THE UNIVERSITY OF ZAMBIA

STUDY OF NUTRIENT COMPOSITION OF RANGE (VILLAGE) CHICKEN EGGS

BY

MIYANDA MAYABA (26100606)

A RESEARCH PROJECT REPORT SUBMITTED TO THE SCHOOL OF AGRICULTURAL SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE (AGRICULTURE)

DEPARTMENT OF ANIMAL SCIENCE

UNZA, LUSAKA

MAY, 2011

DECLARATION

This report has been compiled by myself and has not been accepted in any previous application for a degree. The work which this report records has been done by me and all sources of information have been acknowledged by means of references.

MIYANDA MAYABA

MAY, 2011

DEDICATION

This project report is dedicated to my family, mostly my parents Col L.E Miyanda and Ms D Munansangu Miyanda for their never ending support in all my endeavors.

ABSTRACT

A study was done to compare nutritional composition and external quality of eggs from village chickens with those from commercial chickens. The nutrients evaluated included cholesterol, protein, calcium and phosphorous while the external quality parameters included shell thickness and egg shell weight. Eggs from village chickens were randomly collected from small holder farmers in the outskirts of Lusaka while commercial eggs were randomly collected from commercial farmers. Calcium content was higher ($p<0.05$) in the shells of commercial eggs (10.4%) than in the village chicken eggs (6.8%). Phosphorous content was higher ($p=0.05$) in the village chicken eggs (28.8%) than in the commercial eggs (16.8%). There were no significant differences ($p> 0.05$) between the eggs with regard to cholesterol and shell weight. Commercial egg shells were thicker ($p<0.05$) with a thickness of 0.28 mm than those from village chicken eggs (0.24 mm) but the weights were similar. It is concluded from these results that cholesterol and shell weights are not different between the commercial eggs and those from village chickens. However, the macronutrients and external quality were more superior in the commercial eggs compared to those from village chicken eggs.

ACKNOWLEDGEMENTS

Firstly am thankful to God, for placing people in my life that helped me carry out this study. To my supervisor Dr. K.E.S Yambayamba despite his busy schedule who always found time to advise and make suggestions, am forever greatful and thankful. He was always available throughout this study and worked tirelessly to ensure that the work was done accordingly despite all the challenges that were faced. I also wish to extend my gratitude to the technical staff: Mr. Banda and Mr. Sinkala (Food Science Department), Mr. Mambwe, Ms. Ann Maliti (Animal Science) and Siyumbi Shebby (Biochemestry Lab, Vet School) for their very constructive comments, technical advice and particularly their time.

To my course mates Phebby Musonda, Alfred Mbata, Mathew Zulu, Kabemba Mwambilwa, Mukangwa Memory, Mirriam Mumba and my friends Mulenga Chilumbwa, Moka Kaliwile, Brina Himunzowa, Elijah Manda, Nachilila Yambayamba and Theresa Kinkese for the encouraging words in stressing moments. Finally, special thanks go to everyone who helped in the collection of the village chicken eggs.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Poultry production in Zambia

More than a decade ago, poultry production in Zambia was in a chaotic delirium (Ngosa, 2010). The cost of producing stock feeds and day old chicks had gone up and countries like South Africa and Zimbabwe had found Zambia as an easy destination for their products, be it feeds, chicken or eggs. The local poultry and feed industry was still down until the early 1990s. With less than two chickens per person and just about thirty six eggs per person per annum, consumption of chicken and eggs in Zambia is still one of the lowest in the world. According to Ngosa (2010), in June 1998, the Government of the Republic of Zambia clamped a ban on the importation of poultry and poultry products (Poultry Association of Zambia, 2007). In the last decade, there has been a boost in the production of broilers and commercial eggs.

According to PAZ (2007), small holder producers account for 65% of the total production. The PAZ report of 2007 showed that the poultry industry in Zambia had an annual turnover of K551.7 billion. But then these figures are not inclusive of the range (village) chicken production in Zambia. It is all on commercial broiler and egg production.

With regard to local poultry, almost all households in both urban and rural areas keep at least one local (village) chicken in their back yards. Yambayamba et al., (2006) found that more than 90% of rural dwellers in Zambia kept village chickens. Mushota et al., (2000) also reported similar results. Village chicken and egg production as a form of non-intensive agriculture in rural areas meets the demand for producing natural food as well as contributes to the development of the economical and social structure in rural areas (Kondombo et al., 2003). Worldwide, 80% of the chickens are village chickens (Alabi et al., 2006). This figure proves the importance of village chicken production for rural development and feeding.

