THE EFFECTS OF STORAGE METHOD AND DURATION ON THE QUALITY OF JAPANESE QUAIL EGGS

(*Coturnixcoturnix japonica*)

BY

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DECLARATION

I, AKINDEKO OLUWADAMILOLA AYOMIDE hereby declare that this project **"The Effects of Storage Method and duration on The Quality of Japanese Quail Eggs** ***(Corturnixcorturnixjaponica)*"** has been written by me and that is a record of my own research work. It has not been presented before in any previous application of a degree or any reputable presentation elsewhere. All references have been duly acknowledged.

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AKINDEKO OLUWADAMILOLA.A DATE

CERTIFICATION

This is to certify that this research project entitled **The Effects of Storage Method and duration on The Quality of Japanese Quail Eggs** was carried out by AKINDEKO OLUWADAMILOLA AYOMIDE in the Department of Animal Production and Health, Federal University OyeEkiti,Ekiti State for Award of Bachelor Degree in AGRICULTURE.

______________________________ ______________________

Dr. Mrs. Modupe ORUNMUYI **DATE**

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Dr. A.H. Ekeocha **DATE**

HOD

DEDICATION

This project work is dedicated to Almighty God who is my creator and guardian, without him this project won't be a success. He was with me through it all, financially, morally and physically. I also dedicate this work to my mother, MrsBamideleE.A, after God, she is next in my life.

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ABSTRACT

The experiment was conducted to evaluate the effect of storage method and durationon external and internal qualities of Japanese quail eggs for three storage method(oiling, earthen pot and room temperature) and four storage durations (7,14,21 and 28 days) were used. A total of three hundred and ten eggs were used for this experiment. Eggs were collected daily then oiled and stored on a tray while some where unoiled and stored in an earthen pot and at room temperature (22-24°C) for 7, 14, 21 and 28 days. At the designated day, the eggs were processed to evaluate their internal and external qualities. All data collected were subjected to analysis of variance (ANOVA) using GLM procedure of SAS (2008). Means separation was done using Tukey's Honesty Significant Difference of SAS Procedure.There was no significant difference between the storage methods for the egg height. Also, the Egg breadth for Control (24.45) was significantly different from Room temp (23.75), earthen pot (23.27) and Oiling (23.76). There was significant difference between the yolk height at Control (8.806), oiling (6.67), room temp (6.07) and earthen pot (5.68). The yolk diameter showed significant difference ($P > 0.05$) between control (23.58), Room temperature (27.02), earthen pot (26.34) and Oiling (25.03). The yolk diameter of oiled and earthen pot stored eggs did not differ ($P>0.05$) from each other but were significantly ($P<0.05$) different from those of eggs stored at room temperature. Albumen weight in control (5.41) was highly significant to earthen pot (3.48), significant to oiling (3.92) and room temperature (3.84) which is due to the different storage methods used. Albumen height showed that the control experiment (3.81) was significant to oiling method (3.33), room temp stored eggs (3.14) and earthen pot stored eggs (3.04). Shell weight showed that room temp stored eggs (1.31) was significant to oiled eggs (1.29), earthen pot eggs (1.29) and control (1.19); this was due to the effect of storage method used. All eggs stored in the different methods, increased egg percent yolk weight, yolk diameter and reduced Haugh units, percent albumen weight, albumen height, yolk height at 28 days of storage. Yolk colour changed during the

whole storage period, especially at 28 days. However, eggs oiled showed better quality up to 28 days and in earthen pot up to 14 days.

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CHAPTER ONE

1.0 INTRODUCTION

The quail egg is considered a nutritive food for human consumption, being one of the best and most economical sources of high quality protein, since its composition meets the most essential amino acids, as well as vitamins, minerals and fatty acids requirements(Moura*et al.*, 2010). However, for the nutritional potential of quail egg to remain totally available for human consumption, the egg must be preserved during the storing period, since it may take weeks between the time of laying and its acquisition and preparation; thus, the greater this period, the worse the internal quality of the eggs, since they depreciate continuously after laying. (Moura*et al.*, 2008). Japanese quails are small sized, hardy and prolific that thrives in small cages (Maurice and Randall, 2006) and lay their first eggs between the 5th and 6th week of age (Martins, 1999). Garcia (2005) reported that the meat is lean and the egg is low in cholesterol which is of public health importance. Japanese quail eggs have mottled brown colour and are often covered with a light blue, chalky material. Each hen appears to lay eggs with a characteristic shell pattern or colour, while some strains lay only white eggs.

Several studies have shown that the deterioration of chicken and quail eggs at room temperature is greater than when refrigerated. In this sense, cooling is the primary means of conserving the egg internal quality (Xavier*et al.*, 2008). However, Brazilian law does not require that eggs are kept under refrigeration, being most of them stored in sales markets at room temperature, and, in some cases, they are only cooled at consumers' home (Moura*et al.*, 2008).

The process of depreciation or loss of egg internal quality usually occurs in function of decomposition of carbonic acid into carbon dioxide and water. As carbon dioxide is led to the outside in function of porosity of the eggshell, the remaining water promotes the liquefaction of albumen, causing an increase in pH, leading to a dissociation process with protein complexion. In addition to increasing the size of the air chamber, the yolk also undergoes changes becoming wider and having a weakened membrane. Rodrigues and Salay (2001) explained that this process leads to a deterioration of flavor and odor of the egg.The egg becomes improper for consumption when the yolk unites at one end or laterally, or when there is disruption of the vitelline membrane and the albumen and yolk are mixed (Santos and Espíndola*et al.*, 2009). It may happen to eggs due to changes resulting from aging, microbial deterioration, dehydration of the cuticle that seals the pores of the shell, and shrinkage by increasing the porosity of the shell to air and microorganisms. The significance of protein from animal protein sources such as poultry in sufficient and balanced nourishment is considerable for the human health with respect to the physical and mental progress (Jacqueline *et al.*, 1998;Stadelman, 1994).

Eggs provide means through which the animal protein of the populace can be met.Scott and Silversides (2001) reported that it has various uses and contains many essential nutrients as it supports life during embryonic growth and one of the most nutritious and complete food known to man. However, egg quality characteristics, utilization for food, storage and other purposes have been studied mostly in chicken egg.Egg quality is composed of those characteristics of an egg that affect its acceptability to consumers, it is therefore important that attention is paid to the problems of preservation and marketing of eggs to maintain the quality (Adeogun and Amole,2004). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumer's acceptability of shell eggs. On the other hand, interior characteristics such as yolk index, Haugh unit, and chemical composition are also important in egg product industry as the demand for liquid egg, frozen egg, egg powder and yolk oil increases (Scott and Silversides, 2001).

Eggs deteriorate in internal quality with time and this is depending on the shell and internal content of the egg (Adeogun and Amole 2004;Kul and Seeker , 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. Since storage environment influence the quality of eggs, methods like lower temperature and modified atmosphere packaging such as refrigeration have been recommended (Kul and Seeker, 2004). Japanese quails are characterized by laying similar to that of hens (Baumgartner, 1994;Koźleckaet *al.*, 2006). A prolonged, year-long laying period and egg production during this period all indicate usefulness of investigations of Japanese quail eggs. It should be stressed that Japanese quails reach sexual maturity very early (approximately at 6th week of life) which can be related to a deteriorating egg quality at the peak of laying (Nasrollah*et al.*, 2006;Adamski,2008). Mielenz*et al.* (2000),Kul and Seker(2004):Ri*et al.* (2005),Mennicken et al. (2005):Ayasan*et al.* (2006):Tarasewicz*et a*l. (2006),Sezer,(2007), Sultana *et al.* (2007),Adamski,(2008) and Nowaczewski*et al.* (2010) in experiments on quality the above researchers analysed such external egg traits as: dimensions (width and length), shape and shell index as well as the egg content – yolk and albumen features and based their quality assessment of these eggs on their origin and age. In addition, they also examined the impact exerted by different concentrations in feeds of protein and nutritional additives, e.g. probiotics as well as different sources of fat. The above investigations focused mainly on the evaluation of the eggshell quality which deteriorate significantly at the peak of laying (Durmus*et al.*, 2004).It is well known, that external and internal egg traits also can be significantly influenced by the storage time and egg size. Together with the lengthening of the storage period, unfavourable physicochemical changes of their content take place (Jones and Musgrove, 2005 andSamli*et al.* 2005). In hens, it was noticed that eggs stored for more than 10 days were characterized by worse, in comparison with those examined on the day of laying (0 day of storage), white and yolk indices and lower number of Haugh units (Yilmaz and Bozkurt, 2009).

On the other hand, deteriorating egg quality, especially white and shell traits, may be one of the causes of obtaining worse hatching results (Roque and Soares, 1994; Romanov 2002).Baumgartner (1994) andAdamski(2008) reported that the reproduction potential of Japanese quails is apparent not only in the number of laid eggs by also in their high fertilization as well as very good egg hatchability results. In their investigations, Alkan*et al.* (2008) reported a significant influence of the weight of Japanese quail eggs on hatchability traits and demonstrated declining values of hatchability traits together with the increase of egg weight over 12 g.

Similar relationships between the weight of Japanese quail (meat type) eggs and hatchability results were found by Petek*et al.* (2003) and Petek*et al.* (2005).The impact of egg weight on hatchability traits was also determined in other poultry species (among others, in turkey, guinea fowl and geese) (Machal*et al.*, 1994; Applegate and Lilburn, 1996; Narushin and Romanov, 2002;Isguzar, 2005 andAdamski, 2008).

1.1 PROBLEM STATEMENT

Egg gluts occur from time to time, during which many poultry farmers may incur enormous economic losses including those attributable to spoiled unsold eggs. Similarly, eggs also spoil in homes due to inability to refrigerate the eggs as a result of electricity failure which is common in Nigeria. Deterioration in egg quality is attributed to moisture loss and a decline in interior egg quality during extended storage (Wong *et al.*, 1996).

According to Babangida and Ubosi (2005), the Japanese quail has the potential to serve as an excellent and affordable source of animal protein in Nigeria.

However, for the nutritional potential of quail eggs to remain totally available for human consumption, the egg must be preserved during the storing period.

1.2 JUSTIFICATION

Egg quality is composed of those characteristics of an egg that affects its acceptability to consumers such as cleanliness, shell quality, freshness, and size, (Stadelman and Coterill, 1995 and Song *et al.*, 2000), so proper attention to production, distribution and point-of sale phases are of vital importance in maintaining egg quality. The temperature, humidity, storage method and storage time can all have adverse effects on interior egg quality (Samli*et al.*, 2005). Previous study from (Dudusola, 2009)showed that with increase in length of storage, eggs weights declines due to increase in weight losses: these losses could be due to loss of carbon dioxide, ammonia,nitrogen, hydrogen sulphide gas and water from gas and water from the eggs. Also it was observed that weight losses are not same for all kinds of storage methods.

1.3 OBJECTIVES:

This study aims at investigating:

i)The effect of storage methodsi.e. the oiling method, storage at room temperature and in earthen pot on egg quality characteristics of Quail eggs

ii) The effect ofdifferent storage times at 0, 7, 14, 21, 28 dayson quality parametersof Quaileggs

iii) The interaction between and storage methods and storage times on quality parameters of Quail eggs

1.4 HYPOTHESIS

- **Null hypothesis (H_O):** There are no significant effects of storage methods and storage timeson the quality parametersof Quail eggs.
- **Alternate hypothesis (H_A):** There are significant effects of storage methods and storage times on the quality parametersof Quaileggs.

