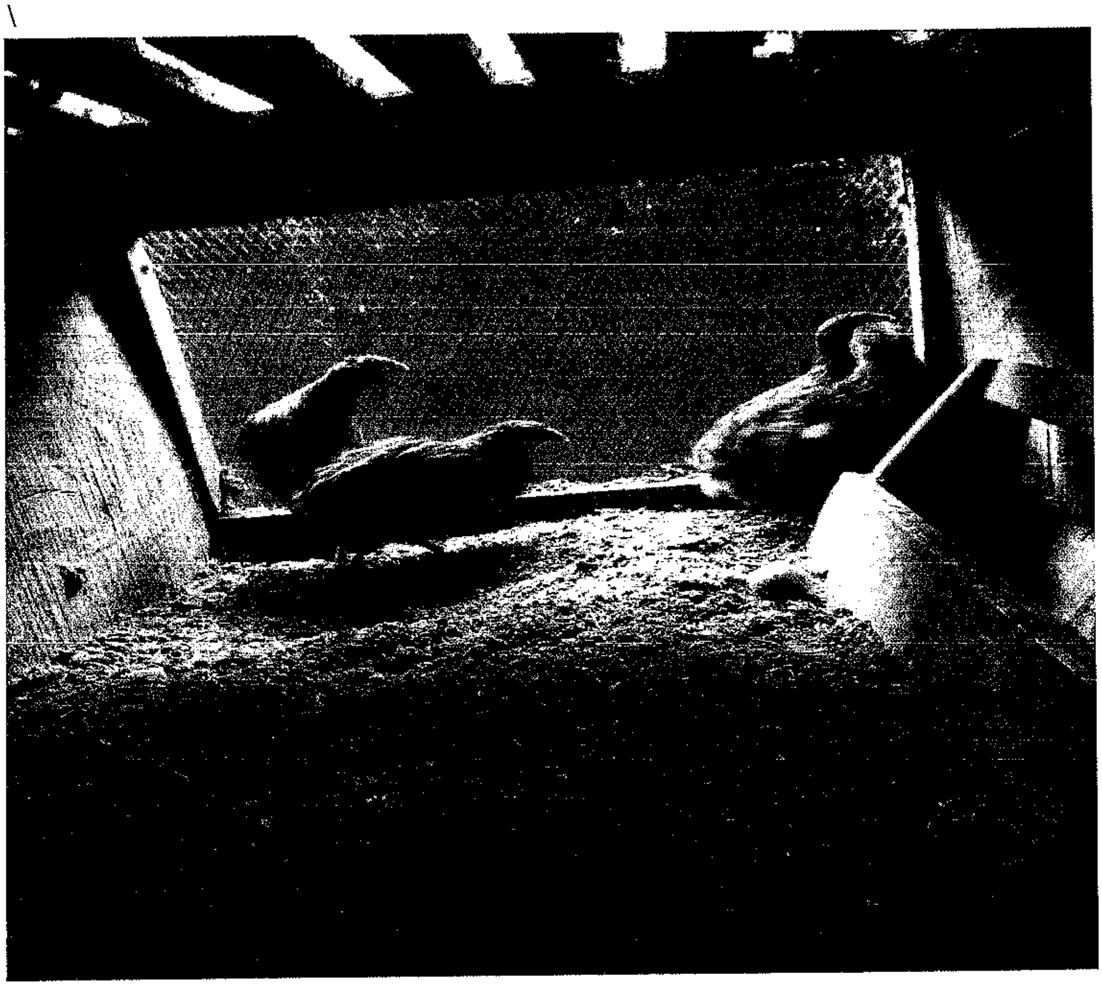

Figure 2: Quail birds

CHAPTER FOUR

4.0. RESULTS

4.1. Effect of Initial Body Weight and Feed Quantity on Egg Laying Performance

Table 2 show the result of the effect of initial body weight on Japanese quail. The table shows that there are significant difference of ($P<0.05$) in the feed in take per week where birds with initial higher body weight has more feed in take than the birds with lower initial body weight. It was also revealed that feed in take per day per hen and egg number per day were not significantly different at ($P < 0.05$).