1.2 The Versatile Egg

Eggs are one of the most versatile foods as they are used in so many different ways in food preparation (Len, 2011). They are said to be a nutritional package of nutrients and other biochemical active components (Wahlqvist & Kouris-Blazos, 2006). They are nutrient dense, providing a wide variety of quality nutrients without having high calorie content (about 70 calories per egg). The protein quality of eggs is high, providing all the essential amino acids needed for human protein synthesis and about 10% of the daily protein requirements (based on a 2000 calorie diet). Since eggs are a good source of high biological value protein and they are easily digested, they are a valuable food for people who are recovering from illness.
Despite a high biological value, eggs have been perceived for many decades, as somewhat unhealthy due to their cholesterol levels. High levels of cholesterol in the blood can cause coronary heart disease. According to Eberhard and Kronhaussen (1990), egg yolks have excessive cholesterol in them, 250 mg per yolk which is almost a daily allowance for a person. Expert bodies like the National Heart Foundation recommend an intake of cholesterol from all sources not exceeding 300 mg per day (Wahlqvist & Kouris-Blazos, 2006). The emphasis on the cholesterol content of eggs has obscured the many valuable nutrient contributions eggs make to the diet (McNamara, 2002).

However, McNamara (2002) observed that the dietary cholesterol question has become less of an issue since emphasis has now shifted towards the valuable role eggs play in a nutritious healthy diet. As new studies document the value of eggs in the diet, the cholesterol argument against eggs has becomes less important. But it has been noted that the fact that cholesterol from an egg can also affect blood cholesterol levels as much as it provides a well balanced source of nutrients for all ages should not be overlooked.

While much information is available on commercial eggs, no study has been carried out to determine the quality of eggs from range chickens in Zambia. This has resulted in speculations on the quality of these eggs as compared to commercial eggs. One of the important questions from a consumer's point of view is whether there is a difference in the internal quality between commercial eggs and those from village chickens. While some studies have been conducted elsewhere to shade some light on this aspect, data is completely absent from Zambian local poultry. Similarly, information on external quality is scanty.

1.3 Objective

The overall objective of this study was therefore to compare the nutrient composition and external quality between commercial and village chicken eggs produced under Zambian conditions. The specific objectives were to compare (1) cholesterol levels; (2) protein and macronutrient levels; and (3) shell thickness and shell weight in the egg from village chickens and commercial layers.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Egg Composition

The size and shape of eggs differs among the various species of birds, but all eggs have three main parts (Jacqueline et al., 2009). These three parts of the egg are separated from each other by membranes. The shell is separated from the albumen (egg white) by the shell membranes, and the yolk is separated from the albumen by the yolk membrane (vitalline membrane).
The yolk is formed in the ovary. There is a small white spot about 2 mm in diameter on the surface of the yolk. This is the germinal disk and it is present even if the egg is infertile. If the egg is infertile, the germinal disk contains genetic material from the hen only. If the egg is fertile, it contains genetic material from both parents and is where embryonic development begins. The yolk material serves as a food source for embryonic development.

The egg white (albumen) is produced by the oviduct. There are four layers of egg white. The outer thin white is a narrow fluid layer next to the shell membrane. The outer thick white is a gel that forms the center of the albumen. The inner thin white is a fluid layer located next to the yolk. The inner thick white (chalaziferous layer) is a dense, matted, fibrous capsule of albumen around the vitelline membrane of the yolk. The matted fibrous capsule terminates on each end in the chalazae, which are twisted in opposite directions and serve to keep the yolk centered. The chalazae are twisted so that the germinal disk always orients itself upwards. During storage, however, the thick albumen becomes thinner allowing greater movement of the yolk.

The shell is produced by the shell gland (uterus) of the oviduct, and has an outer coating, the bloom or cuticle. The shell of an egg is porous (with tiny pores) to allow the developing chick to obtain oxygen (Len, 2011). The pores also allow water and carbon dioxide to escape. The cuticle somewhat seals the pores and is useful in reducing moisture losses and in preventing bacterial penetration of the egg shell. Much of the cuticle is removed from table eggs when they are mechanically washed. To replace the cuticle, table eggs are often sprayed with a light mineral oil mist.

2.2 Nutritional Value of an Egg

Eggs are a nutritional package of nutrients and other biochemical active components. They are nutrient dense, providing a wide variety of quality nutrients without having high calorie content (about 70 calories per egg).

The egg white contains 88.5% water and the egg yolk about 50% water. This water is important for biochemical reactions that occur to maintain the internal egg quality although this internal egg quality can predispose the egg to microorganisms which would proliferate in such an environment.

The protein in eggs has a biological quality greater than any other natural food. Many manufacturers of protein powders often base their products on egg protein, such as albumin because of its protein quality. Thus, the egg protein is said to be the standard against which other food proteins are measured (Wahlqvist & Kouris-Blazos, 2006). Egg protein contains all the essential amino acids in the exact proportions required by the body for optimum growth and maintenance of lean, metabolically active tissue.

