

**STUDY ON THE MEAT AND EGG QUALITY OF DIFFERENT CHICKEN
BREEDS AT DEBREZEIT AGRICULTURAL RESEARCH CENTER**



**A Thesis Submitted to College of Veterinary Medicine and Agriculture of Addis
Ababa University in Partial Fulfillment of the Requirement for Degree of Master of
Science in Animal Production**

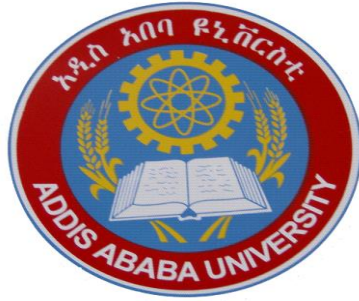
By

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**June, 2017
Bishoftu, Ethiopia**

**STUDY ON CARCASS PARAMETERS AND EGG QUALITY TRAITS OF
DIFFERENT CHICKEN BREEDS AT DEBREZEIT AGRICULTURAL
RESEARCH CENTER**

MSc Thesis



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AND AGRICULTURE, DEPARTMENT OF ANIMAL PRODUCTION
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DEDICATION

This thesis is dedicated to my mother, W/ro Kebenesh Beyene, who tirelessly labored and sacrificed whatever she had for my education, and also encouraged me to start this study program .I am also grateful for what she taught me in life , Thank you for being a friend, mother too.

TABLE OF CONTENTS

Contents	Pages
STATEMENT OF AUTHOR	I
ACKNOWLEDGEMENTS	II
LIST OF ABBREVIATIONS	III
LIST OF TABLES	IV
LIST OF FIGURES	V
LIST OF TABLES IN THE APPENDICE	VI
LIST OF FIGURES IN THE APPENDICE	VII
ABSTRACT.....	VIII
1.INTRODUCTION.....	1
2 . LITERATURE REVIEW	3
2.1 Economic contributions of the poultry sector	3
2.2 Challenges and opportunities of chicken production in Ethiopia	3
2.3 Adoption of exotic breeds in ethiopia.....	4
2.4 Factors affecting productive performance of chickens	5
2.5 Role of chicken meat and eggs compared to other animal proteins.....	6
2.6 Demand and consumption trend of poultry	7
2.7 Egg qualityand their relative importance.....	8
2.8 Egg morphometric analyses	9
2.9 Egg quality characteristics	10
2.10 Effect of breed on egg quality traits	15
2.11 Effect of age on egg quality traits	16
2.11 Effect of age on egg quality traits	17
2.12 Carcass yield characteristics	19
2.12.1 Factors affecting carcass quality.....	20
2.12.2 Growth, body composition and carcass traits of dual purpose genotypes	20
3. MATERIALS AND METHODS	22
3.1. Study area	22
3.2 Study animals	22
3.3 Management of experimental birds	22

TABLE OF CONTENTS (continued)

3.4 Experimental design, treatments and birds.....	23
3.4.1 <i>Evaluation of egg quality characteristics</i>	<i>24</i>
3.4.2 <i>Measurement of carcass yield characteristics</i>	<i>25</i>
3.5 Data Management and statistical analyses	27
4.RESULTS	28
4.1 Egg Quality Traits.....	28
4.2 Carcass Characteristics	36
5. DISCUSSION	39
5.1. Egg Quality Parameters	39
5.2 Carcass Traits.....	49
6. CONCLUSION AND RECOMMENDATIONS.....	53
7. REFERENCES.....	54
8. APPENDICES	68

STATEMENT OF AUTHOR

First, I declare that this thesis is my *bonafide* work and that all sources of materials used for this Thesis have been duly acknowledged. It has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this Thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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LIST OF ABBREVIATIONS

AH	Albumin Height
ANOVA	Analysis Of Variance
AOAC	Association of Official Analytical Chemists
AW	Albumin Weight
BSc	Bachelor of Science
CRD	Complete Randomized Design
CSA	Central Statistical Agency
DZARC	Debre Zeit Agricultural Research Center
EIAR	Ethiopian Institute of Agricultural Research
EL	Egg Length
ESI	Egg Shape Index
EW	Egg Weight
FAO	Food and Agriculture Organization
FCR	Feed Conversion Rate
GDP.	Gross Domestic Product
GIT	Gastro Intestinal Tract
HU	Haugh Unit
HUS	Haugh Unit Score
ILRI	International Livestock Research Institute
ISA	Institution of Selection Animals
RCF	Roche Color Fan
SAS	Statistical Analysis Systems
ST	Shell Thickness
SW	Shell Weight
USDA	United States Department of Agriculture
YH	Yolk Height
YI	Yolk Index
YK	Yolk Color
YW	Yolk Weight

