EFFECT OF STORAGE CONDITIONS ON THE QUALITY OF EGGS IN OPEN MARKETS

KASONKA

EFFECT OF STORAGE CONDITIONS ON THE QUALITY OF EGGS IN OPEN MARKETS

KASONKA

THE UNIVERSITY OF ZAMBIA

EFFECT OF STORAGE CONDITIONS ON THE QUALITY OF EGGS IN OPEN MARKETS

BY

WILLY KASONKA (25056301)

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

DEPARTMENT OF ANIMAL SCIENCE

UNZA, LUSAKA

MAY, 2010

DECLARATION

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

WILLY KASONKA

MAY, 2010

DEDICATION

I would like to dedicate this project report to my family back home, especially my mother Grace Mulenga Lombe and father William Kasonka for their ever loving support.

ABSTRACT

A study was done to evaluate external and internal egg quality, comparing those stored and sold under informal facilities and those sold in commercial facilities. The quality traits that were examined were egg weight, egg shape index, shell thickness, shell weight, albumin height, albumin pH, yolk pH and yolk width. The eggs used in the study were obtained from three commercial facilities and three informal facilities. These outlets have different storage methods. The effects of source of eggs on the quality traits were found to be significant ($p<0.05$) for all the traits except egg shape index, yolk width and yolk pH. Egg weights were higher in eggs that were obtained from commercial facilities as compared to those from the informal facilities. Albumen height was lower in eggs from the informal facilities but albumen pH was higher. Therefore, it was concluded that eggs obtained from informal facilities were of lower quality than those from commercial facilities. This implies that storage conditions have significant effects on egg quality. This may affect processing and quality of products in which eggs are included. Further, consumers need to be aware of possible health risks associated with deteriorated quality of eggs stored under open environments.

ACKNOWLEDGEMENTS

I am greatly indebted to my supervisor Dr. K.E.S Yambayamba who, despite being busy with his numerous responsibilities, found time to make suggestions and advise me. He rendered the necessary guidance throughout the entire study. His very comprehensive comments and suggestions are greatly appreciated. I also wish to extend my gratitude to the technical staff: Mr. Banda (Food Science Department) and Ms. Ann Maliti (Animal Science) for their very constructive comments, technical advice and particularly their time.

I also wish to thank Mr. Martin Sampa for assistance with statistical analysis. **Finaciers:** Mr. Mutotwe Kafwaya. My acknowledgements would be incomplete without thanking my course nates especially Lifuti Fundulu, Lukonde Mwelwa and Mwansa Bwalya for encouraging me in ny work. Finally, special thanks go to smallholder producers and commercial producers for their o-operation during this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

SM1	Supermarket 1
SM2	Supermarket 2
SM3	Supermarket 3
OM1	Open market 1
OM2	Open market 2
OM3	Open market 3

CHAPTER ONE

INTRODUCTION AND BACKGROUND

1.1 Value of eggs

Eggs have been known to be a marvel of nature. This is because eggs are one of the most complete foods known to humans, as evidenced by the excellent balance of proteins, fats, carbohydrates, vitamins and minerals (Hasler, 2000). They provide a well balanced source of nutrients for persons of all ages. During the rapid growth of infants, children and teenagers, eggs can contribute significantly to the body's nutrient needs. Eggs are sources of nutrition for the developing chick embryo (Cordts et.al., 2002). Unlike mammals, the chick embryo cannot secure needed nutrients from the reserves of the mother; rather it lives in a closed system which must contain all the food needed for development.

Eggs contain an abundance of proteins, vitamins and minerals. The protein fraction of the egg has the highest rating of any food. It has a biological value of 94/100 (Miles and Henry, 2004).

Additionally, eggs are a good source of iron, phosphorus, trace minerals, vitamin A and vitamin E and most of the B-vitamins, including vitamin B-12. Eggs are second only to fish liver oils as a natural source of vitamin D (Jones, 2005).

1.2 The poultry industry in Zambia

There is a growing importance of the livestock sector as more and more people realize that the net annual returns from livestock are high. Poultry is one of the key industries in Zambia. It involves production of poultry meat and eggs. In the center of this are small holder producers, accounting for 65% of the total production (Poultry Association of Zambia: Poultry Schedule, 2007). The poultry industry in Zambia has an annual turnover of K551.7 billion (Poultry Association of Zambia, 2007).

Despite having a huge net annual turnover rate, the industry continues to experience huge economic losses. These losses occur at two levels, that is, production and retail. Related to production losses is poor management. Most of the small holder producers do not regularly pick their eggs and storage of the eggs once they are picked is improper.

Further, retailers owning informal structures do not store eggs properly and these eggs are kept for a long time under conditions that leave the quality highly questionable.

Many small holder producers sell their eggs to open markets and other informal trading places where most consumers buy from. The storage conditions in the open markets are not controlled, thus possibly selling eggs whose quality has deteriorated or posing a health hazard to consumers. Unfortunately, many consumers of eggs are equally not concerned about egg quality. They buy from open markets and other informal trading facilities without considering the environment under which the eggs are being sold.

Eggs for the fresh in shell market must meet strict standards to ensure that only those eggs that are of high quality reach the consumer.

1.3 Egg production and consumption in Zambia

According to the Poultry Association of Zambia (2007), egg consumption in Zambia is about 24 eggs per person per month; this corresponds to a total egg consumption of 977,500 eggs per day or 29.3 million eggs per month in Zambia. Of the total egg production, only about 10% is exported to neighbouring countries such as Congo DR, Botswana, Mozambique and Angola (Poultry Association of Zambia, Poultry schedule, 2007).

Egg production in Zambia is mainly done by major corporations like Golden Lay Farm, Cedrics Eggs, Tamba Farms and Bokomo Zambia. The eggs produced by these farms are both for the local market and export market. However, eggs found on the local market are mainly produced and supplied by small holder producers. These producers deliver their eggs in open vans; the eggs are mainly supplied to traders who do not have proper storage facilities. Normally the eggs are sold to consumers at the stalls without any protection from sunlight or other forms of environmental insults. This situation may lead to faster deterioration of egg quality.

1.4 Objectives

Given the above background, the main objective of this study was to investigate internal and external quality of eggs consumed in Lusaka by highlighting the differences in the quality of eggs stored under uncontrolled open markets and those stored in commercial trading facilities.

CHAPTER TWO

LITERATURE REVIEW

2.1 Physical characteristics of an egg

Typically, an egg is oval shaped with a smooth protective covering known as the shell. Although many are truly ovate, eggs differ considerably in shape. Some are nearly spherical, whereas others are elongated. Some eggs are almost equally pointed or rounded at both ends, others taper sharply from the large end to the small end.

The shell is composed of Calcium Carbonate, with some 6 000-8 000 pores (Roberts and Leary, 1999). The pores permit transfer of volatile components including exchange of air between the outside and inside. The normal egg weighs about 58 grammes and the shell thickness is 0.33-0.40 mm (Staldeman and Cotterill, 1995).