CHAPTER TWO

2.0 LITERATURE REVIEW

QUAILS

Quails are small game birds that are used fr eggs and meat (DAFF, 2013). Quail is a collective name for several genera of mid-sized birds generally considered in the order Galliformes. Old world quail are found in the family phasianidae and new world quail are found in the family Odontophoridae (Cox, Kimball, and Braun 2007). The king quail, a member of the old world quail is often sold in the pet trade and within this trade is commonly referred to as "button quail". The collective noun for a group of quail is a covey or bevy. There are two mainkinds of quails suitable for breeding and they are the "Japanese" quail (Coturnix japonica) and the "American" quail (Coturnixcoturnix).

Japanese quail (Coturnix quail) are from pheasant family and are migratory birds which migrate between Asia and Europe. The region of origin of these birds is believed to be South-East Asia. Back in history, the reference to quail can be traced back in the old testament of the bible (Manna from heaven). In the late 11^{th}century, quail was brought to Japan from China (Onyewuchi et al., 2013).

The Japanese quail was introduced toNigeria only in 1992 (NVRI, 1994).Young Coturnix is yellowish in appearance with stripes of brown and somewhat resemble turkey poults except for size. The newly hatched weigh about 6 - 8grams (Hall, 2012) but grow rapidly during the first few days and are fully feathered at about 4weeks of age. The adult male quail weighs about 100-130 grams (Mizutani, 2003). The male birds can be identified readily by the rusty dark brown colour of the breast feather. Males also have a cloacal gland, a bulbous structure located at the upper edge of the vent which secretes a white foamy material. This unique material can be used to access the reproductive fitness of the males. The young male begins to crow at 5 -6 weeks old. The adult female quail are slightly heavier than the male weighing from 120 - 160 grams (Ortlieb, 2013). The body colouration of the female bird is similar to the male except that the feathers on the throat and upper breast are long, pointed and much lighter Cinnamon. Also the light tan breast feathers are characteristically black-stripped. In order to produce fertile eggs, males and females should be enclosed with a maximum of two females per male (Ranklin*et al.*, 1998).

Quail eggs are characterized by a variety of colour patterns; they range from snow white to completely brown. More commonly, they are tan and dark brown, speckled or mottled brown with a chalky blue covering (Randall and Bolla, 2008). The average egg from mature female weighs about 10grams and contains 158callories of energy, 74.6% water, 13.1% protein, 11.2% fat and 1.1% total ash. The mineral content includes 0.59mg calcium, 220mgphosphorous and 3.8 mg iron (Shim kimfah, 2005). The vitamin content is 300 iu of vitamin A, 0.12mg of vitamin B1, 0.85mg of vitamin B2 and 0.10mg nicotinic acid. Coturnix quail make excellent quail for beginners because they start laying eggs at a young age of approximately 6weeks (Chelmonska, *et al.*, 2008) and can be prepared and eaten at 5weeks of age. According to Hemid, *et al.* (2010), quails have early sexual maturity resulting in a short generation intervals, high rate of lay and much lower feed and space requirements than the domestic fowl. If you are raising quail for a strictly commercial and utilitarian purpose, you can turnover your cortunix quail quite quickly. There are many other types of quail including the popular bob white quail.

There are different ways to house your quail but the easiest way is to use a rabbit hutch. Baby quails are fed with poultry starter feed. There are no known morbid diseases affecting them except respiratory disorder with very low mortality rate (Oluwatomi, 2010).

The eggs are rich in vitamin D, antioxidants which according to Sahin, *et al.* (2008) improve animal origin food quality in terms ofcolor, oxidative stability, tenderness, storage properties, and has positive effects on people with stress problems, hypertension, digestive disturbance, gastric ulcer, liver problems, blood pressure and lipid control, migraine, asthma, anemia, various types of allergies, eczema, heart problems, bronchitis illness, depression, panic and anxiety illness. The nutritional value of quail eggs is 3 - 4 times greater than chicken eggs (Tunsaringkarn*et al.*, 2013). Quails are now also commonly used as an experimental animal for biological research and for producing vaccines against many diseases which they themselves are resistant to (particularly certain strains of Newcastle disease) (Shanaway, 1994). Quail eggs are also known to stimulate growth, increase sexual appetite, stimulate brain functions which improves intelligence quotient and generally rejuvenates the body.

It is recommended for children whether cooked or raw. The consumption of quail eggs fortifies the woman's body during pre and post-natal periods as well as after surgery and radiotherapy. It also has beneficial effects on the foetus (physical and mental balance) and for the mother after delivery (physical rehabilitation and rejuvenation of cells). Quail eggs also improve the quality of breast milk. Quail meat is tastier than chicken and has less fat content. It promotes body and brain development in children. Most of the developing countries are presently at a stage of perpetual protein hunger. Poultry meat and eggs though the major source of animal protein is still now unable to meet up the protein hunger of the world (Igado and Aina, 2010). Commercialization of quail bird production is a recent development in Nigeria (Akpan and Nsa, 2009) while quail farming is an uncommon farming business in Imo State but with lots of potentials. For the few people that have embraced it, they are not only smiling to banks, they are also enjoying both the nutritional and health benefits derived from consuming it.

Quail production is not yet known as compared to the large number of livestock farmers in Imo State due to lack of awareness of the existence of the bird as well as its financial and health benefits.

The high rate of returns and low cost of investment in the production of quail meat and egg are some of the reasons many farmers especially in the north are fast resorting to quail farming. The fact that the birds grow and reach maturity stage faster and lay eggs within two months, compared with the 6months maturity period of chicken for whether egg-laying or consumption will attract farmers who see the business as a better and more sustainable investment to explore. It will also serve as a reference material to those writing on quail bird production.

Plate 1: A quail and its eggs

2.1 NUTRITIONAL COMPONENTS OF QUAIL EGGS

Egg consumption is a popular choice for good nutrients which are obtained from variety of chicken, duck, roe, and caviar, but by a wide margin the egg most often humanly consumed is the chicken egg, typically unfertilized (Applegate, 2000). Besides, a lot of people especially in Asian countries consume quail eggs (or Kai NokKraTha, Thai name) which previous study reported that quail eggs are packed with vitamins and minerals even with their small size, their nutritional value is three to four times greater than chicken egg.

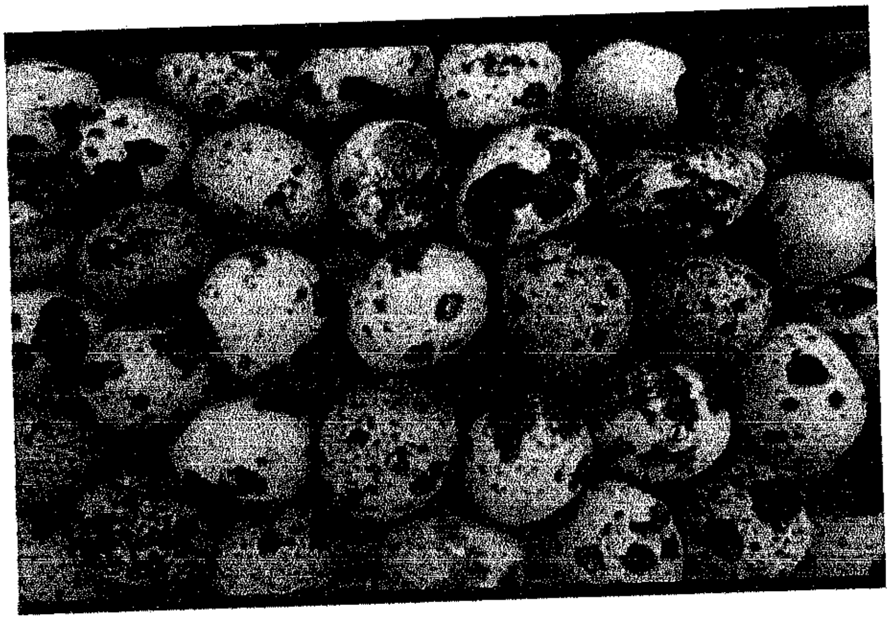

Plate 2: Quail eggs

2.1.1 Nutritional compositions of whole quail eggs, egg whites, and egg yolks

Wholequail eggs is about 10.67gin weight. Their contents of ash, carbohydrate, fat, protein and moisture are 1.06, 4.01, 9.89, 12.7, and 72.25 g 100g-1. Energy obtained from whole eggs is 156.50 kcal 100g-1. Most of nutrients determined in egg yolks were significantly higher in contents than those of egg whites. There are higher proteins content in egg whites. The nutrient compositions of quail eggs has higher ash, carbohydrate (include dietary fiber), fat, protein and calories in egg yolk.

2.1.2 Profile amino acids of quail egg whites

The most essential amino acid (EAA) of egg whites areleucine (1139.0 mg 100g-1), valine (869.5 mg 100g-1) and lysine (790.0 mg 100g-1). Leucine is a branched chain amino acid along with valine and isoleucine. It is beneficial and functional to protein structure for 60-70% in human body, and blood sugar level regulation which maintains a balance of insulin and glucose (Khan, 1999-2012). It proposed as a promising pharmaconutrient in the prevention and treatment of sarcopenia and/or type 2 diabetes (van Loon, 2012). Valine is required for muscle metabolism, repair and growth of tissue and maintaining the nitrogen balance in the body. Valine also assists to regulate blood sugar and energy levels (Vital health zone, 2007a). While lysine is required for growth and bone development in children, it assists in calcium absorption and assists in maintaining the correct nitrogen balance in the body, as well as maintaining lean body mass. Lysine is also needed to produce antibodies, hormones, enzymes, collagen formation as well as repair of tissue (Vital health zone, 2007b). The body consists of the branched chain amino acids, their effects are synergistic when they were taken together. Most of non-essential amino acid are aspartic (1488.0 mg 100g-1), alanine (739.0 mg 100g-1) and serine (665.5 mg 100g-1). Aspartic acid plays a vital role in energy production while alanine plays a key role in maintaining glucose levels in the body by helping the body to convert glucose into energy. Alanine also eliminates excess toxins from the liver (Vital health zone, 2007c, 2007d). They are good health which both NEAA and EAA should be considered in the classic "ideal protein" concept or formulation of balanced diets to maximize protein accretion and optimize health in animals and humans (Wu, 2010).

2.1.3 Profile fatty acids of quail egg yolks

The most essential fatty acid (EFA) in egg yolks are linoleic acid (2.58 g 100g-1), docosahexaenoic acid (0.50 g 100g-1and arachidonic acid (0.44 g 100g-1). Which are UFA. While most non-essential fatty acid (NEFA) in egg yolks are oleic acid (8.84 g 100g-1), palmitic acid (5.13 g 100g-1) and stearic acid (2.03 g 100g-1). Linoleic acid must be consumed for proper health which effects on body composition. A diet only deficient in linoleate causes mild skin scaling, hair loss (Cunnane and Anderson, 1997) and poor wound healing in rats (Ruthig and Meckling-Gill, 1999). Docosahexaenoic acid (DHA) is essential for the growth, visual and functional development of the brain in infants and has a positive effect on diseases such as hypertension, arthritis, atherosclerosis, depression, adult-onset diabetes mellitus, myocardial infarction, thrombosis, and some cancers (Hrrocks and Yeo, 1999; Craig,2005). Arachidonic acid is a polyunsaturated omega-6 fatty acid 20:4(ω-6). Along with omega-3 fatty acids, omega-6 fatty acids play a crucial role in brain function (Wang et al., 2006; Fukaya*et al.*, 2007; Rapoport, 2008) as well as normal growth and development (Auestad et al., 2001; Clandinin*et al.*, 2005 andLeu and Schmidt, 2008). Also known as polyunsaturated fatty acids (PUFAs), they help stimulate skin and hair growth, maintain bone health, regulate metabolism, and maintain the reproductive system (Watkins et al., 2001; Remans*et al.*, 2004 and Kirby, 2004).