Eggs are a nutrition rich food, containing 17 different vitamins and minerals, including omega-3 fatty acids, folate and vitamin E, which may be associated with protection from some of the risk factors for coronary heart disease (Natoli, 2002). Eggs are a good source of vitamin A, B1, B12, D and E as well as folate, phosphorus, zinc and iron. Eggs are one of the rare natural sources of vitamin D. The egg white contains Riboflavin and other B vitamins while the egg yolk contains fat-soluble vitamins A, D, E and K. It also consists of mineral elements including iron. Eggs contain a modest quantity of fat with the egg yolk having 33% of fat and the egg white having a trace of fat. Eggs contain around 250-300 mg cholesterol per yolk. Many dietary guidelines have included a recommendation limiting dietary cholesterol to less than 300 mg per day (McNamara, 2002).

2.3 Internal and External Egg Quality

Besides the positive effects of eggs, eggs which are not produced under suitable conditions or are not consumed, when they are fresh can cause severe health problems (Avan and Alisarli, 2002). In this respect, egg quality characteristics are of high importance. In analyzing egg quality, different internal and external egg quality characteristics are analysed (Silversides and Scott, 2001).

When an egg is laid, it fills the shell. As it cools, the inner portion of the egg contracts and forms an air cell between the two shell membranes. A high quality egg has a tiny air cell, indicating the egg was collected soon after being layed and was stored properly. The air cell is usually located in the large end of the egg where the shell is most porous and air can enter easily (MAFES, 2010).

The albumen has a major influence on overall interior egg quality. Thinning of the albumen is a sign of quality loss. The albumen occasionally contains blood and/or meat spots. Both chemically and nutritionally, these eggs are fit to eat.

Less than 1% of all eggs produced have blood spots. Blood spots result from hemorrhage of a small blood vessel in the ovary or oviduct. If the blood spot is on the yolk, the hemorrhage was probably in the ovary at the time of ovulation or in the infundibulum part of the oviduct before albumen was laid down. If the blood spot is in the albumen, the hemorrhage probably occurred in the wall of the magnum part of the oviduct. Meat spots are degenerated blood spots, loose pieces of ovary or oviduct tissue, or cuticle remnants swept up to the magnum and included in the albumen.

Yolk quality is related to its appearance, texture, firmness, and smell. The yolk of a freshly laid egg is round and firm. As the yolk ages, it absorbs water from the albumen and increases in size. This weakens the vitelline membrane and gives the yolk a somewhat flattened shape on top and a general "out-of-round" shape. Ruptured yolks occasionally occur.

Yolk color depends on the diet of the hen. If the hen gets plenty of yellow-orange plant pigments known as xanthophylls, they will be deposited in the yolk. Natural yellow-orange substances such as marigold petals may be added to light-colored feeds to enhance yolk color. In any consumer survey of egg quality, yolk color ranks high but preference varies among countries (Jacqueline et al., 2009).

One of the characteristics of external egg quality is break strength. The organic and inorganic structure of the egg shell is very important for the break strength (Butcher and Miles, 2005). Shell quality is one of the most important factors in maintaining egg quality. The shell thickness and porosity regulate the exchange of carbon dioxide and oxygen between the developing embryo and the air during embryo development. Shell thickness also has a significant effect on moisture loss during storage (Washburn, 1998). Thin-shelled eggs also have a greater chance of being cracked during handling.

2.4 Nutrient Composition of Eggs

According to Bakalli (2005), products from pastured animals such as eggs and meat offer more "good" fats, and fewer "bad" fats compared to commercial products. They are richer in antioxidants; including vitamins E, beta-carotene, and vitamin C. Furthermore, they do not contain traces of added hormones, antibiotics or other drugs.
According to a study done by (Bornstein and Bartov, 1966), a direct relationship between feed, yolk color, and the nutrient content of the egg was observed. The more orange the yolk, the higher the level of health-enhancing carotenoids. Compared to supermarket eggs, eggs from pastured poultry are a vivid yellow/orange proof of a richer store of disease-fighting carotenes.

A number of recent studies have shown that eggs produced by free-range hens (village) are more nutritious than those laid by hens in commercial battery cages (Copley, 2010). Long and Alterman (2007) found that eggs produced by free range hens had 1/3 less cholesterol, 1/4 less saturated fat, 3 times more omega- 3 fatty acids and 7 times more beta carotene compared to commercial eggs. These hens consume a more natural diet that includes various seeds, worms, insects and green plants whereas commercial chickens have no opportunity to forage since they are confined; hence they are fed concentrates.

According to Scheideler (1997), specific lipids-fatty acids and fat soluble vitamins can be modified in the egg yolk by feeding the hen increased proportions of “good” fatty acids and increased amounts of fat soluble vitamins from dietary plant sources. This would lead to an increase in yolk polyunsaturated fatty acids which is accomplished by a substantial decrease in saturated fatty acids creating a healthier fat profile. Since saturated fatty acids are known to raise the levels of the “bad” LDL (low density lipoprotein) which is often referred to as bad cholesterol in our bodies (Bhuyan, 2010), eggs with polyunsaturated fatty acids can be produced to help lower these levels.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Eggs

Fifty freshly laid eggs from village chickens were randomly collected from small holder farmers in the outskirts of Lusaka. Another 50 commercial eggs were randomly collected from commercial farmers. All the eggs were put on trays and placed in the refrigerator at a temperature of 4 °C to prevent deterioration. The eggs were stored for a maximum period of four weeks.