The egg shell has two membranes just below it; these form the inedible part of the egg. The shell color of the eggs of the domestic hen may be white, brown and various shades of brown or yellow. Sometimes very small dark flecks are present on the shell, especially if it is brown. Color of the egg is peculiar to the breed, although tinted eggs occasionally appear in breeds that ordinarily lay white eggs.

The egg yolk (yellow in colour) is surrounded by a membrane called vitelline membrane. The germinal disc, a normal part of every egg, is located on the surface of the yolk. Embryo formation begins here only in fertilized eggs.

2.1.1 Components of the egg

The characteristic feature of an egg is the shell. The shell is the outer covering of the egg and performs several important functions and tasks. Each individual egg is unique with its own microstructure which provides a wealth of information about the environment in which it was created (Cordts et al., 2002). The shell protects the contents of the egg from mechanical impact to some extent and allows a controlled exchange of fluid and gas through the pores. The egg shell also provides protection against microbial entry from the environment and serves as a source of calcium for the development of the embryonic skeleton (in case of fertilized eggs). (Roque and Soares, 1994).

The two membranes below the shell form the second line of defense. The outer shell membrane is located just inside the shell, and the inner shell membrane, is located between the outer shell membrane and the albumin. As the egg cools, the two membranes are pulled apart to form the air sac. The air sac is an empty space located at the large end of the egg. It provides a way of testing the age of an egg: as the air cell increases in size, the egg becomes less dense and the larger end of the egg will rise to increasingly shallower depths when the egg is placed in a bowl of water (Stewart et al., 2006). A very old egg will eventually float in water and should not be eaten.

The most common part of the egg is the egg white or the albumen. It is transparent when the egg is raw but assumes its characteristic white colour when boiled. The egg white surrounds the egg yolk and is comprised of four layers namely: outer thin or liquid white, dense or thick white/albuminous sac, inner thin or liquid white and inner thick white or chalaziferous layer. The four layers can be catergorised into two broad classes: thick albumin (the stringy part of the egg white located nearest the yolk) and thin albumin (the watery part of the egg white located farthest from the yolk). Suspended in this gel-like fluid is the yolk. It makes up 33% of the liquid weight of the egg. The yolk is the sole source of food for the developing embryo, in fertilized eggs. The yolk of a freshly laid egg is round and firm. As the yolk ages it absorbs water from the albumen, which increases its size and causes it to stretch and weaken the vitelline membrane (Evenepoel et al., 1998). The resulting effect is a flattened and enlarged yolk shape.

The yolk is held in place by the chalazae. These are spiral bands of tissue that hold the yolk and keep it suspended in the egg white.

2.1.2 Biochemical composition of an egg

The egg contains about 88% water in the egg white. This is not only important for biochemical reactions that take place to maintain the internal egg quality but the high levels of moisture can redispose the egg to microorganisms, which would proliferate in such an environment (Kimura t al., 2004).

he egg is one of the few foods that naturally contain Vitamin D. All the egg's Vitamin A, D and are in the yolk (Brothwell et al., 2004). Eggs supply all essential amino acids for humans and rovide several vitamins and minerals, including Vitamin A, riboflavin, folic acid, Vitamin B_6, itamin B_{12}, choline, iron, calcium, phosphorus and potassium (Howe et al., 2004). Table 1 hows the approximate quantities found in the egg.

he egg yolk contains approximately 60 calories (250 kilojoules) while the egg white contains bout 15 calories (60 kilojoules) (Li-Chan and Nakai, 1998).

he proteins of the egg white account for about 13% and contain no cholesterol and little, if any, at (Weggmans et al., 1999). Egg white proteins include Ovalbumin, Conalbumin, Ovomucoid, lobulins, Ovomucin, Flavoprotein, Ovoglycoprotein and Avidin. 27% of the the fat in the egg s saturated fat (Palmitic, Stearic and Myristic acids) that contains LDL cholesterol.

.1.3 Uses of eggs

hicken eggs are widely used in many types of dishes. Eggs can be fried, scrambled, pickled, ard-boiled, soft-boiled or refrigerated. Eggs are also widely used in industrial processes to anufacture products like mayonnaise and hollandaise. Eggs are also used in baking. Eggs can dd many positive attributes to food products such as: emulsification, leavening, smoothness and lavor (Jones, 2007). However, these factors are affected by the quality of eggs. According to ull (2002), egg functionality decreases with storage time and temperature. This is due to the ecline in yolk solids.

ggs can be eaten raw, though this is not recommended for people who may be especially usceptible to Salmonella, such as the elderly and pregnant women. In addition, the protein in aw eggs is only 51% bio-available, whereas that of a cooked egg is nearly 91% bio-available, eaning the protein of cooked egg is nearly twice as absorbable as the protein from raw eggs Evenepoel et al., 1998).

2.2 Development of an egg

The egg is the reproductive cell (ovum) of the hen. A unique phenomena exists in the chicken. This is the inherent capacity of the chicken to produce eggs without fertilization. The chicken egg starts as an egg yolk inside a hen. The yolk (called the oocyte at this point) is produced by the hen's ovary in a process called ovulation (Solomon, 1991). The yolk is released into the oviduct. The yolk continues down the oviduct and is covered with a membrane known as vitelline membrane, structural fibres and layers of albumen. This part of the oviduct is called the Magnus (Solomon, 1991).

2.2.1 Factors affecting development of egg shell

A number of environmental influences to which the hens are exposed play an important role in the formation of the egg shell. Shell quality declines as the hen gets older. This deterioration in the egg shell quality is associated with a change in the matrix material, which affects the mechanism properties of the shell (Hester, 1990). In hot weather there is reduced feed intake. During exposure to warm environmental conditions, the hen reacts by increasing breathing in order to cool itself. This causes the lowering of Carbon Dioxide in the blood and produces a condition known as respiratory alkalosis. The pH of blood becomes alkaline and the availability of calcium for the egg shell is reduced (Peebles et al., 1997).

Another reason for poorer shell quality in older hens is their reduced ability to absorb calcium (Cordts et al., 2002). Absorption of calcium is influenced by Vitamin D_3. which is mainly absorbed from the intestines in association with fats, and requires the presence of bile salts for absorption. It is transported via the portal circulation to the liver, where it accumulates. The first transformation occurs in the liver, where vitamin D_3 is hydroxylated to become 25-hydroxyvitamin D_3 (25-OH-D_3). This vitamin D_3 metabolite is then transported to the kidney where it is conveted to the most active hormonal compound 1, 25-dihydroxyvitamin D_3 (1, 25-$(OH)_2$ D_3) (Acamovic, 2001). The production of 1, 25 $(OH)_2$ D_3 is tightly regulated by the Parathyroid hormone in response to serum calcium.

ianagement regime also affects formation of quality egg shells. Temperature and atmospheric ımidity in particular are crucial for the formation of the shell. Failure to get these two ırameters right means that the hen will suffer from stress. While genetic predisposition for egg ıell quality exists, good genes can be upset by environmental stresses. The shell is formed by e activity of cells lining the oviduct and uterus (Richard et al., 2009). Under stress, the ·cretions of these cells become acidic and are destroyed or damaged.

he health status of laying hens also plays an important role in achieving good shell quality Iester, 1990). Respiratory tract infections (Infectious Bronchitis) in particular are of major gnificance.