Quail eggs have high fat but most of them were UFA which was better for health. The quail eggs has low trans fatty acid which is bad for human health. Consuming trans-fat increases low-density lipoprotein (LDL, or "bad") cholesterol. Food manufacturers in the United States and many other countries list the trans-fat content on nutrition labels. Total unsaturated fatty acid (UFA, 13.3 g 100g-1) is composed of monounsaturated fatty acid

(MUFA, 9.64 g 100g-1) and polyunsaturated fatty acid (PUFA, 3.68 g 100g-1) which is higher than total saturated fatty acid (SFA, 7.41 g 100g-1).

2.1.4Vitamins of quail egg yolk

The fattest soluble vitamins of egg yolks are vitamin E (tocopherol, 5920.0 μg 100g-1) which is higher than vitamin A (717.0 μg 100g-1) and vitamin D (1.14 μg 100g-1). The most vitamin of egg yolks is vitamin E but is low vitamin A and D which is different from previous study which reported that egg yolk is one of the few foods naturally containing vitamin D (NRC, 1976). Vitamin E is a fat-soluble vitamin with antioxidant properties. Vitamin E exists in eight different forms (isomers): alpha-, beta-, gamma-, and delta-tocopherol; and alpha-, beta-, gamma-, and deltatocotrienol but alpha- is the most active form in humans. It has been proposed for the prevention or treatment of numerous health conditions, often based on its antioxidant properties. Its supplementation is linked to a 24% lower risk of cardiovascular death (Lee *et al.*, 2010) and 26% reduces the risk of major cardiac events among women ages 65 and older (Harvard School of Public Health, 2012). Vitamin E might be involved: heart disease (Knekt*et al.*, 1994; Glynn *et al.*, 2007; Traber, 2007), cancer (Weitberg and Corvese, 1997 and Lee *et al.*,2005), eye disorders (Leske*et al.*, 1998 and Jacques *et al.*, 2005) and cognitive decline (Sano *et al.*, 1997; Morris *et al.*, 2002 and Kang *et al.*, 2006). Evidence suggests that regular use of high -dose vitamin E supplements may increase the risk of death from all causes by a small amount, although human research is conflicting. Caution is warranted (Miller *et al.*, 2005; Bjelakovic*et al.*, 2007 and Mayo Clinic, 2011).

2.1.5 Mineral of content of quail eggs

The most essential mineral of whole eggs is nitrogen (6.36 %) which is mostly in egg whites (12.2 %) . While most of trace mineral of whole egg were iron (80.8 mg L-1) and zinc (46.9 mg L-1). Both of iron (116.0 mg L-1) and zinc (70.6 mg L-1) were higher in egg yolks. Nitrogen functions as the component of nucleic acids, proteins, hormones, coenzymes (Soetan*et al.*, 2010). It is especially important during pregnancy. The global nitrogen cycle changes affect human health well beyond the associated benefits of increased food production (Townsend *et al.*, 2003). In addition, most trace minerals in whole eggs are iron and zinc which are higher in egg yolks. Iron has many functions in the body and is also important for maintaining a healthy immune system which is essential for blood to work efficiently. Iron functions as hemoglobin in the transport of oxygen. Iron deficiency is not uncommon among athletes, especially long distance runners which can cause of fatigue among these athletes. If the lack of iron in our bodies is severe, we can get iron deficiency anemia.

Iron deficiency anemia is probably the most common nutritional disease in the world, affecting at least five hundred million people (Mineral Information Institute (Soetan*et al.*, 2010, Mineral Information Institute, 2012). Zinc is involved in well over one hundred different reactions in the body. Some of these reactions help the bodies construct and maintain DNA, the molecule that controls how every single part of our bodies is made and works. It is also needed for the growth and repair of tissues throughout our bodies (DebjitBhowmik and Sampath Kumar, 2010; Mineral Information Institute, 2012). This extremely important element is used to form connective tissue like ligaments and tendons. Teeth, bones, nails, skin and hair could not grow without zinc. The enrichment of zinc would be benefit for reduction of diarrhea and pneumonia mortality in children (Haider and Bhutta, 2009; Yakoob*et al.*, 2011). The previous study presented its biological role in homeostasis, proliferation and apoptosis and its role in immunity and in chronic diseases (Chasapis*et al.*, 2012). Toxicity disease or symptoms of zinc in humans include gastrointestinal irritation, vomiting, decreased immune function and a reduction in high density lipoprotein (HDL) cholesterol. Higher dietary levels of Zn are required in the presence of phytic acid to prevent parakeratosis and allow for normal growth (Sidhu et al., 2004).The optimum dietary level for the individual elements required for humans is very difficult to clarify cause of each variation of physiological response.

2.1.6sex hormones of quail eggs

The most sex hormone of whole eggs is P (318.8 ng g-1) which is both high in egg whites (321.9 ng g-1) and egg yolks (307.8 ng g-1) . And a little T of whole eggs was 3.1 ng g-1which is higher in egg yolks (4.3 ng g-1) than in egg whites(1.9 ng g-1). Sex steroids are pleiotropic hormones that act on multiple targets including the central nervous system, bone, reproductive organs, and the immune system among others. Sex hormones influence the development, maturation, activation and death of immune cells (Verthelyi, 2001). Research shows that most sex hormone of whole eggs is P which is both higher in egg whites and yolks. Hormone P are benefit for antidepressant, balancing blood sugar level, decreasing PMS and menopause symptoms and weight loss (Daniel, 2010). But quail eggs has low T which low testosterone levels lead to many problems for both genders such as reduced sexual drive, sexual dysfunction, infertility, irritability, mood swings, depression, reduced concentration, and sense of wellbeing and prostrate and testicular diseases in men (NSI, 2011). Men and women both possess testosterone hormones; however, the levels are different in both. Some studies also show that low levels of testosterone lead to the onset of Type 2 diabetes.

Overall, quail eggs have both essential and non-essential nutrients which most of them are benefit for human health. The total calories are 156.50 kcal 100g-1for human body using for function and maintenance of organ. Health benefits may be good for anti-cancer effects and inhibits cancerous growth, straightens immune system by stunning aging in organs, helps to prevent anemia by promoting hemoglobin, is a remedy to gastritis and stomach ulcers as many reports (Lalwani, 2011 and Squidoo, 2012)

2.2PRODUCTION AND REPRODUCTION OF EGG AND MEATTYPE QUAILS

Quail rearing for meat and egg production has become an economically viable activity and has increasingly developed. From the technical and economic viewpoints, quail rearing is attractive due to their rapid growth and early onset of lay, high reproduction rates, and low feed intake (Murakami &Ariki, 1998; Albino andBarreto, 2003). The development of quail culture has led farmers to rear both meat- and egg-type quail breeders, which has demanded studies on the reproductive management of this species. General data on the ideal male-to-female ratios, hatching egg storage time, correlation between egg weight and fertility rate, hatchability (Bacon and Nestor, 1975; Narahari*et al.*, 1988; Kobayashi *et al.*, 1994; Adkins-Regan, 1995; Petek*et al.*, 2003 and Hassan *et al.*, 2003), and fertility duration

(Sittman&Abplanalp, 1965; Reddish *et al.*, 1996) have been described for egg-type quails. The most studied aspect of quail production is nutrition, particularly of Japanese egg-type quails (Garcia *et al.*, 2000,Ribeiro*et al.*, 2003, Murakami *et al.*, 2006, Araujo *et al.*, 2007 and Murakami *et al.*, 2007). On the hand, there are few studies on the egg production potential of European meat-type quails (Mori *et al.*, 2005 and Barreto*et al.*, 2007b), and therefore, on their reproduction capacity.

The reproduction strategies of male birds usually involve the rapid production, maturation, and transport of spermatozoa through the genital organs, which is associated with the sperm storage capacity in the genital tract limited to merely one day (Clulow and Jones, 1982). Experiments with breeding quails have demonstrated that the number of fertile eggs drops sharply when males are removed from the group (Sittman andAbplanalp, 1965). Although spermatozoa can survive in the female genital tract for more than 14 days, they are able to fertilize only 45% of the eggs eight days after the removal of the males (Reddish *et al.*, 1996).

Studies on the number of holes produced by spermatozoa through the inner perivitelline layer (IPVL holes) or outer perivitelline layer (OPVL sperm) as a function of time allow inferring the fertility status of eggs laid and yet to be laid by a given female on the subsequent days while it continues to lay fertile eggs (Wishart and Staines, 1999 andHazary, 2000). Fertile eggs laid on consecutive days may result from a single mating or a sperm pool stored in the female genital tract (Bramwell and McDaniel, 1986). For these reasons, this method is adequate to estimate the breeding potential of breeder quails and to correlate it to the number of males and females per cage. The development of the reproductive organs and breeding efficiency are directly influenced by the number of birds per cage during different rearing phases. Cage type and number of birds per cage were evaluated seeking to reduce quails production costs (Faitarone*et al.*, 2005 and Lopes *et al.*, 2006). The number of birds per cage in a given group may influence production and reproduction factors, particularly in breeders, due to the presence of different males in the same cage and the competition between males for females, sexual activity, social interactions, and constant competition for space and feed.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Location of experiment

The experiment was carried out at the Teaching and Research Farm of the Department of Animal Production and Health poultry farm, Federal University, OyeEkiti, Ikole Campus with the following GPS coordinates; latitude of 7.7982661° N and longitude of 5.514493° E. It has an average annual temperature of 24.2 °C.

3.2Method of egg storage

A total of three hundred and ten (310) eggs were collected over a period of fourteen (14) weeks from Japanese Quail (*Coturnixcoturnix japonica*) birds belonging to the Poultry Research Unit of Department of Animal Production and Health, Federal University, OyeEkiti. The birds were between 6 – 19 weeks of age during the period of egg collection and were raised in wooden cages. The birds were fed with layers mash containing 18% crude protein and MEkcal/kg 2900.

3.2.1 Sampling and storing of eggs

The experiment was conducted using the Completely Randomized Design in a Factorial arrangement (2 x 3). At least (23) Fresh eggs were collected once every week and weighed into two groups according to sizes below 10g and 10g and above.Thirty six (36) Fresh eggs were broken at day of collection for the control, then another batch of eggs were collected the following week consecutively., The eggs were further divided into equal numbers of eggs then subjected to the three storage method which was the oiled by which the eggswere immersed into oil and allowed to drip and then was placed on a tray, The (unoiled) eggs which were placed ordinarily on the tray untreated and stored at room temperature, then the earthen pot storage in which the pot was laid with saw dust, then the eggs were placed in it for storage. The eggs were then picked randomly and broken at various storage times.

Immediately after collection, eggs were labelled according to date of production, then weighed by using sensitive balance and grouped according to the two sizes i.e. the large and smaller group size. They were randomly picked to assess the effect of length of storage on the eggs at 7,14,21,28 days for each of the storage methods (treatments).