LIST OF TABLES

Table 1: The amount of nutrients provided by chicken meat and eggs	7
Table 2: Chemical Composition of Eggs in %.....	11
Table 3: Layout of the Experiment	23
Table 4 : Least square means of egg weight (g) and egg length(mm) values.....	28
Table 5: Least square means of Egg width (mm) and Shell thickness (mm) values.	29
Table 6: Least square means of shell weight (g) and albumin weight (g) values.	30
Table 7 : Least square means of yolk height (mm) and yolk weight (g) values.	31
Table 8: Least square means of albumin height (g) and yolk weight (g)values.	32
Table 9 : Least square means of egg shape index and yolk index values.....	33
Table 10: Least square means of shell ratio and yolk ratio values.	34
Table 11: Least square means of Albumin Ratio and Haugh Unit values.	35
Table 12 : Analysis on sex mean and Live weight of the four breeds	37

LIST OF FIGURES

Figure 1: Digital caliper	24
Figure 2 :Yolk Color Fan (left) and Tripod Micrometer (right)	25

LIST OF TABLES IN THE APPENDICE

Appendix Table 1: Egg quality parameter Data Collection Sheet	70
Appendix Table 2: Carcass Measurement Data Collection Sheet	71
Appendix Table 3: Time Schedule for Vaccination	72
Appendix Table 4: Ingredients of the Starter, Grower and Layer Diets	73

LIST OF FIGURES IN THE APPENDICE

Appendix Figure 1 : Double yolk (left) and Egg quality measurement instruments	68
Appendix Figure 2 : Dominant Red Barred (left) and Koekoek (right)	68
Appendix Figure 3: Novo color	68
Appendix Figure 4 : Dressed Carcass Weight	69
Appendix Figure 5 : Birds dry de-feathered by hand plucking,	69

ABSTRACT

A study was conducted to evaluate egg quality traits and carcass characteristics of dual purpose breeds namely Novo color (NC), Dominant red barred (DRB), Koekoek (KK) and Lohmann brown (LB) available at DZARC station. The study lasted for 16 weeks. Egg quality measurements were taken at week 25, 27, 29, 31 and 33 with a total of 120 chickens each having two replications and at the end of the experiment carcass traits were evaluated with a total of 24. Mean values for egg weight, egg length, albumen weight and yolk weight, were significantly different ($p < 0.05$) in dominant red barred followed by lohmann Brown . Mean values for yolk height, Haugh unit, shell weight yolk index and yolk ratio were significantly ($p < 0.05$) higher in dominant red barred than koekoek. There was no statistically significant difference ($p > 0.05$) in egg shape index, eggshell thickness ,shell ratio and yolk color among those breeds compared. albumin weight and albumin ratio was significantly different ($P < 0.05$) and show fluctuating decreasing trend. The mean values for egg weight , shell weight, yolk weight ,albumin weight and egg width for DRB was superior than followed by LB. In general, the current result indicates that dual purpose laying type DRB is superior to that of LB in major internal egg traits of compared. This results revealed genotype had significant ($P < 0.01$) effect on traits compared ,and this traits in DRB being dual purpose might be a very good traits to be considered. Data on carcass traits revealed that genotypic variations had a significant ($P < 0.01$) effect on live carcass weight and highly valued carcass cut parts .mean values for live body weight, were significantly different($P < 0.05$) in KK followed by DRB and the live carcass weight were significantly higher in the male chicks compared to the female ones, and the highly valued carcass cuts (drumstick ,thigh and breast) shows no significant difference ($p > 0.05$) among breeds except drumstick proportion which was higher in DRB , this concludes that growth of chickens was influenced by breed . In general with this dual purpose breeds the ever increasing demand for meat and eggs will be met with further researches and if proper selection and breeding plans are designed .