3.2 Laboratory Analysis

The analysis was done in the Animal Science and Food Science chemistry laboratory at the University of Zambia. The eggs were analyzed for their nutrient composition specifically for cholesterol levels, protein, calcium and phosphorous. With regard to external quality, shell thickness, shell weight and egg weight were measured.

3.2.1 Cholesterol Determination

The reaction which is an absorbance-based assay was used. In this process, 0.3 g egg yolk sample was weighed in a conical flask, to which 20 cm^3 of ethanol ether mixture (2:1) was added. The contents were then thoroughly mixed and heated to boiling in water, stirred and left to cool. After standing for about 30 minutes, the mix was filtered. The precipitate was washed with portions of warm solvents to achieve a filtrate volume of 25 cm^3. The filtrate was evaporated to dryness on a boiling water bath in a fume cupboard. A little ethanol was added and then re-dried.

Following cooling, 5 cm^3 chloroform, 2 cm^3 acetic anhydride and 0.1 cm^3 sulphuric acid (AR) were added in test tubes. The contents were mixed and colour was allowed to develop in the dark for exactly 30 minutes. All the tubes were read at a wavelength of 680 nm. The couvettes were rinsed with a little chloroform between the readings. A calibration curve was then prepared with the standard readings. The cholesterol content was calculated per 100 g egg yolk.

3.2.2 Protein Determination

The micro kjeldahl method was used. Since eggs were wet samples, 1 g of mixture of yolk and egg white was weighed and transferred to the kjeldahl flask. Four grams of the catalyst and 12 mls of concentrated sulphuric acid AR were added to the sample. The flask was placed on the digestion rack and left to digest for 30 minutes. After the mixture had stopped boiling and turned to greenish-blue, it was left to cool to room temperature in a fume cupboard.

Following cooling, 75 ml of water was added and shaken, after which 50 ml sodium hydroxide was added and then placed on the on the distillation apparatus. Twenty five milliliters (25 ml) boric acid was placed in a receiving flask that was placed on the apparatus. The boric acid and ammonia gas was titrated against 0.1 hydrochloric acid solution. The crude protein content was determined using the formulae:

$$\%\text{Protein} = \frac{Bvolume * 14.007 * 6.25 * 100 * 0.1}{Wsample * 100}$$

Where: B= Burette reading

W=Weight of sample

*= Multiplication sign

3.2.3 Calcium Determination

The Permanganometric method was used. Calcium was determined in both the egg shells and the mixture of yolk and egg white. Two milliliters of the mixture of egg white and yolk was measured.

The samples were placed into crucibles, which were transferred to a muffle furnace for ashing at a temperature of 550 °C for 4 hours. The furnace was left to cool to 100 °C and the crucibles were removed and placed in the dessicator.

Ten milliliters of 3 N hydrochloric acid was added to the crucibles and brought to boil on a hot plate. The mixture was filtered and the acid extract collected into 100 ml volumetric flasks. The acid extract was made to the mark with distilled water.

From 100 ml volumetric flasks, 50 ml of the acid extract was pipetted into a 400 ml beaker and 10 ml hot distilled water added. A few drops of methyl red indicator were added with 1g powdered ammonium oxalate and ammonium solution to neutralize the solution and brought to boil for 1 minute. The mixture turned yellow upon addition of ammonium solution.

The mixture was cooled for 2 hours and filtered through a filter paper washed several times. The filter paper was transferred to the beaker and Calcium oxalate was dissolved in 100 ml distilled water and 20 ml 2N sulphuric acid. The mixture was titrated to a faint pink colour with 0.1 N potassium permanganate. Calcium content was determined using the formulae;

$$\%\text{Calcium} = \frac{0.2 * VKmnO_4}{Wsample}$$

Where: V= Volume of Pottasium Permanganate used

W=Weight of Sample

3.2.4 Phosphorus Determination

This was done using the Vanodo-molybdate method spectrophotometrically (AOAC, 1998). The procedure of mineral extraction was the same with that for Calcium determination; 2.5 ml of acid extract was pipetted into a 50 ml volumetric flask and filled up to the mark with distilled water. From the acid extract, 1 ml of aliquot was pipetted into a test tube and together with the standards and blank, 4 ml Molybdate reagent and 3 ml ANSA was added. Colour was left to develop for 20 minutes in the dark and after that, absorbance was read at 660 nm.

$$P\% = \frac{Pconc * DF}{10 * Wsample}$$

Where: Pconc = Concentration of Phosphorous in sample

W= Weight of sample

DF= Dilution factor

3.2.5 Measurement of calcium in Egg Shell

Two grams of ground egg shell was weighed. The determination of calcium as done as described for internal quality (section 3.2.3).