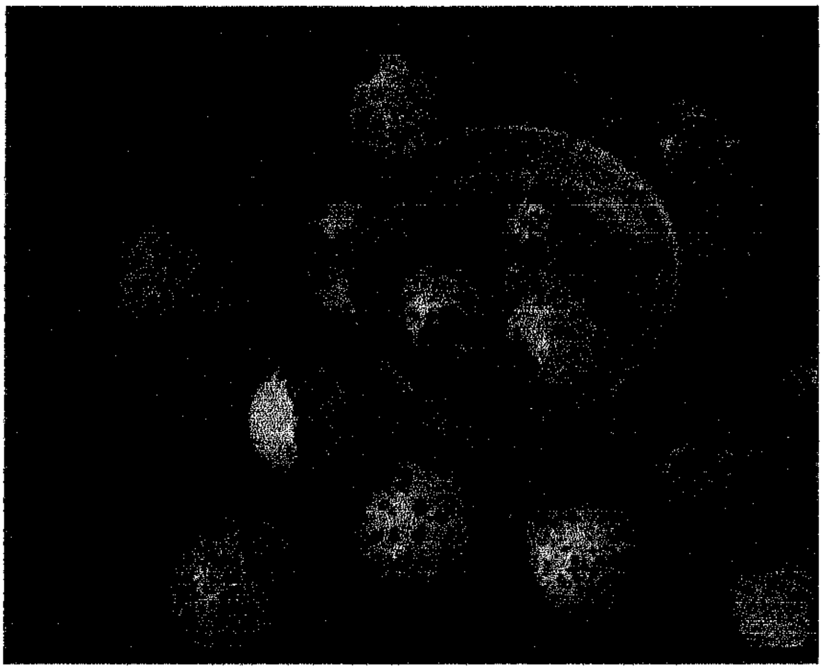

Plate 3: eggs stored in earthen pot

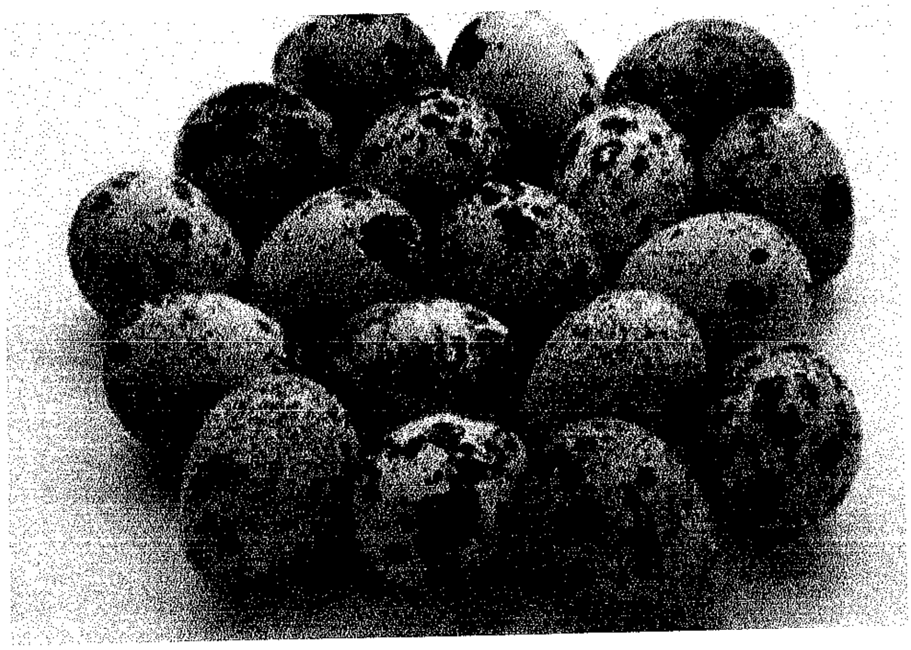

Plate 4: Eggs stored at room temperature

3.2.2 Evaluation of egg quality

Characteristics were evaluated in individual eggs for internal and external quality traits

- Egg weight was measured with diamond digital scale (model A04) at graduation of 0.1g, maximum weight of 500g.

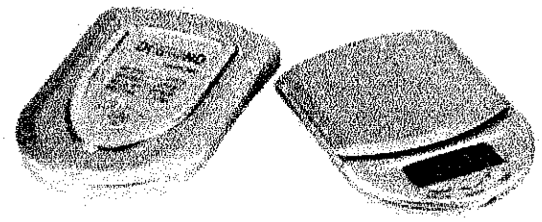

Plate 5: the diamond digital scale used

- Egg height and width were measured with digital Vernier Caliper within 300cm.

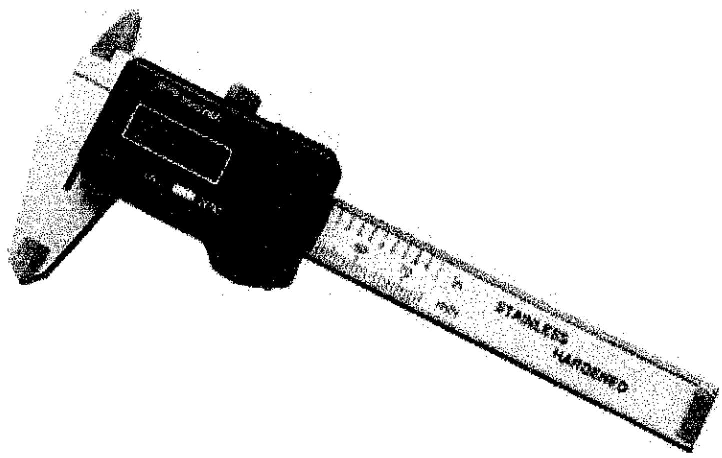

Plate 6: Averniercaliper

- The egg shell thickness was measured with an analog Micrometre screw-gauge (0 – 25 x 0.01mm).

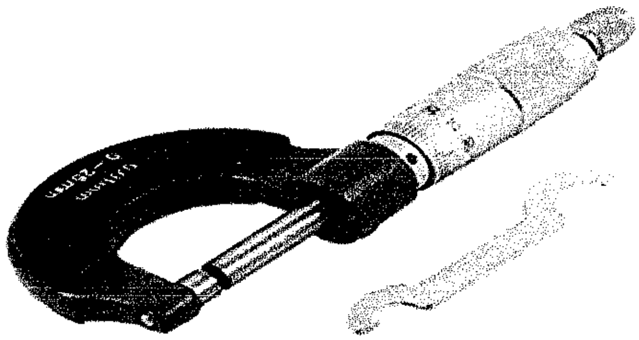

Plate 7: A micrometre screw guage

- After the period of 7, 14, 21 and 28 days, eggs were broken into a flat plate to measure yolk height, yolk width and albumen height using Vernier Caliper.
- The yolk colour was determined by the use of the yolk colour fan.

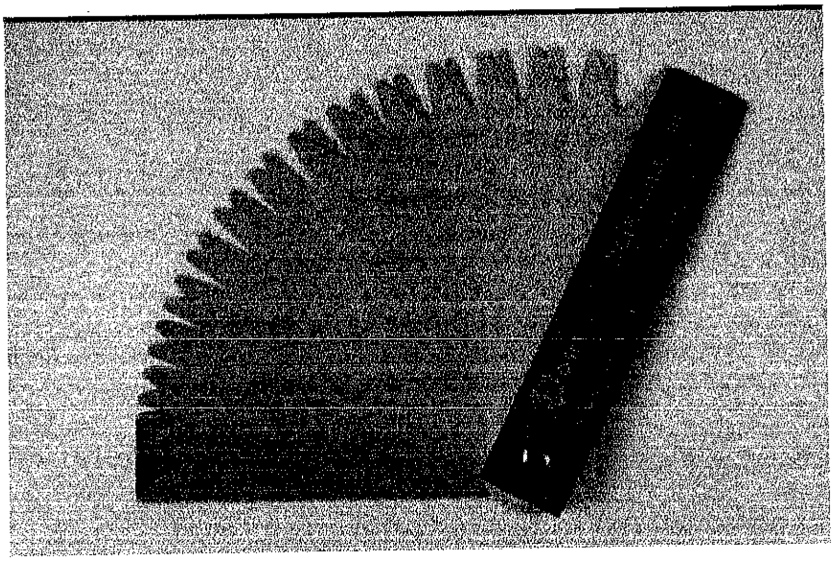

Plate 8: the yolk colour fan

Other Parameter Measured:

- Haugh Unit was determined using the formula below:

$$HU = 100 \log (H + 7.5 - 1.7W^{0.37})$$

Where;

HU = Haugh unit

H = height of albumen (mm)

W = egg weight (grams)

The haugh unit value ranges from 0 - 130 and can be ranked as below:

AA: 72 and above

A: 71 – 60

B: 59 – 31

C: 30 or below

Yolk index was determined using the formula below:

$$\frac{\text{yolk height}}{\text{yolk diameter}}$$

- Egg shape index was determined using the formula below:

$$\frac{\text{egg width}}{\text{egg lenght}} * 100$$

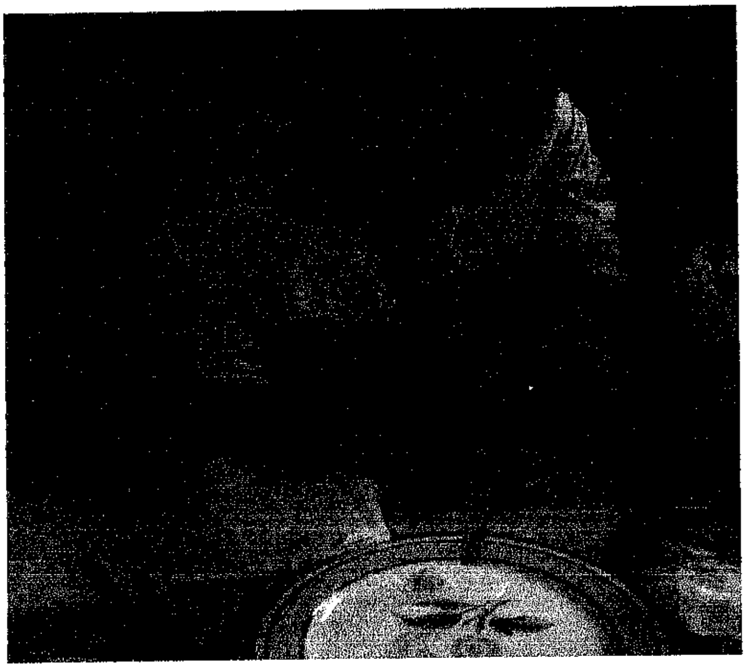

Plate 9: Evaluation of quality parameters

3.2.3 Climatic conditions

Records of atmospheric temperature and relative humidity throughout the period of the experiment was collected from the weather station records of Federal University, Oye-Ekiti, Ikole Campus. A digital thermometer was placed in the room where the eggs was stored to monitor room temperature.

3.2.4 Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using GLM procedure of SAS (2008). Means separation was done using Duncan Multiple Range Test (DMRT) of SAS Procedure.

Statistical Model

$$Y_{ijk} = \mu + M_i + T_j + + MT(ij) + eijk$$

Where: μ = population mean

Mi = ith effect of storage method

Tj = jth effect of storage time

MT (ij) = Interaction between storage method and time

Eijk = residual error

CHAPTER FOUR

4.0 RESULTS

Table 1 shows the effect of storage method on the external quality characteristics of quail eggs. The results showed that there were significant differences in the final weight ($P<0.01$), egg length ($P<0.05$), egg breadth ($P<0.001$) and shell thickness ($P<0.01$) among different storage methods.