.2.2 *Abnormalities in eggs*

/hen a deviation in the mechanics of egg laying occurs, it results in the creation of abnormal ;gs. Some of these abnormalities occur due to management problems or they can also be ıysiological. Some common abnormalities are:

ranslucent patches: these are seen when eggs are candled. They are as a result of defects such as te fusion of the crystal columns and channels or holes in the mammillary layer, which allow ater from the egg contents to penetrate the thickness of the shell (Solomon, 1991).

hin shells: thickness is dependent on the amount of time it spends in the shell gland and the rate : calcium deposition (Kuhl, 2000). Thin shells are due to deficiency of calcium in the diet. It ın also happen if a chicken lays two eggs within a day.

oft shelled eggs: exposure to warm environmental conditions results in the disturbance of acid ıse balance (Voisey and Hunt, 1996). This disturbance causes an increase in soft-shelled eggs ıring summer. They can also result when there is calcium deficiency in the diet.

ouble yolked eggs: it is the result of two yolks ripening on the ovary at the same time and being ·leased simultaneously.

2.3 Quality of eggs

Kramer (1951) defined quality as the properties of any given food that have an influence on the ıcceptance or rejection of this food by the consumer. Quality of any food that is consumed does ıave an effect on the health and well being of the consumer.

Egg quality is inarguably very important. This is because not only are eggs important in the eproduction process of birds but they are also consumed by humans. Egg quality comprises a ıumber of aspects related to the shell, albumin, and yolk and may be divided into external and nternal quality (Kul and Seker, 2004).

nternal quality is evaluated based on the color of the egg white, yolk color, odor and general ıppearance of the contents. Determination of internal quality is based on Air cell space, albumen quality, yolk quality and the presence of blood spots and meat spots (Richards et.al, 2009). As soon as the egg is laid, its internal quality starts to deteriorate; the longer the storage time the nore the internal quality deteriorates (Roberts and Leary, 1999).

The egg white is an important indicator of egg quality. The egg white of a high quality egg must be firm with a rather clear demarcation between the thin and thick albumen (Jones, 2007; Bell et.al, 2007). In a newly laid egg the albumen pH lies between 7.6 and 8.5. During storage the ılbumen pH increases at a temperature dependent rate to a maximum value of around 9.7 (Heath, 1977). In newly laid eggs, the yolk pH is about 6.0; however, during storage it gradually ncreases to reach 6.4 to 6.9. This is because as the egg ages, Carbon Dioxide is lost and the pH ncreases. The Carbon Dioxide loss happens through the shell pores and depends on dissolved Carbon Dioxide, bicarbonate ions, Carbonate ions and protein equilibrium. Bicarbonate and Carbonate ion concentration is affected by the partial pressure in the external environment (Solomon; 1991).

Shell quality is assessed based on the breaking strength, shell thickness and shell weight. 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 very significant effect on moisture loss during storage (Washburn, 1998). Thin-shelled eggs also have a much greater nce of being cracked during handling. Although shell quality can generally be manipulated ›ugh nutrition, there are several other factors that can have an effect, such as:

eases: diseases have a negative impact on shell quality, among other production traits. The ss caused by disease challenge can reduce water and feed intake of the affected birds (Marion ıl., 1990). Reduced feed intake will cause a calcium deficiency, which will cause shell blems.

nagement: temperature during storage has a significant effect on shell quality. Handling can › affect quality after lay. Rough handling can cause small, almost invisible cracks in the shell t make the egg more prone to bacterial infection.

trition: one major dietary component affecting eggshell quality is calcium. Each egg contains to 2.5g of calcium. Both excess and deficiency of calcium will negatively affect shell quality.

:ording to Keener et al. (2005) Albumen height is a measure of albumen quality and therefore ›hness of the egg and also Silversides et al. (1993) proposed measuring albumen height to ermine egg quality. Scott and Silversides (2000) and Jones and Musgroove (2005) reported a :rease in albumin height and weight of eggs with storage leading to decreased egg weight.

Table-1: Nutritional value of the chicken egg per 100g

Energy	647Kj (155 calories)
Carbohydrates	1.22g
Fat	10.6g
Protein	12.6g
Water	75g
Vitamin A (equivalent)	140μg (16%)
Thiamine (Vitamin B1)	0.066mg (5%)
Riboflavin (Vitamin B2)	0.5mg (33%)
Pantothenic acid (Vitamin B5)	1.4mg (28%)
Folate (Vitamin B9)	44μg (11%)
Calcium	50mg (5%)
Iron	1.2mg (10%)
Magnesium	10mg (3%)
Phosphorus	172mg (25%)
Potassium	126mg (3%)
Zinc	1.0mg (10%)
Choline	225mg
Cholesterol	425mg

Source: USDA Nutrient Database

CHAPTER THREE

MATERIALS AND METHODS

.1 Data collection

total of 1,080 eggs were obtained from six major trading areas in Lusaka. Three of the sources ɜre supermarkets (designated SM1, SM2 and SM3) with proper storage facilities and the other ree were open markets (designated OM1, OM2 and OM3) without proper storage facilities. xty eggs were obtained from each source per week for three weeks over a period of two onths. The 60 eggs collected each week were considered a batch. Following collection of eggs, ey were transported in carton boxes to the University of Zambia, Animal Science laboratory. ıe eggs were put on trays, plastics wrapped around them and then refrigerated at 4^0C, cording to the recommendations of St. John and Flor (1930) as quoted by Jones (2007).

ɔr each batch 10 eggs were selected at random for measurement of each parameter. The ırameters measured were; Albumen height, yolk width, albumen pH, yolk pH, colour, shell ickness, shell weight, egg weight and egg shape index.

ıe eggs were analysed in the Animal Science laboratory within a week of collection. Analysis ' external quality was done using the vernier caliper, micrometer screw gauge and sensitive ılance. Internal quality analysis was done using pH meter (has a temperature reader), colour ader, vernier caliper and micrometer screw gauge.

1.1 Measurement of shell thickness

fter carefully breaking the eggs, the shells were washed and dried in the oven at 50^0C, for 24 ɔurs. The shells were then cooled on the desiccators. The shell thickness was then measured cording to the methods of Curtis et al. (1986). The method involves collection of three pieces shells from the narrow, broad and equator. The thickness of these pieces was measured using e micrometer screw gauge. The mean thickness was then taken as the thickness of the ırticular shell.