Keywords: Carcas straits, dual purpose, egg quality, genotype, poultry

1.INTRODUCTION

The Food and Agriculture Organization of the United Nations (FAO 2014) has predicted that the global population will reach nine billion by 2050. Currently, 805 million people which is equal to one in nine, live below the poverty line and are food insecure (World Food Summit, 1996). As a significant number of the world's poor are food insecure, the demand for animal products in emerging economies continues to increase (Foresight, 2011). Poultry has been increasingly recognized as one of the entry points to address the problems of malnutrition, food insecurity, low income and poverty as a whole. In fact, (Gawande *et al.*,2007) and (Dei *et al.*,2009) argue that poultry is a profitable venture and eventually a tool for livelihood improvement and poverty alleviation in the developing countries (Dolberg, 2007; Fasina *et al.*, 2007; Sharma, 2007). The global poultry population has been estimated to be about 16.2 billion, with 71.6 % in developing countries, producing 6.7 million metric tons of chicken meat and 5.8 million metric tons of hen eggs (Gueye, 2003). Increased consumption of eggs and poultry meat brings substantial benefits to the human population in developing countries and is usually the cheapest of all domestic livestock meats FAO (2004). Poultry is now by far the largest livestock species worldwide (FAO, 2000), accounting for more than 30% of all animal protein consumption (Permin and Pedersen, 2000). Poultry meat and egg production is the most environmentally efficient animal protein production system in the world (Van der Sluis, 2007). Over the last decade, the consumption of poultry products in developing countries grew by 5.8 % per annum, faster than that of human population growth (Sonaiya *et al.*,2004).

Chickens make up about 98% of the total poultry numbers (chickens, ducks and turkeys) kept in Africa (Gueye, 2003) and village poultry contributes over 70% of poultry products and 20% of animal protein intake (Kitalyi, 1998) and comprises the major constituent of poultry species in Africa and are kept in most areas of the world and play a vital role in many rural households (Alders *et al.*, 2001). Despite the wide spread of exotic strains, local chickens are known to be predominant in developing countries (FAO, 2004; Do, 2005; Bett *et al.*, 2012).

Chicken meat and eggs have been recommended to bridge the protein gap more than other species of livestock because of short generation interval, high rate of productivity, quick turnover rate, higher feed efficiency, and low labor and land requirements (Ojedapo *et al.*,2008). The role of poultry in Ethiopia became very important over time (Alemu *et al.*,2009). The total poultry population in Ethiopia is estimated to be about 51.35 million and with regard to breed, 96.83, 2.37 and 0.8% of the total poultry were reported to be indigenous, exotic and hybrid, respectively (CSA, 2013). The total national annual poultry meat and eggs production is estimated at 72,300 and 78,000 metric tons, respectively and indigenous poultry contribute almost 99% of the national egg and poultry meat production (Tadelle *et al.*,2003). All the available literature tends to indicate that the per capita poultry and poultry product consumption in Ethiopia is one of the lowest in the world: 57 eggs and 2.85 kg of chicken meat per annum (Alemu, 1995).

To meet the ever increasing demand for meat and eggs, introduction of exotic dual purpose breeds must be practiced as one of the reasonable options. The testing of exotic chicken genotypes for adaptability and productivity in Ethiopia largely focuses on measuring production volume (number of eggs produced and meat production as reflected by total/daily weight gain). However, for a profitable and sustainable poultry enterprise, product quality is an important attribute as it influences the marketability of the products. Product quality as it refers to poultry production obviously relates to the quality of eggs and meat produced. These parameters are inherently the functions among genotypes.

Therefore, the objectives of this study were:

- To evaluate the internal and external egg quality parameters in different chicken breeds and,
- To evaluate carcass characteristics of four different chicken breeds.

2 . LITERATURE REVIEW

2.1 Economic contributions of the poultry sector

Prior to describing the major economic contributions of the poultry sub-sector, it would be important to outline some of the salient facts on the livestock sector of Ethiopian agriculture. Ethiopia has one of the largest livestock populations in Africa. The livestock sector accounts for about 18.8% of the national GDP and 40% of the agricultural GDP (FAO, 2004). It is a major source of foreign exchange earnings next to coffee. Livestock is strongly attached to all farming systems of the country by providing major economic and social functions such as food, draught power, fuel, cash income, security, and investment. It is estimated that livestock supports the livelihood of about 80% of the rural poor (FAO, 2004).

The contribution of exotic poultry to the Ethiopian economy is significantly lower than that of other African countries (Alemu and Tadele, 1997). About 99% of the annual poultry meat and egg production comes from the indigenous chickens kept under the traditional systems, all of these, except some managed by small scale intensive are used by large scale (private and government) commercial poultry farms (FAO., 2008) .In 2006, the total poultry meat and egg production were estimated at 53,493 and 36,624 tones, respectively. This production mainly comes from the rural poultry based on traditional indigenous chicken farming. (ILRI, 2000). the share of exotic chickens in the total annual egg and poultry meat production has increased by 118% over the last 20 years. CSA, 2005; Solomon, 2007).