For egg weight, the control was the highest among the methods, followed by the room temperature and oiled, Eggs stored in earthen pot had the least weight.

For the egg length, breadth and shell thickness, the control were the highest but there were no significant difference among the other storage methods.

However, the shell weight and egg shape index showed no significant differences among the storage methods.

Table 1: The effect of storage method on quail egg external quality characteristics.

PARAMETERS	STORAGE METHOD Control	Room Temperature	Earthen Pot	Oiling	SEM	LOS
EGG WEIGTH(g)	10.37[a]	9.39[b]	8.83[c]	9.38[b]	0.03	***
EGG LENGTH(mm)	31.34[a]	29.31[a]	29.32[a]	29.82[a]	0.00	**
EGG BREADTH(mm)	24.45[a]	23.75[b]	23.27[b]	23.76[b]	0.00	*
SHELL WEIGHT(g)	1.19[b]	1.32[ab]	1.23[ab]	1.29[ab]	0.00	NS
SHELL THICKNESS(mm)	0.33[a]	0.25[b]	0.25[b]	0.25[b]	0.00	***
EGG SHAPE INDEX	78.19[b]	80.94[a]	80.89[a]	79.91[a]	0.01	NS

***=P<0.05, **P<0.01, ***=P<0.1, NS= Not significant**

Table 2 shows the effect of storage methods on the internal quality characteristics of quail eggs. The results showed that there were significant differences in the yolk height (P<0.001), yolk diameter (P<0.001), albumen height (P<0.001), yolk color (P<0.001), Haugh unit (P<0.01) and yolk index (P<0.001) among different storage methods.

For yolk height, albumen height and the Haugh unit, the control was the highest among the methods, followed by the oiled, room temperature while eggs stored in earthen pot hadthe least values.

For the yolk diameter, the control was the highest, followed by the room temperature, the earthen pot and then eggs stored at room temperature.

The yolk color had the highest in earthen pot, followed by room temperature but there wasno significant difference among the control and earthen pot methods.

However, the yolk weight and albumen weight showed no significant difference among the storage methods.

Table 2: The effect of storage method on quail egg internal quality characteristics.

	STORAGE METHOD					
PARAMETERS	**Control**	**Room Temperature**	**Earthen Pot**	**Oiling**	**SEM**	**LOS**
YOLK WEIGTH(g)	3.33	3.55	3.45	3.50	0.00	NS
YOLK HEIGHT (mm)	8.81[a]	6.07[c]	5.69[c]	6.68[a]	0.00	***
YOLK DIAMETER(mm)	23.59[c]	27.03[a]	26.35[a]	25.04[b]	0.00	***
ALBUMEN WEIGHT(g)	5.41[a]	3.85[bc]	3.48[c]	3.92[b]	0.00	NS
ALBUMEN HEIGHT(mm)	3.81[a]	3.15[bc]	3.05[c]	3.33[b]	0.00	***
YOLK COLOUR	1.35[b]	2.96[a]	3.18[a]	2.96[a]	0.00	***
HAUGH UNIT	86.39[a]	83.33[b]	83.30[b]	84.51[b]	0.00	**
YOLK INDEX	0.38[a]	0.23[c]	0.22[c]	0.27[b]	0.00	***

*=P<0.05, **P<0.01, ***=P<0.001, NS= Not significant

Table 3 shows the effect of storage time on the external quality characteristics of quail eggs. The results showed that there were significant differences in the parameters. The final weight ($P<0.001$), egg length ($P<0.001$), egg breadth ($P<0.01$), shell weight ($P<0.01$), egg shape index ($P<0.001$) and shell thickness ($P<0.001$) among different storage duration.

For the final egg weight and egg length, the storage at day 0 was the highest among the duration, followed by day 7, 14. 21 and 28 days.

For the egg breadth and shell thickness, the storage at day 0 was the highest but there were no significant difference among the other storage durations.

The shell weight had no significant differences in the values among the storage duration.

However, the egg shape index increased from day 14 to 28 and was significantly different from day 0 and 7.

Table 3: The effect of storage time on quail egg external quality characteristics.

	STORAGE TIME						
PARAMETERS	DAY0	DAY7	DAY14	DAY21	DAY28	SEM	LOS
EGG WEIGTH(g)	10.37[a]	9.57[b]	9.39[b]	9.14[bc]	8.79[c]	0.34	***
EGG LENGTH(mm)	31.34	30.48[b]	29.30[a]	29.18[a]	28.96[a]	0.01	***
EGG BREADTH(mm)	24.45[a]	23.84[a]	23.77[bc]	23.54[bc]	23.41[c]	0.00	**
SHELL WEIGHT(g)	1.19[b]	1.31[ab]	1.36[a]	1.24[b]	1.21[b]	0.00	**
SHELL THICKNESS (mm)	0.33[a]	0.25[b]	0.25[b]	0.24[b]	0.25[b]	0.00	***
EGG SHAPE INDEX	78.19[b]	78.50[b]	80.61[a]	81.29[a]	81.49[a]	0.01	***

*=P<0.05, **P<0.01, ***=P<0.001, NS= Not significant

Table 4 shows the effect of storage time on the internal quality characteristics of quail eggs. The results showed that there were significant differences in the yolk height ($P<0.001$), yolk diameter ($P<0.001$), albumen weight ($P<0.001$) albumen height ($P<0.001$), yolk color ($P<0.001$), Haugh unit ($P<0.01$) and yolk index ($P<0.001$) among different storage durations.

Yolk height, Albumen weight, HaughUnit and Yolkindex decreased significantly ($P<0.001$) as the storage time increased from day 0 to 28 while Yolk diameter and Yolk colour increased significantly ($P<0.001$) with increasing storage time. However, the Haugh Unit even for eggs stored at 28days fell in the AA quality group (>72).

Table 4: The Effect of Storage Time on Quail Egg Internal Quality Characteristics

	STORAGE TIME						
PARAMETERS	**DAY0**	**DAY7**	**DAY14**	**DAY21**	**DAY28**	**SEM**	**LOS**
YOLK WEIGTH(g)	3.33	3.43	3.52	3.52	3.49	0.00	NS
YOLK HEIGHT (mm)	8.81[a]	7.80[b]	6.41[c]	5.90[c]	5.13[d]	0.00	***
YOLK DIAMETER(mm)	23.59[c]	24.26[bc]	24.85[b]	27.09[a]	27.56[a]	0.01	***
ALBUMEN WEIGHT(g)	5.41[a]	4.57[b]	3.75[c]	3.48[c]	3.37[c]	0.00	***
ALBUMEN HEIGHT(mm)	3.81[a]	3.52[b]	3.27[c]	3.07[d]	2.94[d]	0.00	***
YOLK COLOUR	1.35[c]	1.68[c]	2.57[b]	3.51[a]	3.89[a]	0.00	***
HAUGH UNIT	86.39[a]	85.53[a]	84.14[b]	83.12[bc]	82.61[c]	0.00	***
YOLK INDEX	0.38[a]	0.32[b]	0.26[c]	0.22[d]	0.19[e]	0.00	***

*=P<0.05, **P<0.01, ***=P<0.001, NS= Not significant

Table 5 shows the interaction effect of storage times and storage methods on the external quality characteristics of Quail eggs).

Egg weight with the lowest weight was those stored at 21 and 28 days in earthen pot which was significantly lower than the rest.

On egg breadth, the interaction effect on the eggs stored at room temperature at day 7 was highly significant ($p<0.001$) and those ones stored at room temperature at day 7 was also significant ($p<0.05$). All other effect among all other storage method and various storage duration were not significantly different.

On egg length, the eggs stored at room temperature and in earthen pot at day 7, those stored at room temperature at day21 days and the ones stored at in earthen pot and immersed in oil and stored at day 28 were significantly different ($P<0.05$) while those stored at room temperature and in earthen pot at day 14 were highly significant ($P<0.001$) while all other eggs stored with various storage methods at storage duration were not significantly different.

Shell weight was the highest in eggs stored at 14 days in earthen pot but there were no significant difference on the interaction effect of various storage methods and storage time on the quail eggs.

Shell thickness shows no significant difference (<0.05) but was highest on only eggs stored at room temperature at day 7.

Egg shape index was lowest in eggs stored at 7 days in earthen pot compared to others. However, eggs oiled and stored for 21 days were also low.

Table 5: The interaction effect of storage time and storage method on external quality characteristics of quail eggs

Parameters	Storage time	Control	Storage method: Room temperature	Earthen pot	Oiling	SEM	LOS
Egg weight (g)	0	10.37				0.06	
	7		9.51	9.91	9.37		***
	14		8.91	9.36	9.60		
	21		9.59	8.69	9.31		
	28		9.30	8.29	9.24		
Egg length (mm)	0	31.34	-	-	-	0.11	*
	7	-	30.31	31.37	29.76		
	14	-	28.53	29.69	29.70		
	21	-	29.18	28.21	30.15		
	28	-	29.21	28.01	29.66		
Egg breath (mm)	0	24.45	-	-	-	0.07	*
	7	-	24.17	23.70	23.52		
	14	-	23.12	23.80	23.98		
	21	-	23.74	23.30	23.71		
	28	-	23.65	22.82	23.78		
Shell weight (g)	0	1.19	-	-	-	0.02	*
	7	-	1.33	1.31	1.28		
	14	-	1.33	1.41	1.30		
	21	-	1.38	1.11	1.28		
	28	-	1.27	1.15	1.31		
Shell thickness (mm)	0	0.33	-	-	-	0.00	NS
	7	-	0.25	0.26	0.25		
	14	-	0.24	0.25	0.25		
	21	-	0.26	0.23	0.25		
	28	-	0.23	0.25	0.24		
Egg shape index							
	0	78.19	-	-	-	0.23	**
	7	-	79.81	75.61	79.17		
	14	-	81.34	80.25	80.88		
	21	-	81.50	82.87	78.80		
	28	-	81.20	81.69	80.28		

*=P<0.05, **P<0.01, ***=P<0.001, NS= Not significant

Table 6 shows the interaction effect of storage time and storage method on the internal quality characteristics of quail eggs.

The results showed that on the yolk weight, there were no significant difference between the interaction effect of eggs stored at various storage methods and storage duration.

The yolk height was highly significant (P<0.001) for eggs stored room temperature, earthen pot and immersed in oil at day 7,room temperature at day 14 and day 21.

Yolk diameter showed significant difference (P<0.01) on eggs stored immersed in oil and stored at day 7 while eggs stored at room temperature, earthen pot and immersed in oil and stored at day 7 and eggs stored at room temperature and in earthen pot at day 14 were highest.However, all other eggs that were not mentioned were not significantly different.

Yolk color was the highest in eggs treated with oil and stored at 28 day (4.71) and was lowest in eggs stored earthen pot at day 7. However, there was significant difference (P<0.05) between the interaction effect of various egg storage method and storage time.

Haugh unit showed very significant difference (P<0.01). Eggs treated with oil and stored at day 7 had the highest Haugh unit (86.56) and was lowest at eggs stored at room temperature at 28 days (82.06).

Yolk index was highly significant difference (P<0.001). however, eggs stored at room temperature at day 28 was the lowest, followed by those stored in earthen pot at day 28 while those immersed in oil and stored at day 7 had the highest value.