.1.2 Measurement of yolk and albumen pH

crack, large enough to let the egg white seep through, was made on the egg. The egg white /as carefully emptied into a glass cup. Care was taken to ensure that there was no yolk ontamination of the albumen. [Note: Even a slight contamination of the albumen with yolk ɔuld drastically affect the albumen].

he yolk was put in another cup. The pH was then determined using a pH meter. After every ıeasurement of the yolk and albumen pH, the pH meter was cleaned first with tap water, then istilled water and dried with dry absorbing paper.

.1.3 Measurement of albumen height

his was measured as the height of the chalazae at a point midway between thinner and outer rcumference of egg white with a vertically mounted micrometer screw gauge. Samples of 10 ;gs from each batch were weighed and broken onto a white clean tile, for measurement of the bumen height.

.B: When breaking eggs for internal quality traits, individual eggs were broken out on a flat hite tile being cautious not to break the vitelline membrane that encloses the yolk (Cunningham ıd Cotterill, 1964).

.2 Statistical analysis of data

he data were pooled for each source of eggs, and analysed using GenStat. The source of eggs as the source of error. The means were then separated using Least Significant Differences.

CHAPTER FOUR

RESULTS AND DISCUSSION

1 External quality of Eggs

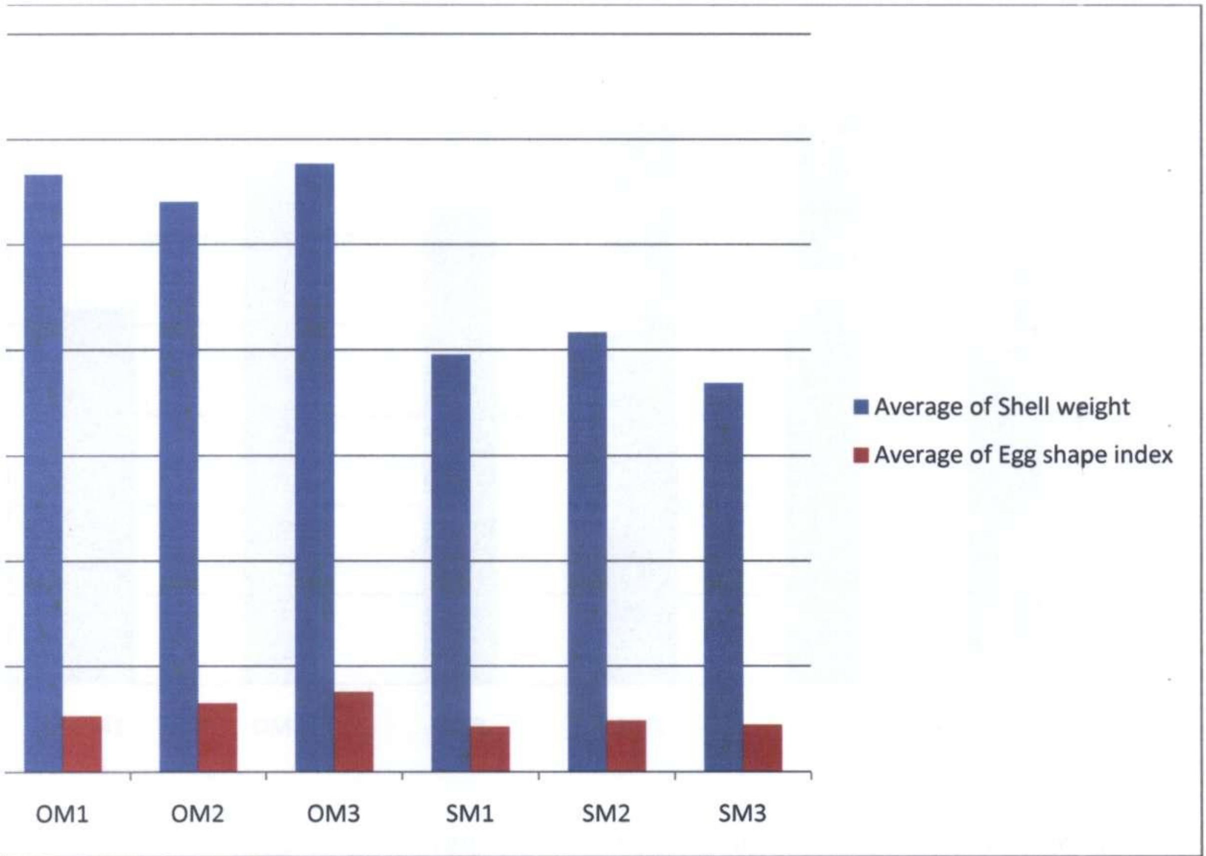
e results for external quality traits are presented in Table 2. There were significant differences <0.001) in egg weight between eggs obtained from open markets and those obtained from nmercial facilities. The general decline in egg weight has been reported by Samli et al. (2003), o observed a decrease in egg weight within 10 days. The decrease in egg weight is probably e to loss in moisture from the eggs. Once eggs are laid, they lose water by evaporation (this o leads to a decline in albumen height). The rate of weight loss of stored eggs is dependent on th temperature and humidity, with weight loss being greatest at higher temperature and lower midity (Roberts, 2005). Most informal facilities lack proper facilities in which humidity can be gulated (see Figure 1 and 2). This results in higher losses of moisture and hence decline in egg ight. The changes in egg weight that were observed are consistent with the reports of ACIAR 998) and Samli et al. (2005).

other trait important in external quality evaluation is shell thickness. The results show that ell thickness was significantly different ($p<0.05$) between eggs obtained from open markets d those obtained from commercial outlets. Scientific evidence shows that egg shell thickness pends on the amount of calcium in the diet and the ability of the hen to re-absorb calcium posited in the bones. This ability usually deteriorates progressively as the hen ages irchgessner, 1997). However, research has shown that with storage, the incidence of cracks reases. This can be attributed to the decline of shell thickness. In the present study, shell ckness of the eggs collected from different sources showed significant differences ($p<0.05$) ong the treatments (sources). Decline in shell thickness can be attributed to a number of tors. These include among others; factors due to the hen's physiology, that is, as the hen ages re is reduced ability to absorb calcium from the bones and there is a general increase in egg ight but this is not in proportion with the increase in shell weight (Roberts, 2005). Egg shape lex of eggs from open markets and commercial facilities was significantly different. This ntrast with what was found by Jones (2004). He found that extended periods of storage, under favourable conditions had no effect on the Egg Shape index. The differences in the results ould be due to difference in storage time. Whereas we do not know how long the eggs obtained d been stored for, Jones had stored his eggs for more than 28 days. It is possible that our eggs uld have been stored for a longer period of time, hence, the change in Egg Shape Index come apparent.