3.2.6 Measurement of Shell Thickness

The shells were washed and dried in the oven at 50 ^{0}C, for 24 hours. The shells were then cooled and the shell thickness was measured according to the methods of Curtis et al. (1986). The method involved collection of three pieces of shells from the narrow, broad and equator. The thickness of these pieces was measured using the micrometer screw gauge. The mean thickness was then taken as the thickness of the particular shell.

3.2.7 Shell Weight

The shells were first weighed after the yolk and albumen were removed. After this, the shells were washed and dried in the oven at 50 ^{0}C, for 24 hours. The shells were then cooled and weighed using the analytical balance.

3.3 Statistical Analysis

Actual values were used to generate means and sums using Microsoft Excel 2007. The t – test, Paired Two Sample for Means, was used to compare variations between the village and commercial eggs.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Nutritional Quality of Eggs

Data for the nutritional egg quality characteristics and differences between the groups are given in Table 1.

Table 1: Nutritional quality in village chicken eggs and commercial eggs

Characteristics	Village Chicken eggs	Commercial eggs	P
Cholesterol (mg/g Yolk)	252±37	256±42	0.7
Protein (%)	23.8±2.1	28.4±1.8	0.01
Calcium (Albumin and Yolk) (%)	0.29±0.1	0.18±0.01	0.01
Phosphorus (Albumin and Yolk) (%)	28.8±7.3	16.8±0.5	0.05

4.1.1 Cholesterol levels

There were no significant differences ($p>0.05$) in cholesterol levels between eggs obtained from village chickens and those obtained from commercial chickens. Anderson (2009) did a study and found that, eggs from range production environment had higher polyunsaturated fats hence less cholesterol levels than eggs produced from caged hens. Cholesterol concentration has been known to be affected by factors such as feeding and age of the bird. Menge et al. (1974) found that cholesterol concentration (mg/g yolk) increased with age of the hens. Harris et al. (1963) reported similar results in their study on the relationship between the age of the hen and cholesterol levels. In contrast, Spencer et al. (1978) and Turk and Barnett (1971) reported no relationship between yolk cholesterol concentration and age of bird. They reported that there is an increase in egg cholesterol content with age of bird and is thus attributed to an increase in yolk concentration and egg weight. This finding was consistent with results by Kline et al. (1965) and Cunningham et al. (1960) who showed that as the age of the laying hen increased cholesterol concentration and egg mass increased. This increase in cholesterol levels is probably due to its increased use in the normal body functioning of the body. As the chickens get older and reach the productive stage, the body needs more cholesterol for the role it plays in normal body functioning. Cholesterol exists in the outer layer of every cell in the animal's body and has many functions, including building and maintaining cell membranes (outer layer) and preventing crystallization of hydrocarbons in the membrane. It is also involved in the production of sex hormones (androgens and estrogens) (Nordqvist, 2009). Cholesterol content in eggs has been seen to vary depending on the diet of chickens (Cyprus, 2010). The author found that there was a positive correlation between diet and cholesterol concentration in eggs. If the diet for the chickens has high levels of cholesterol, this will lead to high cholesterol content. Schneider and Lewis (1997) did a special feeding and genetic program where they kept both range and commercial chickens and upon measuring the cholesterol content in the eggs, found a consistent reduction in cholesterol content of the eggs in range chicken compared to the commercial egg. Anderson (2009) did a study and found that there was no difference in cholesterol content in eggs from range chickens compared to commercial. These findings are consistent with results from this study which showed no significant difference ($p>0.05$) which probably might have been due to the age and feeding factor. Since village chickens are mostly kept for a longer period compared to commercial chickens, cholesterol content in eggs increases as they grow older. Commercial chickens are mostly fed high concentrate feeds with high amounts of saturated fats from animal products which contribute to high levels of cholesterol in the eggs. Since both of these factors contribute to high cholesterol content in eggs, this may have been the reason why cholesterol concentrations in these eggs were similar.

4.1.2 Protein Content

There was a significant difference at ($p<0.05$) between village chicken eggs and commercial eggs in the protein content. The egg protein is said to be the standard against which other food proteins are measured (Wahlqvist & Kouris-Blazos, 2006). Egg protein contains all the essential amino acids in the exact proportions required by the body for optimum growth and maintenance of lean, metabolically active tissue. According to Dana and Ogly (2002), if protein requirement is not met, the egg will contain protein in low amounts hence reducing the essential amino acid content. This is because most of the protein given in the feed would probably be channeled to the normal body functions. Emmans (1991) reported that protein is one of the key parameters in the diet of chickens. Protein is required for feather development, muscle deposition and also for production of reproductive organs such as ovaries and oviduct. It would be expected to increase the protein demand, and thus protein intake, in a feeding situation. This has been observed by Scott and Balnave (1989) as a marked increase in protein content before the onset of lay. Protein content in the commercial eggs determined in this study was 28.4% and in village chicken eggs 23.8%. Since village chickens are left to fend for themselves with no supplementation, the diet tends to be low in protein since most of its diet is forage. Protein is mostly obtained for animal products hence differences might have probably been due to the difference in the diet.