The table also shows that the weight of the eggs laid weekly and daily and also the average egg weight of the birds with initial body weight greater than 120g are much higher than those with initial body weight lower than 120g and are significantly different at ($P < 0.01$). The feed conversion ratio, feed cost per egg and also per dozen egg laid are not significantly different between the two groups, so also is the number eggs laid per week, and the hen-day egg production. The number of egg laid per hen per week was significant at ($P<0.05$).

Table 3 shows the effect of feed quantity given to different groups of Japanese quail on their laying performance. Laying performance such as the egg weight per week, average egg weight, egg weight per day and the egg number per week shows no significant difference between the birds offered 25g and the ones offered 30g. Egg number per day was significant at ($P<0.05$).

The table shows that the quantity of feed given to the birds influence the feed cost per day, feed cost per egg and feed cost per dozen egg laid by the birds. The feed cost per day for birds given 25g and 30g is ₦19.89 and ₦23.49 respectively and are significantly different at ($P < 0.001$) while that of feed cost per egg birds given 25g and 30g is ₦6.94 and ₦7.93 respectively which makes them to be significant at ($P<0.05$). Feed intake per day and feed intake per week are also significant at ($P < 0.001$) so also is the feed intake per hen per day.

The table also reveals that feed conversion ratio does not influenced by the difference in feed quantity and are not significantly different at ($P < 0.05$) while egg number per hen per week in significantly at ($P < 0.01$).

Table 4 shows the effect of period on the laying performance of Japanese quail. The table shows that there was no difference in the feed intake per hen per day throughout the periods.

All other parameters were highly significant at (P<0.001), parameters include feed intake per day and per week, feed cost per day, feed cost per egg, feed cost per dozen egg, feed conversion ratio, egg number and egg weight per week, average egg weight, egg number and egg weight per day, egg number per hen per week and the hen-day egg production.

Table 5 shows the interaction between the body weight and feed quantity on the laying performance of Japanese quail. The table reveals that feed in take per week, feed intake per day per hen and feed intake per day are highly significant at (P<0.001). The table also shows that the effect of the interaction between the body weight and feed quantity is highly significant at (P<0.001) on the feed cost day.

There was no significant difference in the effect of the interaction on feed conversion ratio, feed cost per egg and feed cost per dozen.

The egg number and egg weight per week and the egg number and egg weight per day were also significant at (P<0.001). The result reveals that there was no interaction between body weight and feed quantity on the average egg weight, egg number per hen per week and the hen-day egg production.

Table 6 shows that there is no interaction between the body weight of Japanese quail and the periods on laying performance of Japanese quail and also table 7 show that there is no interaction between feed quantity and periods on the laying performance of Japanese quail as all the parameters are not significantly different at (P<0.05).

4.2. Effect of Egg Storage Length on Egg Quality Parameters

Table 8 shows the result of the effect of the difference in storage length on egg quality parameters of Japanese quail. The result shows that there were significant difference of ($P < 0.05$) in the weight of the eggs after storage and the weight of the yolk.

The result also shows that there were significant difference of ($P < 0.001$) in height of the yolk, yolk index and the yolk diameter after storage for different number of days.

Egg quality parameters such as length of egg, egg diameter, yolk colour, albumen weight, albumen height, shell weight, egg shape index, haugh unit and shell thickness have no significant difference.