Albumen weight showed significant difference (P<0.05). Eggs stored in earthen pot at day 7 had the highest value (4.89mm) and lowest at day 21 (3.19mm) among eggs stored at room temperature, earthen pot and immersed in oil and stored at day 7.

Albumen height showed significant difference (P<0.05) among eggs. However, eggs immersed in oil and stored at day 7 had the highest value and those stored at room temperature and earthen pot at day 28 had the lowest value (2.90).

Table 6: The interaction effect of storage time and storage method on internal quality characteristics of quail egg

			STORAGE METHOD				
PARAMETERS	**STORAGE TIME**	**CONTROL**	**ROOM TEMPERATURE**	**EARTHEN POT**	**OILING**	**SEM**	**LOS**
YOLK WEIGTH(g)	0	3.33	-	-	-	0.00	NS
	7	-	3.56	3.56	3.17		
	14	-	3.26	3.57	3.54		
	21	-	3.61	3.48	3.49		
	28	-	3.57	3.33	3.79		
YOLK HEIGHT(mm)	0		-	-	-	0.01	NS
	7	8.81	7.80	7.54	8.01		
	14	-	7.28	5.83	6.97		
	21	-	5.81	5.88	6.06		
	28	-	4.92	4.99	5.46		
YOLK DIAMETER(mm)	0	23.59	-	-	-		
	7	-	24.55	25.25	23.08	0.00	NS
	14	-	25.06	25.07	24.45		
	21	-	27.81	26.87	26.38		
	28	-	28.51	27.19	26.64		
YOLK COLOUR	0	1.35	-	-	-		
	7	-	1.82	1.50	1.65	0.00	**
	14	-	1.88	2.82	2.46		
	21	-	3.41	3.74	3.21		
	28	-	3.97	3.56	4.71		
YOLK INDEX (%)	0	0.38	-	-	-		
	7	-	0.32	0.30	0.35	0.01	***
	14	-	0.29	0.23	0.29		
	21	-	0.21	0.21	0.23		
	28	-	0.18	0.19	0.21		
ALBUMEN WEIGHT(g)	0	5.41	-	-	-	0.00	NS
	7	-	4.43	4.89	4.49		
	14	-	3.49	3.33	3.71		
	21	-	4.00	3.50	3.83		
	28	-	3.48	3.19	3.71		
ALBUMEN HEIGHT(mm)	0	3.81	-	-	-	0.00	NS
	7	-	3.50	3.40	3.66		
	14	-	3.36	3.21	3.34		
	21	-	3.08	2.97	3.25		
	28	-	2.90	2.90	3.07		
HAUGH UNIT	0	86.39	-	-	-	0.00	**
	7	-	85.41	84.47	86.56		
	14	-	85.05	83.77	84.37		
	21	-	82.72	82.93	84.11		
	28	-	82.06	82.89	82.96		

*=P<0.05, **P<0.01, ***=P<0.001, NS= Not significant

CHAPTER FIVE

5.0 DISCUSSION

The parameters for measuring the quality traits of all the eggs are at maximum when the eggs are freshly laid and broken and decrease between each methods and increased storage time (7 – 28 days),therefore storage conditions are chosen with regard to the retention of these quality traits. Temperature, relative humidity and flow of air or moisture are considered as the main factors in determining the technological conditions for storing eggs (Orji *et al.*, 1981). The internal egg quality traits are important properties for quality determination of table eggs.

The results ofeffects ofstorage time on external and internal quality parameters of Quail eggs in this results (Table 1 & 2) showed the final egg weight decreased with the length of storage, as reported by many researchers for various poultry species and the losses could be due to loss of carbon dioxide, ammonia, nitrogen, hydrogen sulphide gas and water from the eggs (Haugh, 1937).Similar results were reported by (Panigraphi *et al*, 1989) who observed that parameters for measuring the quality traits of all eggs are at maximum when the eggs are freshly laid and decrease with increased storage time.

When the storage period is extended, the internal quality of pheasants' eggs progressively declines due to loss of moisture from the egg. It has been shown by Gibbons (1950) that the beneficial effects ofoiling or other means of shell coating eggs soon after laying are dependent on the retention of inherent carbon dioxide in the egg. Yuichi et al, (1970) claimed that oiling significantly reduced the incidence of rotten eggs or eggs with collapsed yolk when stored duringthe summer season.

These findings on shell thickness are also in agreement with (Dudusola, 2009), who did not find anyeffect of storage time on shell thickness inpartridges and Japanese quail eggs.

Shell weight as percentage was not affected significantly(P>0.05) by storage time. These findings are in line with (Silversides and Scott, 2001, Tilki and Inal, 2004), who reported no effect ofstorage time on egg shell weight. In contrast, Samli,*et al.* (2005) noticedsignificant (P<0.05) change in shell weight during storage at different time.

The results of Haugh unit (HU) of eggs declined with the increasing storage time. Haugh unit reduction may be due to the decrease in the thick albumen height, because during storage, the ovomucin-lysozyme complex breaks down, these results of this studywere supported by (Morais *et al.*1997) who observed the reduction in the Haugh unit of eggs at 21 days of storage.

Albumen weight loss was recorded for 28 days of storage. This loss of albumen weight may be due to lossof solvents from albumen, which may decrease the weight of thealbumen in egg by increasing the weight of yolk. These results are consistent with (Siyar *et al.*, 2007) and (Tabidi, 2011), who reported thatthe loss in albumen weight is attributed to loss of humidity frominside the egg due to evaporation.

It was observed that the duration of storage significantly increased the value of yolk diameter.The increase in yolk diameter observed in this study could be due to decrease in the strength of vitelline membrane. These results are in agreement with (Kirunda and McKee,2000),who reported that vitelline membrane strength (VMS) decreases during storage and makes the yolk more susceptible to breaking.As a result, water slowly enters into the yolk from the albumen, this creates a mottled appearance in yolk and the yolk becomesflattened.

Yolk weight showed no significant difference with increase in storage time, though increased linearly with storage time. These results concur with (Haugh, 1937 and Barbosa *et al.*, 2004).

Dramatic deteriorations were observed in yolk index (0.38 to 0.19mm),albumen height (5.41 to 3.37mm) and yolk height (8.81 to 5.13mm) with storage time. These results are in agreement with those of (Scott and Silversides, 2000 and Samli *et al.*, 2005). Samli *et al.*(2005) also reported significant ($P<0.001$) decrease in egg weight, albumen height, Haugh unit, albumen and yolk indices with increase in storage time. In their study, albumen height decreased from 9.16 to 4.75mm.

The egg length, breadth and egg shape index maintained the highest values with fresh eggs (control).

There was no significant difference within the shell weight and thickness as the storage time increased (4weeks) because mineral compounds in the eggshell provide a long term stability and mechanical resistance to deformation. Nowacezewski *et al.* (2010) reported that shell weight decreased with increase in storage time, although these authors observed the lowest shell weight after 5 and 8 weeks of egg storage.

The effect of storage method on the external and internal quality parameters of quail eggs obtained in this study indicates that generally, reduction in quality parameters was highest in earthen pot than oiling and in room temperature.

Egg breadth, egg length, egg shape index were not affected as stated in the storage time.

The highest value of egg weight was obtained inoiled eggs, which may be due to blockage of shell pores by thin films of oil thus preventing water or gaseous escape and was the second highest to eggs broken fresh which was the control, the earthen pot method had the lowest egg weight and this result agrees with (Abiona *et al.*, 2013).

The difference between the various methods to maintain egg quality could be due to their varying ability to retard carbon dioxide loss and breakdown of carbonic acid to carbon dioxide. This is because these losses cause Mucinfibre which gives the albumen andyolks their gel like texture to lose their structure and so the albumen and yolk becomes watery (Mountney, 1976).

This author further enumerated that as the albumen and yolk becomes watery, there is a loss of albumen and yolk height, thus a decline in the egg quality in storage.

The increase in yolk width observed in this study could be due to decrease in the strength of vitelline membrane.When eggs are stored under room temperature for long periods, the strength of vitellinemembrane breaks and makes the yolk to spread into the albumin. The yolk diameter values were higher in eggs stored at room temperature, because at a very high temperature, the amount of water migrationfrom the albumen to the yolk is high, which helped to increase yolk width (Brake *et al.*, 1997).

As a result, HU of eggs stored in earthen pot was reduced significantly ($P<0.05$) compared to the ones stored at room temperature while oiled eggs retained the highest value after the freshly broken eggs. The results are in agreement with (Samli, 2005). Haugh unit and yolk indices are generally considered as good indicators to evaluate egg quality (Chang & Chen, 2000). The higher the yolk index (Ayorinde, 1987) and the Haugh unit (Haugh, 1937), the more desirable the egg quality which was found in eggs stored in the earthen pot.

The Haugh unit is an important trait in egg grading and highly influenced by the albumen quality, particularly the albumen height.

Shell thickness was not affected by any storage method; these findings on shell thickness are also in agreement with (Dudusola, 2009 and Alayan *et al.*, 2009) who did not find any effect of storage method on shell thickness in partridges and Japanese quail eggs. Also, shell weight was not affected by storage method. These findings are in line with (Silversides and Scott 2001, Tilki and Inal, 2004, Akyurek and Okur, 2009 and Alayan *et al.* 2009), who reported no effect of storage time on egg shell weight. In contrast, (Samli *et al.* 2005) noticed significant ($p<0.05$) change in shell weight during storage atdifferent time and temperature.

The significant ($p<0.001$) effect of Interactions between storage time and storage methods on egg weight, egg shell weight, egg length, yolk index, HU, yolk color, egg breadth and egg shape index was observed.

The yolk index decreased significantly as storage time increased among the storage method; the lowest was observed in eggs stored at room temperature at day 28 while the highest value was observed in eggs oiled at day 7. Similar results were reported by (Malden *et al.*, 1979) indicating that the average values for yolk index of fresh eggs decreased with increasing storage time. These results were further confirmed by (Edith *et al.*, 1990) and (Jay *et al.* 1992). The decline of Yolk index was attributed to increase in storage time which resulted in the passage of the water from the white into the yolk; the yolk height will decrease while its diameter will increase. The highest yolk index was recorded for eggs treated with oil. These results agree with the result reported by (Mohamed 2011) who found the yolk index is higher in the egg treated with oil compared to that obtained from eggs stored at room storage. It was also confirmed that the yolk index decreased according to the storage duration.

These results agree with results reported by (Kato *et al.*, 1994) who found that the yolk and albumen height decrease as the storage time increased. (Mountney, 1976) reported that the different methods for maintaining egg quality differ in their ability to retard carbon dioxide losses and break down of carbonic acid to carbon dioxide. This results in agreement with the results reported by (Raji *et al.*, 2009) who found that the yolk height of oiled was significantly high compared to the control group (8.81mm).

The egg shell weight (g) was decreased significantly ($P < 0.01$) storage time increased, the highest value was observed in eggs stored in earthen pot at day 7 while the lowest value was observed in eggs stored in earthen pot at day 28. This result in line with the results reported by

(Samli et al., 2005) who found that egg shell weight changed significantly with storage time and method. It was observed the high value was recorded in the oiled eggs group, followed by the room temperature while the earthen pot group had the lower value. These results agree with results reported by (Dudusola, 2009) who found that Haugh units decreased as length of storage increased and also eggs treated with oil had high Haugh units. Haugh units are 75 and above for excellent quality eggs and 50 and below for stale eggs. The highest Haugh unit (86.39) for this study was recorded when the egg was fresh, which is the recommended value for the excellent quality eggs (Bien &Thien, 2005).