4.1.3 Calcium and Phosphorus in the Egg

There was a significant difference ($p<0.05$) in calcium and phosphorous contents in the mixture of the yolk and albumen between the two treatments. According to Cicek and Kartalkanat (2009), calcium content is related directly with nutrition in chicken. While calcium content in eggs from village chickens was 0.28 % on average, it was 0.18 % in commercial eggs. It was observed that the edible part of the egg from village chickens had more calcium than the commercial egg. In a review article by Roland (1986), it was observed that additional calcium adversely affected feed intake and egg production due to the excessive levels of calcium and other minerals, such as magnesium, present in calcium sources, as well as that excessive calcium added to the diet is not absorbed by the digestive tract.

With regard to phosphorous, the content was 28.8% in village chicken eggs while it was 16.8% in commercial eggs. Phosphorous is one of the minerals found in eggs essential for building and maintaining healthy bodies. Phosphorous has been found to be an important component of ATP. It is essential for energy production infertile eggs. According to (Watanabe, 2001) eggs low in phosphorous are of low quality.

It may be speculated that the high calcium and phosphorous contents in village chicken eggs could be due to the fact that the growing embryos need these minerals as opposed to the infertile commercial eggs. Commercial chickens deposit most of their calcium in the egg shells, hence maintaining egg quality by having thick shells which helps in reduction on breakages.

4.2 External Quality of Eggs

Results for external egg quality are presented in Table 2.

Table 2: External quality of village chicken eggs and commercial eggs

Characteristics	Village Chicken egg	Commercial egg	P
Shell Thickness (mm)	0.24±0.01	0.28±0.01	0.01
Shell weight (g)	0.96±0.2	1.27±0.3	0.18
Calcium (Shell) (%)	6.7±1.2	10.4±0.5	0.01

4.2.1 Shell Thickness

There was a significant difference ($p<0.05$) between village and commercial eggs in terms of egg shell thickness. The shell thickness from village chicken eggs was 0.24 mm while that for commercial eggs was 0.28 mm. The shell in particular contains calcium carbonate which when in large amounts will result in the shell having a thicker shell. In contrast Cicek and Kartalkanat (2009) reported that village eggs had thicker shells than the commercial. Since calcium carbonate content in shells is directly related with nutrition, the contrast must have been due to the differences in the diets. Scientific evidence shows that egg shell thickness depends on the amount of calcium in the diet and the ability of the hen to re-absorb calcium deposited in the bones. This ability usually deteriorates progressively as the hen ages (Kirchgessner, 1997). Therefore the calcium rate in the diet of the village chickens affects shell thickness (Boltumelo, 2004). The laying hen is not 100 percent efficient in extracting calcium from the available sources in the diet. Therefore, many times the diet has to furnish in excess of 4 grams of calcium to the hen daily. Calcium availability values are sometimes not known, and it must be remembered that higher daily intakes are needed when the availability values are known to be low (Butcher and Miles, 2005).

During this study eggs were stored in the refrigerator at 4 °C Jones, (2007). It was observed that eggs from village chickens when stored in the refrigerator at this temperature cracked showing that shells were thin. This might have been due to the low calcium content in the diet of the village chickens and low ability to re-absorb calcium since they are usually kept longer than the commercial chickens. The age factor therefore contributes to the low calcium content in the shells. Shell thickness contributes to strength of the eggs hence bringing about a reduction in breakages.

4.2.2 Egg Shell Weight

There was no significant difference ($p>0.05$) in egg shell weight of the village and commercial chickens. According to Cicek and Kartalkanat (2009), this result is dependent on the determined low egg weight. It may probably depend on the age of the bird, genotype and feeding of the chicken. It has been seen that as the chicken grows older, if diet is not monitored, the same amount will be required to be deposited in the shell. As the chicken gets older, the eggs will become larger. According to (Boltumelo, 2004) the calcium requirement of the laying hen is great. It can be calculated that during the 20 hours that are required to form an eggshell, 25 milligrams of calcium must be deposited on the egg every 15 minutes. This amount of calcium is the total amount of calcium in a normal hen's circulatory system at any given time. The average shell weight for village chicken eggs was 0.96 grams while it was 1.27 grams for commercial eggs. This difference was probably dependant on the diet of the chickens with the village chickens having low calcium content in its diet compared to the commercial. Hence less calcium is deposited in its shell. The age factor may have also contributed to the low calcium content due to poor calcium re-absorption from the bones.