Table 2: EFFECT BODY WEIGHT ON EGG LAYING PERFORMANCE

VARIABLES	W1	W2	SEM	LOS
Feed intake(g)	968.72^{b}	1044.50^{a}	14.61	*
Feed intake/day/kg	0.15^{b}	0.16^{a}	0.002	**
Feed cost/day(₦)	20.83^{b}	22.49^{a}	0.29	**
Feed cost/egg(₦)	7.29	7.56	0.11	NS
Feed cost/dozen(₦)	87.52	90.74	1.31	NS
Feed intake/day(g)	145.69^{b}	157.32^{a}	1.99	**
Feed intake/day/hen(g)	26.21^{b}	26.37^{a}	0.11	NS
FCR	6.79	5.92	0.28	NS
Egg number/week	19.40	20.80	0.34	NS
Egg weight/week(g)	171.21^{b}	202.90^{a}	3.81	**
Average egg weight(g)	8.81^{b}	9.71^{a}	0.10	***
Egg number/day	2.94^{b}	3.17^{a}	0.05	NS
Egg weight/day	25.98^{b}	30.94^{a}	0.55	**
Egg number/hen/week	3.72^{a}	3.60^{b}	0.05	*
Hen day egg production	55.22	53.19	0.71	NS

SEM = standard error of mean, LOS = Level of significance.
ab = means with different superscript in the same row are significantly different
NS = Non-significant, * = Significant at P<0.05, *** = highly significant at P<0.001.
W1= less than 120g, W2= above 120g

Table 3: EFFECT FEED QUANTITY ON EGG LAYING PERFORMANCE

VARIABLES	T1	T2	SEM	LOS
Feed intake(g)	923.29[b]	1093.24[a]	14.61	***
Feed intake/day/kg	0.14[b]	0.16[a]	0.002	***
Feed cost/day(₦)	19.89[b]	23.49[a]	0.29	***
Feed cost/egg(₦)	6.94[b]	7.93[a]	0.11	*
Feed cost/dozen(₦)	83.22[b]	95.21[a]	1.31	*
Feed intake/day(g)	139.72[b]	164.35[a]	1.99	***
Feed intake/day/hen(g)	24.05[b]	28.57[a]	0.11	***
FCR	5.70[b]	6.99[a]	0.28	NS
Egg number/week	20.86[a]	19.39[b]	0.34	NS
Egg weight/week(g)	182.43	192.63	3.81	NS
Average egg weight(g)	9.28	9.27	0.10	NS
Egg number/day	2.95[b]	3.17[a]	0.05	*
Egg weight/day	27.78	29.29	0.55	NS
Egg number/hen/week	3.51[b]	3.81[a]	0.05	**
Hen day egg production	52.66	55.78	0.71	**

SEM = standard error of mean, LOS = Level of significance.
abc = means with different superscript in the same row are significantly different
NS = Non-significant, * = Significant at $P<0.05$, ** = very significant at $P<0.01$, *** = highly significant at $P<0.001$. T1= 25g feed, T2 = 30g feed

TABLE 4: EFFECT OF PERIOD ON LAYING PERFORMANCE OF JAPANESE QUAIL

VARIABLES	P1	P2	P3	P4	SEM	LOS
Feed intake(g)	1279.44^{a}	1036.12^{b}	761.90^{c}	572.50^{d}	14.61	***
Feed intake/day/kg	0.18^{b}	0.16^{a}	0.12^{c}	0.08^{d}	0.002	***
Feed cost/day(₦)	26.13^{a}	23.29^{b}	17.03^{c}	11.69^{d}	0.29	***
Feed cost/egg(₦)	9.01^{a}	6.32^{b}	6.60^{b}	8.43^{a}	0.11	***
Feed cost/dozen(₦)	108.16^{a}	75.80^{b}	79.23^{b}	101.18^{a}	1.31	***
Feed intake/day(g)	182.78^{a}	162.95^{b}	119.17^{c}	81.79^{d}	1.99	***
Feed intake/day/hen(g)	26.47	26.73	25.21	27.36	0.11	NS
FCR	9.26^{a}	4.58^{b}	5.05^{b}	6.11^{b}	0.28^{b}	***
Egg number/week	21.43^{b}	23.74^{a}	16.87^{c}	9.86^{d}	0.34	***
Egg weight/week(g)	186.27^{b}	231.17^{a}	160.28^{c}	94.91^{d}	3.81	***
Average egg weight(g)	8.48^{b}	9.74^{a}	9.56^{a}	9.67^{a}	0.10	***
Egg number/day	3.06^{b}	3.78^{a}	2.62^{c}	1.41^{d}	0.05	***
Egg weight/day	26.61^{b}	36.74^{a}	24.80^{b}	13.56^{c}	0.55	***
Egg number/hen/week	3.17^{c}	3.93^{b}	3.64^{b}	4.59^{a}	0.05	***
Hen day egg production	45.23^{c}	62.44^{a}	56.64^{b}	47.53^{c}	0.71	***