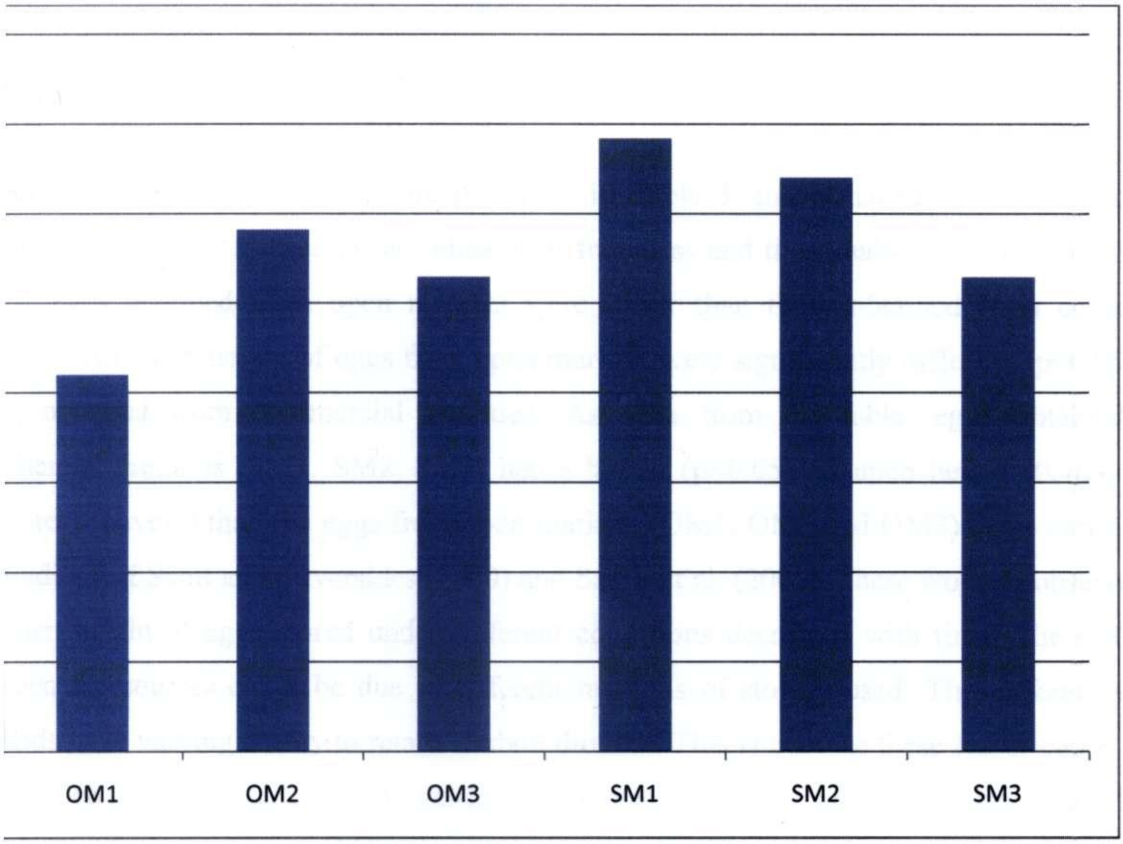
le-2. External quality of eggs obtained from open markets (OM) compared with commercial supermarkets (SM)

quality traits	**OM1**	**OM2**	**OM3**	**SM1**	**SM2**	**SM3**
l weight	5.67^{c}	5.41^{bc}	5.77^{c}	3.95^{a}	4.17^{ab}	3.69^{a}
l thickness	0.0493^{b}	0.0473^{b}	0.0550^{c}	0.0346^{a}	0.0340^{a}	0.0359^{a}
weight	42.0^{c}	53.5^{a}	41.2^{c}	68.4^{b}	64.1^{b}	52.9^{a}
shape index	0.530^{ab}	0.652^{b}	0.759^{c}	0.429^{a}	0.487^{a}	0.448^{a}

neans within rows with different superscript are significantly ($p<0.05$) different from each other



e 1: Differences in shell weight and egg shape index of eggs obtained from open markets and commercial supermarkets (SM)



2: Differences in egg weight of eggs obtained from open markets (OM) and commercial
arkets (SM)

nternal quality of Eggs

s for internal quality traits are presented in Table 3. In evaluating internal egg quality, en height is often used as an indicator of freshness and thus quality. The albumen heights eggs obtained from open markets were lower than those obtained from commercial es. Albumen height of eggs from open markets were significantly different ($p<0.05$) from obtained from commercial facilities. As seen from the table, eggs obtained from ercial facilities (SM1, SM2, SM3) had a higher ($p<0.05$) albumen height (0.469, 0.454, respectively) than the eggs from open markets (OM1, OM2 and OM3). This corroborates dings of Scott and Silversides (2000) and Samli et al. (2005). These workers observed that en height of eggs stored under different conditions decreased with time. The difference n the sources could be due to different methods of storage used. The different storage ls have varying ability to retard Carbon dioxide. This is because these losses cause Mucin which gives the albumen its gel-like texture to lose their structure and so the albumen es watery (Mountney, 1976; Jones, 2009). They further enumerated that as the albumen es watery, there is a loss of albumen height, thus a decline in egg quality with storage. The ration is more rapid and drastic if storage conditions are poor. According to Miles and (2004), eggs stored at temperatures higher than 20^0C are no longer fit for consumption weeks.