4.2.3 Calcium and Phosphorous in the Shell

There was a significant difference ($p<0.05$) in the calcium content in the shells between village chicken eggs and commercial eggs. The shell is a material that in particular contains calcium carbonate. In the shell of the village chicken, it was found to be 6.7 % and 10.4 % for commercial chickens. Calcium requirement of the laying hen is great hence it is important to provide adequate nutrition in the diet so as to maintain adequate egg shell quality. There are a number of factors that can influence the amount of calcium being laid down by the hen, (Butcher and Miles, 2005). As the hen ages and eggs get larger, the similar amount of calcium has to be spread over a large surface. Environmental temperature is also one of the factors that can influence calcium deposition. In hot weather, hens do not consume adequate feed hence measures should be taken to assure adequate daily nutrient requirement to maintain shell quality. It was observed from this study that the commercial egg deposits more calcium in its shell compared to village chickens. The diet of the chickens could also have contributed to the high levels in shells for commercial chickens since they are supplemented.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study showed no significant differences in cholesterol level and shell weight between village chicken eggs and those obtained from commercial chickens. While some studies have shown that village chicken eggs have less cholesterol, the present study showed similar levels in both egg types. Significant differences were observed in the protein and calcium contents in both the shell and the edible part of the egg. Commercial eggs had more calcium in the shells compared to village chicken eggs. The village chicken eggs had thin shells which showed that they were more fragile and prone to breakage. This was probably due to the nutritional factor.

5.2 Recommendation

Given the scanty data under Zambian conditions, it is recommended that further research be undertaken to generate more information.

REFERENCES

1) Alabi R.A., A.O. Esobhawan and M.B. Amna, 2006. Ecanimetric determination of contribution of Family poultry to Womens income in Niger – Delta, Nigeria. Journal Central Europe Agriculture, 7: 753-760.

2) Avan T and Alisarli M, 2002. The effects of storage conditions on the physical, chemical and microbiological quality of the egg. Turk Journal Veterinary Medicine 13(1-2): 98-107.

3) Bakalli R. (2005). Feed and egg quality control. Kosovo cluster and business support project. Journal of Nutrition. 6(3) 225-242.

4) Bhuyan R, 2010. Cholesterol: Effects of High Cholesterol, 3rd Edition. Wolfe Publishing. London.

5) Boltumelo P.T., 2004. Influence of Limestone Particle Size in Layer Diets on Shell Characteristics at Peak Production. World Poultry science journal. 48: 5-16.

6) Bornstein S. and I. Bartov (1966). "Studies on egg yolk pigmentation. I. A comparison between visual scoring of yolk color and colorimetric assay of yolk carotenoids." Poultry Science 45(2): 287-96.)

7) Browne AW., P.J.C. Harris Hofney A.N. Collins N. Pasiecznik and P.R Wallace 2000. Organic Production and Ethical Trade: Definition Practice and Links Food Policy, Journal of Food Science and Agriculture 2:69-80.

8) Butcher G.D and Miles R.D, 2005. Concepts of Eggshell Quality. Poultry Science Department, University of Florida, Gainesville Press, 5: 8-27.

9) Cicek K and Kartalkanat A; 2009. Comparison of Village Eggs and Commercial Eggs in Terms of Egg Quality. Journal of Animal and Veterinary Advances, p. 2542-2545.

10) Copley Jennifer, 2010. “Nutrition- Free range vs Battery cage hens.” Available online: www.motherearthnews.com

11) Cunningham D.L, Krueger W.F, Fangury R.C and Bradly J.W, (1974). Primary Results of Bidirectional Selection for Yolk Cholestrol Level in Laying Hens. Poultry Science, 53:384.

12) Cyprus Sheri, 2010. What are Omega-3-eggs? United States Department of Agriculture. Available online: www.nal.usda.gov

13) Dana N and Ogle B 2002 Effects of scavenging on diet selection and performance of Rhode Island Red and Fayoumi breeds of chicken offered a choice of energy and protein feeds. Tropical Animal Health and Production. 34:417-429.

14) Eberhard D and Kronhaussen, 1990. Nutritional Value of Healthy Eggs. Alive publishing group. Iowa State University Press, pp.6-18.

15) Emmans G C 1991. Diet selection by animals: Theory and experimental design. Proceedings of the Nutrition Society. 15: 59-64.

16) Faria LV. 2002.Granulometria do calcário calcítico e níveis de cálcio para poedeiras comerciais em segundo ciclo de reprodução [dissertação]. Lavras (MG): Universidade Federal de Lavras; 5(6): 120-138.

17) Harris P.C, and Wilcox F.H., 1963. "Studies on Egg Yolk Cholesterol." Genetic Variation and some Phenotypic Correlations in a Random Bred Population."Poultry Science 42, No 1 178-182.