SEM = standard error of mean, LOS = Level of significance. FCR= feed conversion ratio
abcd = means with different superscript in the same row are significantly different
NS = Non-significant, * = Significant at $P<0.05$, *** = highly significant at $P<0.001$.
P1= period of May-July, P2= period of August-October, P3= November-January, P4= February-April

TABLE 5: EFFECT OF THE INTERACTION BETWEEN BODY WEIGHT AND FEED QUANTITY ON LAYING PERFORMANCE OF JAPANESE QUAIL

VARIABLES	WF1	WF2	WF3	WF4	SEM	LOS
Feed intake(g)	682.38	1015.11	1067.70	903.71	14.61	***
Feed intake/day/kg	0.10	0.15	0.16	0.14	0.002	***
Feed cost/day(₦)	14.47	21.79	22.94	19.38	0.29	***
Feed cost/egg(₦)	6.93	7.61	7.75	8.05	0.11	NS
Feed cost/dozen(₦)	83.16	91.28	93.02	96.61	1.31	NS
Feed intake/day(g)	101.21	152.46	160.45	135.57	1.99	***
Feed intake/day/hen(g)	23.55	24.82	28.95	28.21	0.11	***
FCR	5.94	5.74	7.10	6.22	0.28	NS
Egg number/week	14.21	20.33	20.73	17.02	0.34	***
Egg weight/week(g)	125.84	199.18	183.88	166.70	3.81	***
Average egg weight(g)	8.90	9.73	8.99	9.80	0.10	NS
Egg number/day	2.72	3.09	3.14	2.58	0.05	***
Egg weight/day	18.86	30.21	27.80	25.28	0.55	***
Egg number/hen/week	3.75	3.53	4.16	3.86	0.05	NS
Hen day egg production	51.52	49.42	57.29	53.43	0.71	NS

SEM = standard error of mean, LOS = Level of significance. FCR= feed conversion ratio
NS = Non-significant, *** = highly significant at $P<0.001$.
WF1= below 120g and 25g feed, WF2= below 120g and 30g feed
WF3= above 120g and 25g feed, WF4= above 120g and 30g feed

TABLE 6: EFFECT OF INTERACTION BETWEEN BODY WEIGHT AND PERIOD ON LAYING PERFORMANCE OF JAPANESE QUAIL

VARIABLES	P1	P2	P3	P4	P1	P2	P3	P4	SEM	LOS
		(Below-	120g)			(Above-	120g)			
Feed intake(g)	1245.52	974.91	729.13	550.60	1228.34	1015.69	890.12	643.50	14.61	NS
Feed intake/day/kg	0.18	0.15	0.11	0.08	0.18	0.16	0.14	0.09	0.002	NS
Feed cost/day(₦)	25.41	21.90	16.27	11.22	26.31	22.88	19.92	13.24	0.29	NS
Feed cost/egg(₦)	8.94	6.21	6.45	7.77	8.99	6.34	7.03	8.96	0.11	NS
Feed cost/dozen(₦)	107.25	74.56	77.35	93.21	107.86	76.08	84.31	107.52	1.31	NS
Feed intake/day(g)	177.78	153.20	113.84	78.51	184.05	160.05	139.36	92.61	1.99	NS
Feed intake/day/hen(g)	26.34	26.28	25.25	27.12	26.31	26.72	26.51	26.52	0.11	NS
FCR	10.19	4.71	5.44	5.74	8.24	4.40	4.81	6.48	0.28	NS
Egg number/week	20.66	22.49	16.57	10.15	21.90	23.37	18.74	10.69	0.34	NS
Egg weight/week(g)	163.93	209.87	145.37	95.29	200.39	234.90	191.84	104.62	3.81	NS
Average egg weight(g)	7.93	9.32	9.01	9.51	8.98	10.04	10.28	9.76	0.10	NS
Egg number/day	2.95	3.57	2.56	1.45	3.13	3.73	2.93	1.542	0.05	NS
Egg weight/day	24.11	33.34	22.27	13.59	28.63	37.40	29.89	15.07	0.55	NS
Egg number/hen/week	3.19	3.98	3.77	4.86	3.14	3.88	3.57	4.19	0.05	NS
Hen day egg production	45.58	62.80	58.33	50.92	44.86	61.82	55.87	55.82	0.71	NS