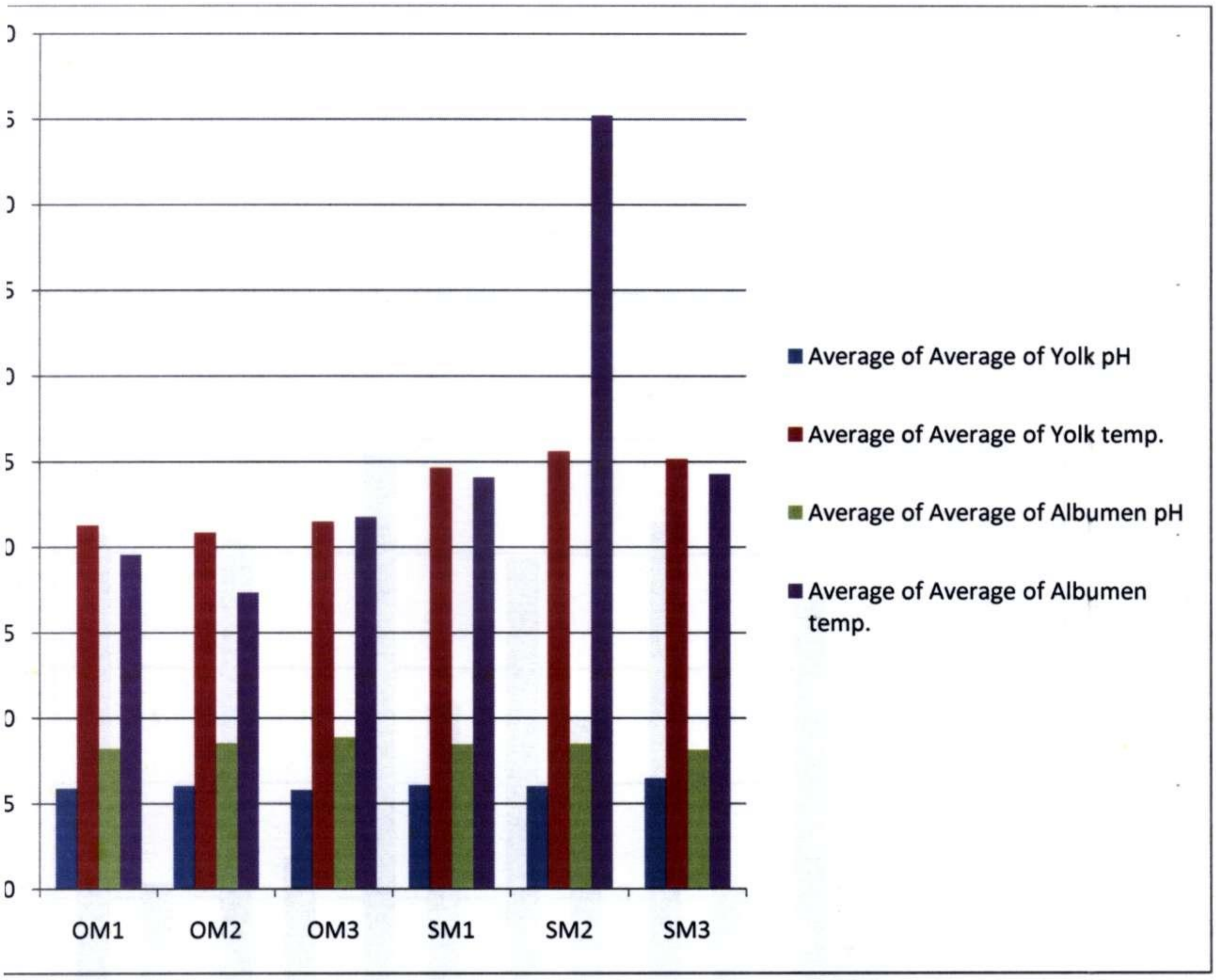
cant differences were also noted for the albumen pH. Increases in albumen pH can be ed to the breakdown of carbonic acid into carbon dioxide. The carbon dioxide is lost 1 the pores in the shell leading to the pH of the albumen becoming alkaline. Interestingly, noted that regardless of the temperature of the albumen or the yolk, the pH remained constant (Figure 3). Measure of acidity (pH) is an important parameter, which affects and many other biochemical processes in the egg. Homeostasis is the process which is d in the maintenance of constant pH. This is important because the egg is a reproductive it therefore, requires optimal conditions to ensure proper growth and development of the . Any sudden fluctuations in the internal environment can be disastrous to the embryo.

, eggs have many uses and as such eggs need to be of a particular standard and most ntly, must appeal to consumers. This cosmetic characteristic that has economic ɪrtance was analysed to provide an understanding of changes that occur in colour during ge. Colour has no bearing on the nutritional status of an egg, but some classes of consumers, cially those in the baking and manufacturing sector (mayonnaise), are particular about the ıetic appearance of the product. In the present study it was shown that the differences in L*, nd b* colour measurements were minor (Figure 4). There were approximately 3-5 point rences between high and low colour values for each L*, a* and b* values during the study. was in agreement with the findings of Lechevalier et al. (2005). He found that the effects of ge conditions, on the colour of the yolk, were barely observable by the human eye. In this therefore, egg to egg variability can be considered to be affected by hen health, nutrition, ıgement practices and other factors such as amount and type of pigments in the feed. evalier et al. (2005) determined that raw materials accounted for 70% of the variability in ır quality of the yolk, when comparing egg treatments.

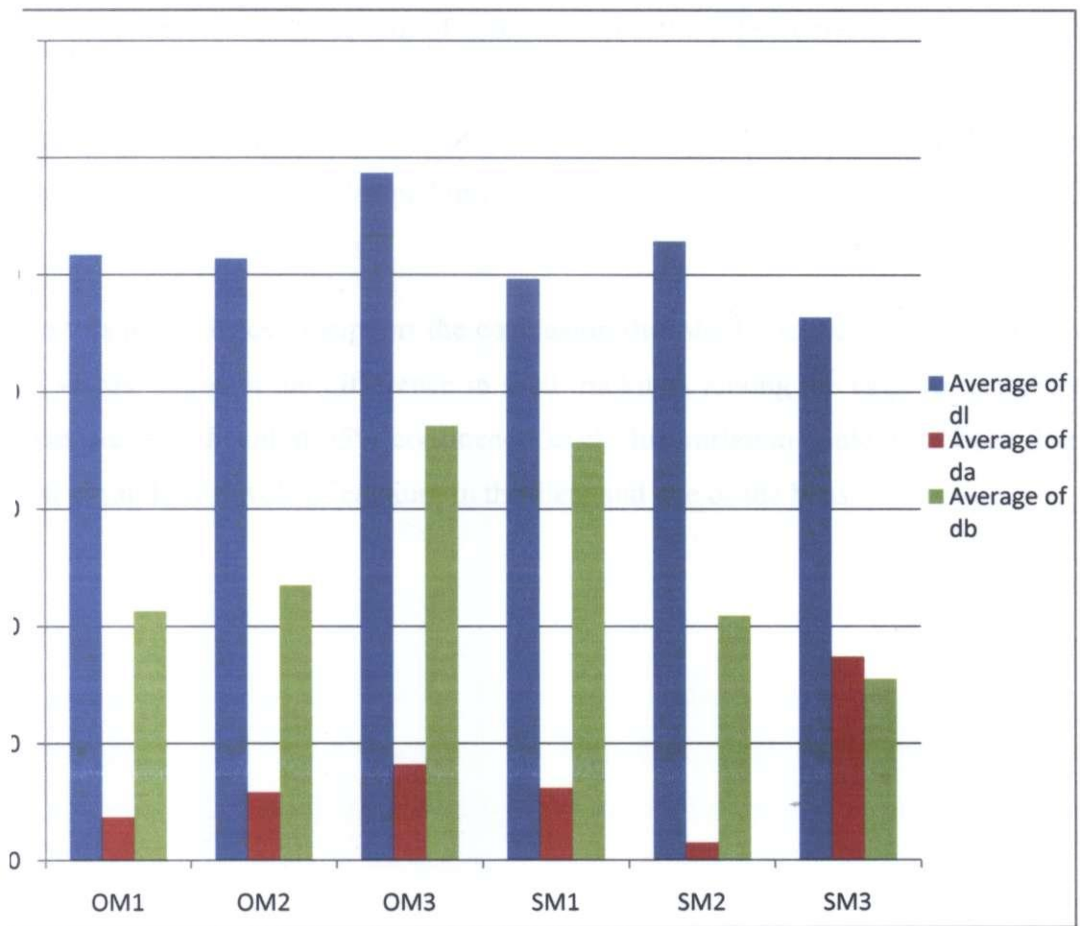
le-3. Internal quality of eggs obtained from open markets (OM) compared with commercial supermarkets (SM)

quality traits	OM1	OM2	OM3	SM1	SM2	SM3
ımen Height	0.213^{b}	0.253^{b}	0.258^{b}	0.465^{a}	0.454^{a}	0.331^{ab}
: pH	5.87^{a}	5.47^{a}	5.78^{a}	4.32^{a}	4.28^{a}	4.63^{a}
: width	3^{a}	4^{a}	3^{a}	3^{a}	4.875^{a}	3^{a}
ımen pH	8.20^{bc}	7.73^{b}	8.87^{c}	6.04^{a}	6.07^{a}	5.81^{a}