18) Jacqueline P.J, Richard D.M, Mather F.B, 2002. Egg Production Poultry Science. University of Florida IFAS Cooperative Extension Services. U.S. Department of Agriculture. Poultry Science. 62: 1800-1805

19) Jones D.R. (2004). Effects of extended storage time on egg quality factors. Journal of Poultry Science. 6 (3): *157-162.*

20) Kirchgessner M. (1997). Egg shell quality in laying hens. Paper presented at the Sixth International Poultry Breeders Conference. Frakfurt.

21) Kline L, Meehan J.H and Sugihara T.F (1965) Relation between Layer Age and Egg – Product Yields and Quality. Food Technology 19:1296-1301.

22) Kondombo, S.R., AJ. Nianogo, R.P. Kwakkel, H.M.Y. Und and M.Slingerland, 2003. Comparative Analysis of Village Chicken Production in Two Farming Systems in Burkina Faso. Tropical Animal Health and Production, 35(6): 563-574.

23) Len K, 2011. Eggs Composition and Nutritional Content. 4th Edition. New York: Mcmillan Co.

24) Long, C., & Alterman, T. (2007). "Meet the Real Free-Range Eggs." Mother Earth News, Available online: www.motherearthnews.com

25) McNamara D.J, 2002. Eggs Come Full Circle. Iowa Egg Council. Egg Nutrition Center. Available online:www.enc-online.org.

26) Menge H., Littleffield L.H, Frobish L.T and Weinland, 1974. B.T. "Effect of Cellulose and Cholesterol on Blood and Yolk Lipids an Reproductive Effeciency of the Hen." Journal of Nutrition, 104 (1974), 1554-1566.

27) Mississippi Agricultural and Forestry Experiment Station, 2010. Poultry; Production and Incubation. Contents of chicken egg. Mississippi State University Press.

28) Mushota N.M, Mfitilodze M.W, Wollny C.B.A, Gondwe T.N, Nyirenda D, 2002. Characterisation of the local Zambian chicken. Journal of Agricultural Science., 4: 28-35.

29) Mwalusanya N.A., Katule A.M, Mutayoba S.K, Mtamb, M.M.A, Olsen J.E and Minga U.M, 2002. Productivity of Local Chickens Under Village Management Conditions. Tropical Animal Health and Production 34: 405-416.

30) Natoli S, 2002. Cholesterol in Eggs. Food Nutrition, 2nd Edition. Victoria press. Australia.

31) Ngosa M.B, 2010. "The Zambian Poultry Newsletter." Poultry Association of Zambia. First issue.

32) Nordqvist Christian. 2009. What is Cholesterol? What Causes High Cholesterol? Medical use today. Publication 332. USA.

33) Pizzolante CC, Garcia EA, Laganá C, Saldanha ESPB, Deodato AP, Faitarone ABG, Scherer MR, Batista L. 2006. Effect of the calcium level and limestone particle size on the performance of semi-heavy layers in the second cycle of egg production. Revista Brasileira de Ciência Avícola; 8(3):173-176.

34) Poultry Association of Zambia, 2007. Poultry Schedule Hand book.

35) Roland DA. Sr. Eggshell quality III: Calcium and phosphorus requirements of commercial leghorns. World's Poultry Science Journal 1986; 42:154-165.

36) Samli H.E., A. Agma and N. Senkoylu. (2005). Effect of storage time and temperature on egg quality in old laying hens. Journal of Applied Poultry Research. 1 4: 548-553.

37) Schneideler E.S, and Lewis N.M, 1997. NF97-354 Omega Eggs- A Dietary Source of n-3 fatty acid. University of Nebraska- Lincoln Press.

38) Scott T A and Balnave D 1989 Responses of sexually-maturing pullets to self-selection feeding under different temperatures and lighting regimes. British Poultry Science 30:135-150.

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

40) Spencer J.V, Becker W.A., Mariosh L.W and Verstrate J.A, (1978). Effect of Fertilization and Age of Hen on the Cholesterol Content of Chicken Egg Yolk. Poultry Science., 57:261-164.

41) Turk D.E and Barnett B.D., (1971). Cholesterol Content of Market Eggs. Poultry Science., 50:1303-1308.

42) Wahlqvist and Kouris-Blazos 2006. Eggs. 3rd Edition. Victoria press, Inc, Australia.

43) Washburn K.W. and Marks H.L, 1998. "Changes in Fitness Traits Associated With Selection for Divergence In Yolk Cholesterol Concentration." British Poultry Science, 18, No.2 (1977), 189-199.

44) Watanabe W, 2001. Progress in controlled breeding of summer flounder Paralichthys lethostigma. Journal of Applied Agriculture, 11(1/2): 89-111.

45) Yambayamba K.E., Mukumbuta W.A., Chileshe E.C., Simainga S and Chonde D. 2006. A survey of prevailing traditional ownership of Livestock by smallholders in four provinces of Zambia. Zambian Journal of Agricultural Science 8:13-18.