SEM = standard error of mean, LOS = Level of significance.
ab = means with different superscript in the same row are significantly different
NS = Non-significant, * = Significant at P<0.05, *** = highly significant at P<0.001
P1= period of May-July, P2= period of August-October, P3= November-January, P4= February-April

TABLE 7: EFFECT OF THE INTERACTION FEED QUANTITY AND PERIOD ON LAYING PERFORMANCE OF JAPANESE QUAIL

VARIABLES	P1	P2 (25g	P3 Feed)	P4	P1	P2 (30g	P3 Feed)	P4	SEM	LOS
Feed intake	1171.28	917.27	711.78	594.66	1362.58	1073.33	907.47	599.44	14.61	NS
Feed intake/day/kg	0.17	0.14	0.11	0.09	0.20	0.17	0.14	0.09	0.002	NS
Feed cost/day	23.90	20.52	15.93	12.18	27.82	24.26	20.26	12.28	0.29	NS
Feed cost/egg	8.13	6.13	6.41	8.41	9.79	6.43	7.06	8.32	0.11	NS
Feed cost/dozen	97.59	73.51	76.92	100.86	117.52	77.13	84.74	99.87	1.31	NS
Feed intake/day	167.20	143.52	111.43	85.20	194.63	169.72	141.77	85.93	1.99	NS
Feed intake/day/hen	24.13	24.16	23.62	24.82	28.52	28.84	28.14	28.82	0.11	NS
FCR	8.04	4.55	4.62	6.16	10.39	4.55	5.63	6.06	0.28	NS
Egg number/week	21.31	21.51	16.01	10.25	21.35	24.35	19.31	10.60	0.34	NS
Egg weight/week	186.86	205.03	158.97	99.19	182.46	239.74	178.24	100.72	3.81	NS
Average egg weight	8.43	9.49	9.74	9,60	8.48	9.86	9.56	9.68	0.10	NS
Egg number/day	3.04	3.41	2.50	1.47	3.04	3.89	2.99	1.52	0.05	NS
Egg weight/day	26.67	32.50	24.75	14.21	26.06	38.24	27.42	14.44	0.55	NS
Egg number/hen/week	3.17	3.75	3.48	4.15	3.16	4.12	3.86	4.90	0.05	NS
Hen day egg production	45.26	58.94	54.30	43.39	45.18	65.68	59.90	50.68	0.71	NS

SEM = standard error of mean, LOS = Level of significance.
ab = means with different superscript in the same row are significantly different
NS = Non-significant, * = Significant at P<0.05, *** = highly significant at P<0.001
P1= period of May-July, P2= period of August-October, P3= November-January, P4= February-April