2.2 Challenges and opportunities of chicken production in Ethiopia

Indigenous chickens provide major opportunities for increased protein production and income for smallholders. Chickens have a short generation interval and a high rate of Productivity. They can also be transported with ease to different areas and are relatively affordable and consumed by the rural people as compared with other farm animals such as cattle and small ruminants (Sonaiya, 1997).They also play a complementary role in

relation to other crop livestock activities. Indigenous chickens are good scavengers as well as foragers and have high levels of disease tolerance, possess good maternal qualities and are adapted to harsh conditions and poor quality feeds as compared to the exotic breeds. In some communities, village chickens are important in breaking the vicious cycle of poverty, malnutrition and disease (Roberts, 1992).

However, Under farmer management poultry production, prevailing disease, predators, market problem, lack of water, lack of proper health care, poor feeding and extension together with veterinary services were reported as the major constraint by (Moges *et al.*,2010).While diseases were the first frequently occurred chicken production constraint. The other comprehensive study showed that New castle disease is highly infectious and causes more losses than any other diseases in the tropics and it spreads rapidly through the flock and mortality could reach up to 100% (Nigussie *et al.*, 2003).

The production performance of exotic birds under the Ethiopian condition needs to be monitored regularly to provide guidelines for policy makers. Lack of recorded data on the productive performance of chicken makes it difficult to assess the importance and contributions of the past attempts made to improve the sector (Moges *et al.*, 2010). It was indicated that all the imported breeds of chickens performed well under the intensive management system in Ethiopia. The idea of distributing exotic chickens particularly Rhode Island Red (RIR) to the farming population was to improve the productivity of local birds by mating them with improved cocks (Alemu and Tadelle, 1997). This scheme usually failed to work due to the fact that the introduced breeds could not adapt to the hot climate, low feeding and extensive management (Permin, 2008).

2.3 Adoption of exotic breeds in ethiopia

Shortages of protein availability are a well-known problem in Africa. Poultry is by far the largest group of livestock species (FAO, 2000) contributing about 30% of all animal protein consumed in the world (Permin and Pedersen, 2000). The poultry sector is characterized by its industrialization, faster growth in consumption and trade than any

other major agricultural sectors in the world. Worldwide industrial systems now account for approximately two-thirds of egg and poultry meat production (Dolberg, 2007). Moreover, (FAO, 2010) reported that poultry meat represents about 33% of the total global meat production.

There is no recorded evidence indicating the exact time and locations of introduction of the first batch of exotic breeds of chickens into Ethiopia. It is widely believed that the importation of the first batch of exotic poultry was probably done by missionaries. Four breeds of exotic chicken (Rhode Island Red, Australorp, New Hampshire and White Leghorns) were imported to Jimma and Alemaya in 1953 and 1956, respectively under USAID project (Solomon, 2007). On top of these, the Ministry of Agriculture established several exotic chicken breeding and multiplication centres at different parts of the country to enhance the national poultry extension activities.

The Oromia region habitat about 34.4% of the total national chicken population and contribute 36% of the total annual national egg and poultry meat production. Almost all the available commercial poultry farms of the country are located in Oromiya region specifically in and in the vicinity of Debre Ziet (CSA, 2005). According to (CSA, 2007) reports chicken population in Ethiopia was around 50.38 million; however, this number was increased to 51.35 millions (CSA., 2013). There has been an increase in the number of exotic breeds of chickens and at present it is estimated that these make up about 2.56% of the national poultry population (CSA., 2007).

2.4 Factors affecting productive performance of chickens

Poultry production is affected by factors such as breed and strain of chicken used, environmental conditions in poultry house, management practices and feed and feeding management (Bell and Weaver, 2002). The knowledge of performance of economic traits in chicken is important for the formulation of breeding plans for further improvement in production traits. Growth and production traits of a bird indicate its genetic constitution and adaptation with respect to the specific environment (Ahmed and Singh, 2007).