In this study, the pigmentation was observed for all methods at different storage periods, and there were significant difference for each storage period difference and the oiled egg stored at day 28 was the highest. (Spada et al. 2008) found increased pigmentation of the red in yolks after 28 days of storage at room temperature and stabilizing on the 36th day. No recent data was found regarding the relationship between yolk color and storage method or time.

In contrary, Maria Elena et al. (2006) reported that for storage time, color did not diminish at 4°C, while at 20°C there was an average reduction of 9.91 to 8.33 at 30 days of storage. This could be attributed to dilution of the egg yolk. Jones (2006) stated that as the internal temperature of an egg increases, the protein structures of the thick albumen and vitelline membrane breakdown faster. This result does not agree with the research due to the difference in species of bird.

The non significant effect of Interactions between storage time and storage methods on egg shell thickness, yolk height, yolk weight, yolk diameter, albumen weight and albumen height was observed.

Highest yolk diameter was recorded for the eggs stored at room temperature for 28 days and lowest in oiling at day 7. Similar results were reported by (Raji *et al.*, 2009) who found that the yolk width increased as storage time was increased. This result disagree with result reported by (Raji *et al*, 2009) who found that the yolk diameter of oiled and earthen pot did not differ ($P > 0.05$) from each other but were significantly ($P < 0.05$) different from those of eggs stored at room temperature.These differences in the result could be attributed to differences in the experimental condition especially the storage temperature.

The highest yolk weight was recorded in group treated by oiling, followed by room temperature and lower yolk weight in earthen pot. These results agree with the result reported by (Haugh, 1937) who found that egg yolk size increased with storage time due to movement of water from the albumen to the yolk as a result of osmotic pressure differences.The egg yolk weight was affected significantly ($P < 0.001$) by the different methods of storage (room temperature, oiling and earthen pot).

Also it was observed that the oiled eggs had high albumen height followed by room temperature and low value was recorded by the earthen pot group. Similar result was reported by (Mohamed, 2011) who found that the albumen height of the eggs oiled was high compared to those stored at room temperature. These results agree with results reported by (Raji *et al.*, 2009) who found that the albumen height decreased as the storage time increased.

The Albumen weight was highest in the group stored at earthen pot followed by oiled egg group and lower value was found in the room temperature group. Similar results were reported by (Scott *et al.*, 2000) who found that longer period of storage resulted in lower albumen weight and albumen height. The albumen weight loss at room temperature than in earthen pot and oiled eggs at 28 days of storage may be due to the higher amount of water loss from the albumen to the yolk. Similar results were demonstrated by (Akyurek and Okur, 2009), who observed that water loss from eggs may be influenced by storage time,temperature, relative humidity and porosity of the shell.

In shell thickness, there was no significant difference between the treatments, the highest value was observed in eggs stored in earthen pot at day 7 (0.26) while the lowest value was observed in eggs stored in room temperature at day 28 (0.23). This result disagree with the result obtained by (Mohamed, 2011) who reported that there was no difference in the egg shell thickness between the eggs stored at room temperature and those treated with oil up to 21days. This differences in the result could be attributed to differences in the strain used and to the diets composition especially calcium level or source needed for optimum shell formation.

CHAPTER SIX

6.0 CONCLUSION

From the study, it was observed that egg shell weight, albumen and yolk height, Haugh unit, albumen weight, yolk index, decreased while yolk width increased with increase in storage time. Albumen and Egg length and width were not affected by storage time and method.The findings reveal that there were observable trends that rapid deterioration of eggs occurred as storage time increased and that the quality was affected by the method of storage. It can be concluded that the quality of an egg is affected by the method and length of storage.

According to Haugh unit evaluation of egg quality, eggs in all storage methods and time maintained the very good rating (80 - 89). It was observed that quail eggs can be stored at room temperature for up to 28 days, however treating by oiling the shell would reduce evaporation of water and CO_2 from the pores thereby aid in maintaining the acid-base balance and retaining high quality and maintained the highest egg quality rating. Eggs stored in earthen pot were able to maintain their quality comparable to the fresh eggs,considering the fact that it maintained its quality characteristics next to the oiling method and were better than eggs stored at room temperature.

6.1 RECOMMENDATIONS

The following recommendations are made from the findings of this study:

- Quail eggs to be stored for period of 28 days may be oiled, as oiling preserved both the internal and external qualities of the eggs.
- More studies are recommended on other methods of preservation of eggs to extend shelf life.

REFERENCES

Abiona, J.A., Adio, B.R., Osinowo, O.A. and Abioja, M.O. (2013). Effects of method and length of storage on egg quality of giant African land snail (*A. Marginata*). Archivos de Zooteccnia vol. 62, num. 240, page. 601.

ACIAR. 1998. Measurements and maintenance of duck and hen egg quality in Vietnam.Australian Centre for International Agricultural Research. Research note RN 2312/99.

Adamski, M. (2008). Relationship between egg constituency and hatchability results of selected species of poultry. Rozprawy nr 130. WydawnictwaUczelnianeUniwersytetuTechnologiczno-Przyrodniczego Bydgoszcz, 5-100 [in Polish]

Adeogun I.O. & Amole F.O., (2004). Some quality parameters of exotic chicken eggs under different storage conditions. Bull. Animal. Health. Production. Africa, 52, 43-47.

Akpan, I. A. and Nsa, E. E. 2009. Growth performance of growing Japanese quail (Coturnixcoturnix japonica) fed diets containing different crude protein levels. Proceedings 14thAnnual conference of Animal Science Association of Nigeria (ASAN). 14th-17thSept. LAUTECH, Ogbomoso, Nigeria, pp553-555.

Akyurek H. andOkur A.A. (2009). Effect of storage time, temperature and hen age on egg quality in free-range layer hens. Journal Animal Veterinary Advance 8, 1953-1958.

Alkan S, Karabag K, Galic A and Balcioglu M.S. (2008). Effects of genotype and egg weight on hatchability traits and hatching weight in Japanese quail. South Africa Journal Animal Science 38, 231-237.

Applegate T. J and Lilburn M.S (1996). Independent effects of hen age and egg size on incubation and poultry characteristics in commercial turkeys. Poultry Science 75, 1210-1216.

Applegate E. Introduction: nutritional and functional roles of eggs in the diet. Journal of the American College of Nutrition 2000; 19, 495S-498S.

Auestad N., Halter R., Hall R.T., Blatter M., Bogle M.L., Burks W., Erickson J.R., Fitzgerald K.M., Dobson V., Innis S.M., Singer L.T., Montalto M.B., Jacobs J.R., Qiu W., Bornstein M.H. Growth and development in term infants fed long-chain polyunsaturated fatty acids: a double-masked, randomized, parallel, prospective, multivariate study. Pediatrics 2001; 108(2), 372-381.

Ayasan T, Ozcan B.D, Baylan M. and Canogullari, S. (2006). The effects of dietary inclusion of probiotic Protexin on egg yield parameters of Japanese quails (Coturnixcoturnix japonica). International Journal Poultry Science 5, 776-779.

Ayorinde K.L., 1987, Physical and chemical characteristics of eggs of four indigenous guinea fowls (Numidia meleagrisgallentapallas). Nigeria. Journal. Animal. Production. 14, 1&2, 125-128

Barbosa NAA, Sakomura NK, Mendonça MO, Freitas ER, Fernandes JBK. Qualidade de ovoscomerciaisprovenientes de poedeirascomerciaisarmazenados sob diferentes tempos e condições de ambientes. ARS Veterinaria. 2008; 24(2): 122-133.

Baumgartner J. (1994). Japanese quail production, breeding and genetics. World's Poultry Science Journal 50, 227-235

Bjelakovic G., Nikolova D., Gluud, L.L., Simonetti R.G., Gluud C. Mortality in randomized trials of antioxidant supplements for primary and secondary prevention: systematic review and meta-analysis. Journal of the American Medical Association 2007; 297, 842-857.

Bien L.L. & Thien P.C., 2005, Evaluation of shrimp head meal and cassava leaf meal as protein sources in diets for Luong Phuong Hoa laying hens. National Institute of Animal Husbandry, Hanoi, Vietnam Workshop. Seminar, 23-25 May, 2005. Retrieved from http://www.mekarn.org/ proctu/bienzo.htm

Brake J., Walsh T.J., Benton C.E., Petite J.N., Meijerhof R. &Penalva G., (1997). Egg handling and storage. Poultry. Science. 76, 1, 144-151.

Chang Y. & Chen T.C., 2000, Effects of packaging of shell egg quality stored. aginfo.snu.ac.kr/foodengin/internetposter/13/13.htm

Chasapis C.T., Loutsidou A.C., Spiliopoulou C.A., and Stefanidou M.E. Zinc and human health: an update. Archives of Toxicology 2012; 86(4), 521-534.

Chelmonska, B., Jerysz, A., Lukaszewicz, E., Kowalczyk, A. And Malecki, I. 2008. Semen Collection from Japanese quail (Coturnix japonica) using a teaser Female. Turkey.Journal.Veterinary.Animal .Science 2008; 32(1): 19-24.

Clandinin M.T., Van Aerde J.E., Merkel K.L., Harris C.L., Springer M.A., Hansen J.W., Diersen-Schade D.A. Growth and development of preterm infants fed infant Formulas containing docosahexaenoic acid and arachidonic acid. Journal of Pediatrics 2005; 146(4), 461-468.

Cox, W. A., Kimball, R. T. and Braun, E. L. 2007. Phylogenetic position of the new World Quail (Odontophoridae): Eight nuclear Loci and three Mitochondrial Regions contradict morphology and the sibleyahlquist tapestry. The Auk 124(1):71-84, 2007

Craig L., Jensen C.L., Robert G., Voigt R.G., Thomas C., Prager T.C., Zou Y.Z., Fraley J.K., Rozelle J.R., Turcich M.R., Llorente A.M., Anderson R.E., Heird W.C. Effects of maternal docosahexaenoic acid intake on visual function and neurodevelopment in breastfed term infants. American Journal of Clinical Nutrition 2005; 82(1), 125-132.

Cunnane S., Anderson M. Pure linoleate deficiency in the rat: influence on growth, accumulation of n-6 polyunsaturates, and (1-14C) linoleate oxidation. Journal of Lipid Research 1997; 38 (4), 805–812.

DAFF. 2013. Structure and dynamics of the quail. Commonwealth of Australia.

Daniel B. The health benefit of natural progesterone. 2010. http://www.hormonhealthy.com/Benefits_of_Natural_Progesterone.htm Accessed 21th March 2012.

DebjitBhowmik C., Sampath Kumar K.P. A potential medicinal importance of zinc in human health and chronic Disease. International Journal Pharmaceutical and Biomedical Sciences 2010; 1(1), 05-11.

Demirel, S. and Kirikçi, K. (2009). Effect of different egg storage times on some egg quality characteristics and hatchability of pheasants (Phasianuscolchicus). Poultry Science 88, 440-444

Durmuş, I., Ataşoğlu, C., Mizrak, C., Ertaş, S. and Kaya, M. (2004). Effect of increasing zinc concentration in the diets of brown parent stock layers on various production and hatchability traits (short communication). Arch Tierz 47, 483-489.

Dudusola, I. O. (2009). Effects of storage methods and length of storage on some quality parameters of Japanese quail eggs. Tropicultura 27(1):45-48.35.