ıeans within rows with different superscript are significantly ($p<0.05$) different from each other



ure 3: Differences in yolk pH and Albumen pH of eggs obtained from open markets (OM) commercial supermarkets (SM), with varying temperatures



re-4. Effect of source of eggs on L*, a* and b* values

.3 Implication of results

esults obtained indicated that variations in the albumen height, albumen pH, egg weight, and ıell weight and shell thickness of the eggs from informal as compared to commercial facilities re largely due to storage conditions at the trading facilities. Eggs at informal facilities are kept or long periods under unfavourable conditions. This not only leads to rapid deterioration of uality but also reduces the nutritional value of the egg. Deteriorated egg quality may have erious implications on the health of consumers. Further, the domestic and industrial use of such ggs may be compromised. It is also possible that poor management by small holder producers f eggs could contribute to the lower quality of eggs in informal trading facilities. Poor ıanagement includes irregular picking of eggs, lack of routine checks to examine the birds and oor disease control measures.

here was no evidence to support the conclusion that shell thickness was affected by storage. In ther words, although the difference in shell thickness among the eggs collected from different ources was significant at 95% confidence level, this variation could have been due to variation ı hen physiology, levels of calcium in the diets and age of the hens.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Conclusion

m the study it was observed that eggs from informal facilities had smaller albumen heights, er shell weights and egg weights, and higher albumen pH (more Alkaline). The significant erence in these egg quality traits are in agreement with the findings of Fosenko et al. (1995); ıira et al. (2003) and Miles and Henry (2004) who observed that when eggs are stored under ıvourable and uncontrolled conditions, there is a decline in albumen height and increase in ımen pH. The results are further supported by Scott and Silversides (2000) who reported that weight changes are significant when stored under room temperature and high temperatures 'C). It can be concluded that storage conditions at different retail facilities, in Lusaka, do ct the internal and external quality of eggs. Therefore, consumers are buying and consuming ; of poor quality, because eggs are being stored under conditions that lead to rapid rioration of quality.

Recommendations

he best knowledge of the author, this is the first time a study looking at the quality of eggs luced and consumed in Lusaka is being done. It is, therefore, recommended the research be ınded to look at the quality of eggs produced by different breeds reared in Zambia. The study ıld also be extended to analyse eggs produced by smallholder producers at farm level. The ings would be useful in raising awareness among retailers on the importance of proper ıge of eggs, to retard egg quality deterioration. Further, the results will enlighten consumers he dangers of consuming eggs which have been stored under unfavourable conditions and the ; this may pose to their health.

REFERENCES

1. Abanikannda O.T.F, O. Olutogun, A.O. Leigh and L.A. Ajayi. 2007. Statistical modeling of egg weight and egg dimensions in commercial layers. *International Journal of Poultry science*. 6(1): 59-63.
2. Acamovic T. (2001). Commercial application of enzyme technology for poultry production. *World's Poult. Scie. J. 57:225-242.*
3. ACIAR (1998). *Measurements and maintenance of duck and hen quality in Vietnam.* Australia Centre for International Agricultural Research. Research note RN 23 12/99.
4. Bakalli, R. (2005). Feed and egg quality control. Kosovo cluster and business support project. Available online: *www.usaid.gov*
5. Bell, D.D., Patterson, P.H., Koelkebeck, K.W., Anderson, K.E., Darre, M.J., Carey, J.B., Kuney, D.R. Ziedler, G. (2001). Egg marketing in national supermarkets: egg quality-Part 1. *Poult. Sci.* 80: *383-389*
6. Brothwell D. R. and P. Brothwell (1997). *Food in Antiquity: A Survey of the Diet of Early Peoples*. Johns Hopkins University Press. pp. 54–55.
7. Chiroma, S., Igwebuike, J.U., Aliyu, J. and Raji, O.J. (2009). Effect of storage methods and time on egg quality traits of laying hens in a hot dry climate. *ARPN journal of agricultural biological sciences*. 4: *1990*
8. Christian, C., Shchmutz, M. and Preisinger, R. (2002). New alternatives for improving egg shell stability through breeding. *Poult. Sci.* 26: *177.*
9. Cunning F. E. and O. J. Cotterill. (1986). Effect of centrufiging yolk-contaminated liquid egg white on functional performance. *Poult. Scie.* 43:283-291.
10. Curtis P.A., F. A. Gardner and D. B. Mellor. (1986). A comparison of selected quality and compositional characteristics of brown and white eggs. III.composition and nutritional characteristics. *Poult. Scie.* 65: 501-507.
11. Evenepoel P., Geypens B., Luypaerts, A., Hiele M., Ghoos Y. & Rutgeerts, P. (1998). Digestibility of Cooked and Raw Egg Protein in Humans as Assessed by Stable Isotope Techniques. *The Journal of Nutrition. 128 (10):* 1716-1722.

12. Fletcher, D.L., Britton, W.M., Pesti, G.M., Rahn, A.P. and Savage, S.I. (1990). The relationship of layer flock age an egg weight on egg component yields and solids content. *Poult. Sci.* 62: *1800-1805*

13. Fasenko G.N., V.L. Christensen, M.R. Baskt, and J.N. Petite. (1995). Evaluating yolk membranes from short and long stored turkey eggs using transmission electron microscopy. *Poultry Sci.* 74(Suppl. 1): 44.(Abstr).

14. Hamilton R. M. G. (1982). Methods and factors that affect the measurement of eggshell quality. *Poultry science* 1: 2022-2039.

15. Hasler, C.M. (2000). The changing face of functional foods. *American journal of nutrition.* 19: *499S-506S.*

16. Heath J.L (1977). Chemical and related osmotic changes in egg albumen during storage. *Poult. Scie.* 73:1590-1596.

17. Hester P. Y.(1990). Egg shell quality in laying hens. Sixth International poultry Breeders Conference. Auchincruive, 50-67.