The laying cycle of a chicken usually covers a span of about 12 months. Egg production begins when the birds reach about 18-22 weeks of age, depending on the breed and season. Flock production rises sharply and reaches a peak of about 90%, 6-8 weeks later, production then gradually declines to about 65% after 12 months of lay. There are many factors that can adversely affect egg production. Unraveling the cause of a sudden drop in egg production requires a thorough investigation into the history of the flock. Egg production can be affected by feed consumption (quality and quantity), water intake, intensity and duration of light received, parasite infestation, diseases, management and environmental factors (Jacob *et al.*, 1998).

Different authors reported the effect of breed on egg production (Duduyemi, 2005) found no significant effect of breed on egg production, while (Majaro, 2001) and (Yakubu *et al.*, 2007) reported significant effect of breed on egg production and mortality rate. Moreover, (Gwaza and Egahi 2009) reported significant effect of breed on age at peak egg production in a farm consisting of four strains of layers (Abdel-Rahman, 2000) reported that naked neck genotype was superior to full feathered mates in egg production, sexual maturity, mortality rate and feed efficiency.

2.5 Role of chicken meat and eggs compared to other animal proteins

Poultry meat and eggs are usually without taboos and can be consumed by a family in a single sitting. A comparison of chicken meat with other meats shows that it is a healthy meat. It is low in total fat and in the undesirable Trans fats, but high in the desirable mono-unsaturated fats which make up about half of the total (FAO, 2004). Chicken meat and eggs are reported to complement staple diets of rural Africa due to the higher nutrient concentration. they provide not only high-quality protein, but also important vitamins and minerals (FAO, 1997) .Resourcepoor households of South Africa with small poultry production units having 12 layers each have reported an increase in the consumption of animal protein and reduced incidence of malnutrition (MacGregor and Abrams, 1996).

Chicken meat and eggs are the best source of quality protein, and are badly needed by the many millions of people who live in poverty. A recent survey of several countries found that 34 percent of the people surveyed in South Asia and 59 percent in Sub Saharan Africa were suffering from severe energy deficiency (Smith and Wiseman, 2007). Eggs are high in lutein which lowers the risk of cataracts and macular degeneration, particularly among people living in developing countries. In the least developed countries, the projected increase in egg consumption between 2005 and 2015 is 26 percent, compared with only 2.4 percent in the most developed countries (Windhurst, 2008).

Table 1: The amount of nutrients provided by chicken meat and eggs

Product	Energy (kcal)	Protein (g)	Calcium (mg)	Iron (mg)	Vitamin A (µg)
Egg (fresh)	158	12.1	56	2.1	156
Poultry meat	139	19	15	1.5	0

Source: FAO, (1997)

2.6 Demand and consumption trend of poultry

Chicken production is used for efficient transforming feed protein and energy in to consumable human diets. Among the different food sources, poultry products contribute significantly to the Ethiopia's protein demand. The demand of protein food is progressively growing with the improvements of society's income and population growth that affects trends of chicken production. With an annual human population growth rate of 2.4%, the present 77.4 million Ethiopia's human population will increase to about 149.3 million by the year 2040. With the increasing population of the country, there is an increasing demand for the supply of food. Thus, the demand for animal products is expected to increase substantially (FAO, 2005).

To meet the ever-increasing demand for meat and eggs, introduction of superior/exotic breed has been proposed as one of the plausible option. Under the prevailing management situations, it may be difficult to fulfill these demands in short time. Therefore, intensification and upgrading of the potential of birds will be inevitable to provide surplus products. In line with this aim different chicken breeds have been introduced into this country (Yami, 1995; Ashenafi, 2000). Estimated egg and poultry meat per capital consumption in the mid 1990s was 57 eggs and about 2.85 kg (ILCA., 1993), respectively in Ethiopia. However, the per capital annual poultry meat and egg consumption has been declining and estimated at the national average of close to 0.12 and 0.14 kg, respectively (USAID, 2006; 2010).

An increase in egg and poultry meat consumption for developing countries is 26% and 2.4%, compared with only 2.4% and 1.6% in the most developed countries (Windhorst , 2008). Similarly, (FAO 2009) reported that there is a strong positive relationship between the level of income and the consumption of animal proteins. The current growth of poultry production and consumption makes a good case for the need and desire for future growth of the poultry industry (Daghir, 2009).

2.7 Egg quality and their relative importance

Egg is one of the most essential cheap sources of protein in human diet all across the globe, egg quality is composed of those characteristics of an egg that affects its acceptability to consumers such as cleanliness, freshness, egg weight, shell quality, yolk index, albumen index, Haugh unit and chemical composition (Song *et al.*, 2000). Quality of an egg ascertains the success of a poultry business because it is associated with the acceptability among the consumers (Rajkumar *et al.*, 2009).