Table 8: EFFECT STORAGE LENGTH ON EGG QUALITY PARAMETERS

Variable	7 days	14 days	21 days	SEM	LOS
Initial egg weight (g)	9.72	9.75	9.83	0.109	NS
Final egg weight (g)	9.26[a]	9.22[a]	8.68[b]	0.102	*
Egg length (mm)	30.39	30.35	30.17	0.187	NS
Egg width (mm)	23.91	24.19	24.21	0.150	NS
Yolk weight (g)	3.44[a]	3.44[a]	3.13[b]	0.056	*
Yolk height (mm)	7.78[a]	6.26[b]	5.71[c]	0.090	***
Yolk diameter (mm)	27.69[b]	31.34[a]	32.33[a]	0.251	***
Yolk colour	4.63	4.96	4.50	0.210	NS
Albumen weight (g)	4.29	4.15	3.93	0.068	NS
Albumen height (mm)	3.91	3.63	3.84	0.062	NS
Shell weight (g)	1.03	1.05	1.03	0.020	NS
Shell thickness	0.20	0.21	0.24	0.011	NS
Yolk index	28.22[a]	20.22[b]	17.77[c]	0.365	***
Haugh unit	78.72	79.83	80.76	0.725	NS
Egg shape index	88.18	80.76	88.26	0.368	NS

SEM = standard error of mean, LOS = Level of significance.

abc = means with different superscript in the same row are significantly different

NS = Non-significant, * = Significant at $P<0.05$, *** = highly significant at $P<0.001$.

CHAPTER FIVE

5.0. DISCUSSION

5.1. EFFECT OF INITIAL BODY WEIGHT AND FEED QUANTITY ON EGG LAYING PERFORMANCE OF JAPANESE QUAIL

According to the present study the weight of the eggs produced by the birds in group with body weight lower than 120g and group with body weight above 120g are very significant at ($P<0.01$) with mean weight of 25.98g and 30.94g respectively per day. The weight of egg laid by group with body weight lower than 120g and group with body weight above 120g per week was also found to be very significant with mean weight of 171.21g and 202.90g respectively. Group W2 with higher body weight lay egg with the highest egg weight. This result was the same with the experiment of (Jatoi, *et al.*, 2013) who study flock of imported Japanese quail local breed and reported significant ($P<0.05$) higher egg weight in the imported breed. Average egg weight was found to be highly significant at ($P<0.001$).

(Shoukat *et al.*, 1988) reported that apart from breed and strain, the size and weight of an egg also depend on the individual which can result in variation in egg weight within a flock. This same result have been reported by (El-Fiky *et al.*, 2000), (Aboul-Hassan 2001). (Juliank and Christians, 2002) stated that egg size increases with increase in the age of the bird. The result of this experiment is also comparable to the findings of (El-Sagheer and Hassanein 2006) and (Kirikci *et al.*, 2007) who observed that heavy eggs were obtained from the heavy birds and the light eggs were produced by the small size birds. It has further been indicated that a positive correlation exists between body weight and egg weight (Siegel, 1962). It was also reported by (Lacin *et al.*, 2008) that egg weight was lower in the group with low body weight than those of medium and heavy hens, respectively.

The difference in the initial body weight of quail affect the egg produced per hen per week in this experiment and was significantly different at ($P<0.05$) with the birds with lower body weight producing more eggs than those with higher body weight. (Akhtar *et al.*, 2007) and (Genchev and Kabakchiev, 2009) also reported that there was significant difference in egg production in breeds with higher body weight and breeds with lower body weight and attributed it to the better genetic potential of the breed with higher production. (Hanan, 2010) also reported highly significant differences in egg number and egg production percent in Japanese quails. (Jatoi, *et al.*, 2013) reported that the difference in quantity of egg laid by each group could be attributed to the variation in the number of the ovarian follicle in the groups.

This present study shows that there was no significant difference in feed conversion ratio of the two groups. These results are similar to those of (Jatoi *et al.*, 2013) and (Rehman, 2006) who indicated non-significant difference in FCR (g feed/egg) between different local and imported flocks of Japanese quails. (Kingori *et al.*, 2003) reported that in pullets, feed conversion is the best when the young age of the hen, it then gradually decreases with age. (Varkoohi *et al.*, 2010) experiment does not agree with the result of the present study who reported 18.4 percent cumulative genetic improvement in FCR or 6.1 percent improvement per generation of quails through selection.