18. Howe J. C., Williams J. R. and Holden J. M. (2004). *USDA Database for the Choline Content of Common* Foods, *United States Department of Agriculture.* Available online: www.nal.usda.gov

19. Jones, D.R. (2004). Effects of extended storage time on egg quality factors. *J. poultry Sci.* 6 (3): *157-162.*

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

21. Keener K.M., K.C McAvoy, J.B. Foegeding, P.A. Curtis, K.E. Anderson and J.A. Osborne. (2006). Effect of Testing Temperature on internal Egg quality Measurements. *Poultry Science.* 85: 550-555.

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

23. Kul S. and I. Seker. (2004). Phenotypic correlations between some external and internal egg quality traits in the Japanese quail (*Cortunix cortunix japonica*). *International Journal of Poultry Science.* 3(6): 400-405.

24. Kuhl S. (2000). Factors affecting the hatchability of eggs from broiler breeders. *Br. Poult. Sci.* 21:37-53.

25. Lechevalier V., E. Perinel, R. Jeantet, C. Lesaffre, T. Croguennec, C. Guerin-Dubiard and F. Nau. (2005). Statistical analysis of effects of industrial processing steps on functional properties of pasteurised liquid egg white. *J. Sci. Food Agric.* 85:757-769.
26. Li-Chan, E. and Nakai, S. 1995. Biochemical basis for the properties of egg white. *Crit. Rev. Poult. Biol.* 2: *21-59.*
27. Lusiano M., A. Hildalgo, E. M. Comelli and M. Rossi. (1996). Evolution of chemical and physical albumen characteristics during the storage of shell eggs. *Journal of Agricultural and Food Chemistry.* 44: 1235-1240
28. Marion W. W., A. W. Nordskog, H. S. Tolman and R. H. Foryshe. (1990). Egg composition as influenced by breeding, egg size, age and season. *Poult. Scie.* 43:255-264.
29. Miles R.D. and P.R. Henry. (2004). Effect time and storage condition on albumen quality of eggs from hens fed vanadium. *Journal of Applied Poultry Research.* 13(4): 619-627.
30. Monira K.N., M. Salhuddin, and G. Miah. (2004). Effect of breed and holding period on egg quality characteristics of chicken. *International Journal of Poultry science.* 2: 261-263.
31. Mountney G.J. (1976). *Poultry production technology.* 2nd Edition. AVI Publishing company, West Port Connecticut. P. 261.
32. Peebles E.D., J. Brake and R.P. Gildersleeve (1997). Effects of egg shell cuticle removal and incubation humidity on embryonic development and hatchability of broilers. *Poult. Scie.* 66:834-840.
33. Poultry Association of Zambia. (2007). Poultry Schedule.
34. Roberts J.R. and Ball M. (1998). Egg shell quality problems: Causes and solutions. University of New England and RIRDC, 43pp.
35. Roberts, J.R. and Leary, A. (1999). The short report No. 5: Factors affecting egg and egg shell quality. RIRDC Publication. 9pp
36. Roque L. and M.C. Soares. (1994). Effects of eggshell quality and broiler age on hatchability. *Poult. Scie.* 73:1838-1845.
37. 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.
38. Scott T.A. and F.G. Silversides. (2000). The effect of storage and strain of hen on egg quality. *Poult. Scie.* 79: 1725-1729

39. Silversides F. G., F. Twizeyimana and P. Villeneuve. (1993). Research note: a study relating to the validity of the Haugh unit correction for egg weight in fresh eggs. *Poult. Scie.* 72:760-764.
40. Solomon S.E (1991). *Egg and shell quality.*2nd. Wolfe Publishing. London.
41. Staldeman, W.J. and Cotterhil, O.J. (1995). *Egg science and technology,* Fourth edition. Haworth press, Inc., Binghamton, New yolk.
42. Stewart R. M., J. M. Durnian and M. C. Briggs. (2006). "Here's egg in your eye": a prospective study of blunt ocular trauma resulting from thrown eggs. *Emergency Medicine Journal.* 23(10):756-8.
43. St. John J.L and I. H. Flor. (1930). A study of whipping and coagulation of eggs of varying quality. *Poult. Scie.* 10: 71-82.
44. U.S. Department of Agriculture, Agricultural Research Service. (2007). USDA National Nutrient Database for Standard Reference, Release 20. Available online: www.usda.gov.
45. Voisey P. W. and Hunt J.R. (1996). Relationship between applied force deformation of eggshells and fracture force. *Journal of Agricultural Engineering Research.* 12(1):1-4.
46. Walsh T. J. (1993). The effects of flock age, storage humidity, carbon dioxide, and storage on albumen characteristics, weight loss and embryonic development of broiler eggs. M.S. thesis. North Carolina State University, Raleigh, NC.
47. Washburn K.W. (1998). Incidence, cause and prevention of egg shell breakage in commercial production. *Poultry Science.* 61:2005-2012.
48. Weggemans R. M., Zock P. L. and Katan M. B. (2001). "Dietary cholesterol from eggs increases the ratio of total cholesterol to high-density lipoprotein cholesterol in humans: a meta-analysis". *Am. J. Clin. Nutr.* 73 (5): 885–91.
49. Williams K. C. (1992). Some factors affecting albumen quality with particular reference to Haugh unit score. *World Poultry science journal.* 48: 5-16.
50. Yassin H., Velthus A.G.J., Boerjan M., van Riel, J.and Huirne, R.B. (2008). Field study on broilers eggs hatchability. *Poult. Sci.* 87 (11): *2408-2417*

APPENDIX

ble-3: ANOVA table for albumen height

urce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
et	5	2.67177	0.53435	9.54	<.001
esidual	67	3.75356	0.05602		
otal	72	6.42533			

ble-4: ANOVA table for yolk pH

urce of variation	d.f.	s.s.	m.s	v.r.	F pr.
et	5	31.644	6.329	1.17	0.331
sidual	67	360.915	5.387		
tal	72	392.558			

ble-5: ANOVA table for yolk width

urce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
ɛt	5	9.334E+07	1.867E+07	0.83	0.531
sidual	67	1.502E+09	2.241E+07		
tal	72	1.595E+09			

le-6: ANOVA table for shell weight

rce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
t	5	52.270	10.454	2.02	0.087
idual	67	347.371	5.185		
al	72	399.641			

ɘ-7: ANOVA table for shell thickness

ce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
	5	0.0046755	0.0009351	2.59	0.033
dual	67	0.0241576	0.0003606		
.l	72	0.0288331			

le-8: ANOVA table for egg weight

rce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
t	5	33372.5	6674.5	37.93	<.001
;idual	67	11791.3	176.0		
:al	72	45163.8			

le-9: ANOVA table for egg shape index

rce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
:	5	0.9508	0.1902	1.61	0.170
idual	67	7.9272	0.1183		
ıl	72	8.8780			

le-10: ANOVA table for albumen pH

rce of variation	d.f.	s.s.	m.s.	v.r.	F pr.
:	5	100.219	20.044	2.01	0.088
idual	67	667.580	9.964		
ıl	72	767.800			