Edith , A. and Sarda , A. (1990). Changes occurring in eggs during prolong storage and optimal storage. Position Revista – Cubana – de – ciencia – avicala. 17:79-85.

GARIP, M., S. DERE (2011): The effect of storage period and temperature on weight loss in quail eggs and the hatching weight of quail chicks. Journal. Animal. Veterinary. Advanced, 10, 2363-2367.

Gibbons, N. E. (1950).Preservation of eggs VII, Effect of age of egg and carbon dioxide content at time of oiling on keeping quality. Canadian. J. Research (F) 28: 118-127.

Hall, G. 2012. Brown Quail and its Management. 2012-05_brown-quail-and-its-Management.pdf.

Haugh R.R., (1937). The Haugh unit for measuring egg quality. United States Egg Poultry. Magazine. 43, 552-555, 572-573.

Hemid, A. F. A., Abd El-Gawad, A. H., El-Wardany, I., El-Daly, E. F., and Abd El-Azeem, N. A. 2010. Alleviating Effects of some Environmental stress Factors on productive performance in Japanese quail 2. Laying performance World Journal of Agricultural Sciences 6 (5), 517-524

Igado, O. O., and Aina, O. O. 2010. Some Aspects of the Neurometrics and Oculometrics of the Japanese quail (coturnixcoturnix japonica) in Nigeria. J. Morphol. Sci, 27(3-4): 133-135.

Isguzar E. (2005). Some egg and hatching traits of local ducks, Turkish Pekins and Muscovy ducks in Isparta/Turkey (short communication). Arch Tierz 48, 94-100

Jay, M., Tandron, E. And Ramos, M. (1992). Effect on duration and conditions of storage on egg quality of cross- bred EIXE23 heavy hen. Revista – de - salud- Animal 14:7-11.

Jones D.R. and Musgrove M.T. (2005). Effects of extended storage on egg quality factors. Poultry Science 84, 1774-1777

Jones, D. R. 2006. Conserving and monitoring shell egg quality. Proceedings of the 18th Annual Australian Poultry Science Symposium. pp. 157-165.

Kato, S., Kawamura, T., Goto, T., Ohguchi, K.(1994). Effect of condition on interior quality (Coturnix coturnix japonica) egg Research Bulletin of the Aichi-ken- Agricultural Research centre. 26:371-3.

Kirunda, D. F. K. and McKee, S. R. 2000. Relating quality characteristics of aged eggs and fresh eggs to vitelline membrane strength as determined by a texture analyzer. Poultry Science 79(8):1189-1193

Koźlecka M., Szukalski G. and Wencek E. (2006). Results of poultry performance evaluation in 2005. KrajowaRadaDrobiarstwa-IzbaGospodarcza Warszawa, 5-123 [in Polish]

KOZUSZEK, R., H. KONTECKA, S. OZUSZEK, R., H. KONTECKA, S. NOWACZEWSKI, A. ROSIŇSKI (2009): Storage time and eggshell colour of pheasant eggs vs. the number of blastodermalcells and hatchability results cells and hatchability results. Folia biologica (Kraków). 57, 121-130.

Kul S. and Seker I. (2004). Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (Coturnixcoturnix japonica). Journal Poultry Science 3, 400-405.

Lee, J. T., Connor-Appleton, S., Bailey, C. A., Cartwright, A. L., 2005. Effects of guar meal by-product with and without beta-mannanasehemicell on broiler performance. Poultry. Science, 84 (8): 1261-1267

Machal L., Ingr I., Kalova J. and Abek S.J. (1994). The dependence of the hatchability, laying and egg weight on the egg cholesterol level and cholesterol and total lipids concentration in the blood plasma in hens of laying strains. Arch Tierz 37, 567-575.

Malden, c. Nesheim, Richard, Autic and Leslie, E. (1979). Poultry production. Twelfth Edition card lead febiger Philadephia U.S.A.

Maria Elena, C. J., S. G. Leonor, M. B. Eduardo, C. D. Silvia, A. G. Avila, F. M. Benjamin, R. P. Miriam and P. G. R. Fernando. 2006. Shrimp head meal in laying hen rations and its effects on fresh and stored egg quality. INCL.31:http://www.scielo.org.ve/scielo.php?pid=S037818442006001100009&script=sci_arttext.

Mennicken L., Ponsuksili S., Tholen E., Khang N.T.K., Steier K., Petersen J., Schellander K. and Wimmers K. (2005). Divergent selection for ω3:ω6 polyunsaturated fatty acid ratio in quail eggs. Arch Tierz 48, 527-534 NOWACZEWSKI et al.: Eggs weight of Japanese quail vs. eggs quality after storage time and hatchability results 730

Mielenz N., Dittmar E. andSchüler L. (2000). Effectiveness of genetic evaluation with transformed data by using dam-daughter pairs of Japanese quails. Arch Tierz 43, 299-309 [in German]

Mizutani, M. 2003. The Japanese quail. www.angrin.tlri.gov.tw/apec2003/chapter /pdf.

Mohamed Hassan Tabidi, (2011). Impact of Storage Period and Quality on Composition of Table Egg. Advances in Environmental Biology, 5(5): 856-861.

Morais, C. F. A., Campos, E. J. and Silva, T. J. P. 1997. Qualidadeinterna de ovoscomercializadosemdiferentessupermercadosnacidade de Uberl?ndia. ArquivoBrasileiro de MedicinaVeterin?ria e Zootecnia 49:365-373.

Moura GS, Barreto SLT, Lanna EAT. Efeito da redução da densidadeenergética de dietassobre as características do ovo de codornajaponesa. RevistaBrasileira de Zootecnia. 2010; 39(6): 1266-1271.

Mountney G.J. 1976. Poultry production technology. 2nd Edition. AVI publishing company, west port Connecticut. Page. 291.

Murakami AE, Barriviera VA, Scapinello C, Valério SR. Efeito da temperatura e do período de armazenamentosobre a qualidadeinterna do ovo de codornajaponesa (Coturnixcoturnix japonica) para consumohumano. RevistaUnimar. 2007; 16(suplemento 1): 13-25.

Narushin V.G. and Romanov M.N. (2002). Egg physical characteristics and hatchability. World's Poultry Science Journal 58, 297-303

Nasrollah V., Edriss M.A. and Moshtaghi H. (2006). Comparison of egg weight between two quail strains. International Journal Poultry Science 5, 398-400

Nowaczewski S., Kontecka H., Rosiñski A., Koberling S. and Koronowski P. (2010). Egg quality of Japanese quail depends on layer age and storage time. Folia Biol (Kraków) 58, 201-207.

NVRI, 1994. Farmer training on quail production and health management. National Veterinary Research Institute Vom, Nigeria. Pg.44.

Oluwatomi, O. 2010. Raising Quails: A Beginners Introduction. Tribune.com

Orji B.I., Igboeli C. &Okoye P.T., (1981). The effect of pre-incubation storage on embryonic growth rate, mortality, hatchability and total incubation period of fowl egg. Nigeria. Journal of Agricultural Science. 31, 99-103.

Ortlieb.G. 2013. Raising Coturnix Quail. www.howtoraisequail.com/coturnix quail.

Panigraphi S., Plumb V.F. & Mantrin D.H., (1989). Effect of dietary cotton seed meal with and without non-treatment on laying hens. British. Poultry Science. 30, 641-649.

Petek M., Baspinar H. and Ogan M. (2003). Effects of egg weight and length of storage on hatchability and subsequent growth performance of quail. South Africa Journal Animal Science 33, 242-247.

Petek M., Baspinar H., Ogan M. and Balci F. (2005). Effects of egg weight and length of storage period on hatchability and subsequent laying performance of quail. Turk Journal Veterinary Animal Science 29, 537-542.

Raji A. O., J. Aliyu, J. U. Igwebuike and S. Chiroma, (2009). Department of Animal Science, University of Maiduguri, Maiduguri, Borno State, Nigeria. ARPN Journal of Agricultural and Biological Science. VOL. 4, NO. 4.

Randall, M. And Bolla, G. 2008. Raising Japanese quail. State of New South Wales Department of Primary Industies. Prime Fact 602 2ndEdition.

Rankling, F. W., Artin, A., Lison G. M., Artin, D. And Nnabelle, M. A. 1998. Quail: An egg and meat production system. www.echocommunity.org/./quailegg.pdf

Ri E., Sato K., Oikawa T., Kunieda T. and Uchida H. (2005). Effects of dietary protein levels on production and characteristics of Japanese quail eggs. Journal Poultry Science 42, 130-139.

Rodrigues KRM, Salay E. Atitudes de granjeiros, atacadistas, varejistas e consumidoresemrelação à qualidadesanitária do ovo de galinha in natura. Revista de Nutrição. 2001; 14(3): 185-193.

Roque L. and Soares M.C. (1994). Effects of eggshell quality and broiler breeder age on hatchability. Poultry Science 73, 1838-1845

Sahin, N., Akdemir, F., Orhan, C., Kucuk, O., Hayirli, A. and Sahin, K. 2008. Lycopene-enriched Quail egg as functional food for humans. Food Research International 41: 295-300.

Samli H.E., Agma A. and Senkoylu N. (2005). Effect of storage time and temperature on egg quality in old laying hens. Journal Applied Poultry Research 14, 548-553

Santos MSV, Espíndola GB, Lôbo RNB, Freitas ER, Guerra JLL, Santos ABE. Efeito da temperatura e estocagememovos. Ciência e Tecnologia de Alimentos. 2009; 29(3): 513-517.

Scott T.A. and Silversides F.G. The effect of storage and strain of hen on egg quality. Poultry Science. 2000; 79: 1725-1729.

Shanaway, M. M. 1994. Quail production systems: A review. FAO.

Shim Kim Fah. 2005. Nutrition and Management of Japanese quail in the Tropics. www.that quail place.com.

Silversides, F. G. and T. A. Scott. 2001. Effect of storage and layer age on quality of eggs from two lines of hens. Poultry. Science.80:1240-1245.

Siyar, H. S. A., Aliarabi, H., Ahmadi, A. and Ashori, N. 2007. Effect of different storage conditions and hen age on egg quality parameters. Australia Poultry Science Symposium 19:106-10

Song, K. T., Choi, S. H. and Oh, H. R. 2000. A comparism of egg quality of pheasant, chukar, quail and guinea fowl. Asian-Australian Journal of Animal Science 7:986-990.

Stadelman W.J., (1994). Egg production, processing and products. Encyclopedia of Agricultural Science, 2(E-L), 43.

Tabidi, M. H. 2011. Impact of storage period and quality on composition of table egg. Advanced Environmental Biology 5(5):856-861.4

Tilki, M. and Inal, S. (2004). Quality traits of goose eggs. 1. Effects of goose age and storage time of eggs. 68:82-186

Tunsaringkarn, T., Tungjaroenchai, W. And Siriwong, W. 2013. Nutrient benefits of Quail (Coturnixcoturnix japonica) eggs. International Journal of Scientific and Research publications.3 (5). May 2013.

Xavier IMC, Cançado SV, Figueiredo TC, Lara LJC, Lana AMQ, Souza MR, Baião NC. Qualidade de ovos de consumosubmetidos a diferentescondições de armazenamento. ArquivoBrasileiro de MedicinaVeterinária e Zootecnia. 2008; 60(4): 953-959.

Yuichi, T., Takao, N., Masami, I., and Takahashis, (1970). Survey ofthe methods for long term storage of Poultry eggs.1- Effect of parafine oil coating on chicken egg quality. Japan - Poultry Science.7:186.