The feed intake was found to be significantly different at ($p<0.05$) in which the group with higher body weight consume more feed than the ones with lower body weight which makes the feed cost per day to be also significantly different at ($p<0.01$) in which the feed given to the birds in the group with higher body weight to cost more than the group with the lower body weight. (Jatoi, *et al.*, 2013) reported that feed consumption is a variable phenomenon which is influenced by various factors such as strain of the bird, energy content of the diet, ambient temperature of the farm, floor density, hygienic conditions and rearing environments. Feed cost per egg and feed cost per dozen egg were not affected by the difference in the initial body weight.

This experiment also shows that irrespective of the initial body weight of Japanese quail, the hen-day egg production is not affected.

According to this present study, the effect of feed quantity on the feed intake per hen was found to be significantly different at ($P<0.001$) and feed cost per egg was also significant at ($P<0.05$) but has no effect on the egg weight of Japanese quail as they are not significantly different at ($P<0.05$). (Saad *et al.*, 2015) reported a significant difference of ($P<0.05$) in feed intake of Japanese quail. (Leeson *et al.*, 1992) reported that variation in feed consumption could be caused by environmental condition such as temperature. The hen-day egg production was significantly different at ($P<0.01$) which shows that feed quantity does influence the hen-day egg production of Japanese quail. However, the feed conversion ratio was not significantly different at ($P<0.05$).

The number of eggs laid per day was found to be significantly different at ($P<0.05$) while the number of egg laid per hen per week was very significantly different at ($P<0.01$). This shows that the quantity of feed that is given to Japanese quail affect the quantity of eggs that they lay.

Effect of the periods on the feed in take of Japanese quail was highly significant at ($P<0.001$) so as also is the feed cost per egg and feed cost per day. Feed conversion ratio was higher at P1 than other periods. The feed conversion ratio was also highly significant, this is in line with the report of (Sekeroglu *et al.*, 2014).

Hen-day egg production, average egg weight, egg number produced per hen per day and egg number produced per day was also significantly different at ($P<0.001$). The hen-day production of the P1 is lesser than other periods so also is the average weight. This shows that as the hen grows and their body weight increases, the weight of the egg laid also increases. In support of this experiment, (Baumgartner *et al.*, 2007), (Johnston and Gous, 2007) and (Zita *et al.*, 2009) showed that egg weight increases with the age of hens. Contrary to this experiment, (Zemková *et al.*, 2007) demonstrated that egg weight was not influenced significantly by the age of hens.

The difference in the age period does not affected the feed intake per day each hen as it was not significantly different at ($P<0.05$).

The interaction between body weight and feed quantity shows that the average egg weight and number of eggs per hen per week were not significantly different at ($P<0.05$). Also, the feed conversion ratio, feed cost per egg and feed cost per dozen were not affected by the interaction between body weight and feed quantity.

Feed intake and feed cost per day were found to be significantly different at ($P<0.001$). The group with low body weight and low feed quantity (WF1) are seen to produce lower eggs and lower egg weight while those with higher body weight and feed quantity (WF4) produce more eggs with higher weight. There is positive correlation between the feed consumed and the produced. Summers (1987) and Harms *et al.*, (1982) also reported , that were significant relationship between the body weight of Japanese quail and the quantity of feed given.

It was determined in this experiment that the interaction between body weight and the different periods and the interaction between the quantity of feed given to Japanese quail and the different periods used in this experiment were not significantly different and therefore does not affect the egg laying performance of Japanese quail.

5.2. EFFECT OF STORAGE LENGTH ON EGG QUALITY PARAMETERS

In this present study, it was realized that there were significant difference of ($P < 0.05$) in the weight of the eggs after storage and the weight of the yolk. There was no difference in the weight loss of the egg stored for 7 days and 14 days but there were difference in the weight of the eggs stored for 21 days. This result correspond with the research conducted Rhode island Red Chicken by (Khan, *et al.*, 2014) who further explained that weight losses occur when eggs are stored at room temperature (15 °C) and 80% RH and these losses which occur during the storage of eggs, are related to the temperature and humidity of the environment during the storage of eggs, are also related to the temperature and humidity of the environment all through the storage period. (Dudusola, 2009) also reported that increase in length of storage, egg weights declined as a result of increase in weight losses. The losses could be due to loss of carbon dioxide, ammonia, nitrogen, hydrogen sulphide gas and water from the eggs.

There was no significant difference in albumen weight in this study unlike other study by (Marek *et al.*, 2017) who said that there was significant difference in albumen weight due to loss of water and carbon dioxide from the egg albumen there occurs thinning of its thick fraction, which is characteristic of the advanced ageing process in the egg. (Inci *et al.*, 2015) also reported that there was decrease in albumen weight as storage length increases and that it was due to storage temperature.

This study also proved that yolk index decreases with length of storage which was also the same with what (Dudusola, 2009) reported and further explained that it was due to breakdown of the fibrous glycoprotein ovomucin. This result also correspond with the reports of (El-Tarabany *et al.* 2015), (Wilkanowska and Kokoszyński, 2012) and (Inci *et al.*, 2015).

(Dudusola, 2009) also indicated that egg yolk diameter increased with storage time due to movement of water from the albumen to the yolk as a result of osmotic pressure differences this was in line with this study as the mean if the yolk diameter at 7 days, 14days and 21 days are 27.69mm, 31.34mm and 32.33mm respectively. (Nowaczewski *et al.*, 2010) also supported that yolk index decreases with increase in storage length.

There was no significant difference in the Haugh unit according this study. The result (Nowaczewski, 2010) experiment contradicted this study. They reported that there was a significant difference in the Haugh unit.

Yolk height and yolk weight were both found to be significantly different in this study. Yolk height was seen to be high after storage for 7 days and continue to reduce as the storage length increases. The mean of the yolk height after storage for 7 days, 14 days and 21 days are 7.78mm, 6.26mm, 5.71mm respectively. This could be due to passage of water from the albumen into the egg yolk which reduces the firmness if the yolk and makes it spread out. Yolk weight also reduces as the storage length increases. (Sylvie *et al.*, 2018) also found decrease in yolk weight as the storage length increases. (Olawumi and Babatope, 2016) also found significant difference in yolk weight, yolk diameter and yolk size in the difference in storage length of Japanese quail.

Yolk colour is not affected by storage. The yolk color of Japanese quail eggs is one of the important characteristics of egg quality. However, this fact is very easily influenced, especially by feeding a feed, either in the form of natural, i.e green feed, or in the form of carotenoid-enriched compound feeds. (Sylvie *et al.*, 2018).

CONCLUSION

In conclusion, the initial body weight of Japanese quail affected egg weight where it was observed that birds with higher body weight produced eggs with higher weight but body weight had no effect on the quantity of egg produced and feed intake per hen per day.

Feed quantity had effect on feed intake of Japanese quails which made the feed cost to be affected as well in which high feed quantity led to high feed intake and high feed cost. Feed quantity affect feed intake and egg number but did not affect egg weight. Production increased with age and started declining. Also the interaction between body weight and feed quantity was observed to affect the egg number produced and the feed intake.

It was found that no interaction exist between age and body weight and between age and feed quantity on the laying performance of Japanese quail.

Also, Japanese quail eggs can be stored till 21 days and it will still be fit for consumption because there was no significant difference in the important egg quality parameters that determines the fitness of egg such as Haugh unit.

It is recommended that feed quantity should be considered properly by farmers as feed quantity is an important factor in production cost and profitability in Japanese quail farm business. It helps farmers to determine amount to be spent on feed and quantity to be given so that the birds can produce at their maximum potential with the lowest cost.

Body weight should also be taken into consideration as it plays a vital role in the weight of egg produced and also determines when birds start laying eggs which is important for the business to be profitable.

Finally, quail eggs are better stored for a shorter period of time as the quality of the egg reduces with the length of storage.

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