Egg quality is factor which contributes for better economy price of fertile and table eggs. In general, the characteristics of egg quality have genetic basis (Scott and Silversides, 2001).

Egg quality was defined by Stadelman (1977) as characteristics important for consumers. Economic success for a production flock is measured with total number of produced eggs (Monira *et al.*,2003). A wide range of physical and chemical properties make up a total egg quality (Shanawany , 1988). The avian egg is an excellent source of nutrient which is widely accepted for human consumption. Egg production is one of, if not the major performance parameter of a laying bird. Egg production is believed to be a complex qualitative trait which is influenced by several factors e.g. breed, nutrition, age, weight of birds, level of production, management practices and environmental factors. (Williamson and Payne,1982 ; Oluyemi and Roberts, 2000).Certain traits of economic importance in egg production include the egg number, egg quality traits, and other egg indices (Oluyemi and Robert, 2000).

The management and nutrition of the hen do play a role in internal egg quality, egg handling and storage practices do have a significant impact on the quality of the egg reaching the consumer , The interior of hen's egg consists of the yolk and white or albumen. Interior characteristics such as yolk index, haugh Unit, and chemical composition are also important in egg product industry as the demand for eggshell colour has always received more attention from the consumer than it deserves (Gerber, 2012).

Eggshell colour does give an indication of the breeding history of the hen. White eggs are produced commercially by lines derived principally from the White Leghorn breed, whereas brown eggs are produced by hens derived from a number of dual-purpose breeds, including Barred Plymouth Rock, Rhode Island Red, Rhode Island White, Australorp, New Hampshire, Oravka, and others. These dual-purpose breeds were kept in farm flocks in the last century, and brown eggs have been perceived by the consumer to be more natural or healthy than white eggs (Scott and Silversides, 2000).

2.8 Egg morphometric analyses

Morphometrics in general refers to measurements of the body parts. The knowledge and information on morphometric parameters is therefore essential for understanding an

animal and its reproductive biology in particular (Danilov, 2000). Egg morphometric parameters such as egg weight, egg width, albumen and yolk weights are very important in poultry because these factors influence egg quality and grading (Farooq *et al.*,2001), reproductive fitness of the chickens and embryonic development (Onagbesan *et al.*,2007). Effects of feed (Shapira, 2010) and housing system (Wang *et al.*,2009) on egg composition and its quality have been reported. Internal egg quality parameters such as albumen weight and yolk weight are very important from nutritional and cholesterol content for human consumption (Sparks,2006).

Economically important egg morphometric parameters such as weight, size, albumen and yolk contents are quantitative traits that show continuous variability (Chatterjee *et al.*,2007; Islam & Dutta, 2010). It is also an established fact that the weight of an egg is a direct proportion of shell, albumen and yolk that it contains and this varies significantly between strains of the bird species (Jones *et al.*,2010; Momoh *et al.*,2010).

2.9 Egg quality characteristics

The overall quality of an egg can be discussed under two broad categories namely “external” and “internal” quality (Monira *et al.*,2003). The external quality of the egg is determined by features such as the size and shape of the egg as well as the structure, thickness and strength of the shell (Bain, 2005). The internal quality is measured on the basis of the quality of the albumen as indicated by the Haugh Units (HU), the relative size of the various internal components and the integrity of the shell membrane. Several studies have looked at this egg quality assessment in chickens (Tona *et al.*,2002; De Ketelaere *et al.*,2004; Bain, 2005). Among many quality characteristics, external factors including cleanliness, freshness, egg weight and shell weight are important in consumer’s acceptability of shell eggs (Adeogun and Amole, 2004; Dudusola, 2010).

Egg quality characteristics are of high importance. In analyzing egg quality, different internal and external egg quality characteristics have to be analyzed ,egg quality is presented by its weight, percentage of eggshell, thickness and strength of eggshell

(Silversides and Scott, 2001). Of the internal egg quality characteristics, thick albumen is quite an important measure for the freshness of an egg. The longer an egg is stored, the more the height of the thick albumen decreases (Toussant and Latshow, 1999). Internal quality of the egg begins to decline as soon as the egg is laid. The management and nutrition of the hen do play a role in internal egg quality, egg handling and storage practices do have a significant impact on the quality of the egg reaching the consumer (Gerber, 2012).

It is obvious that beneficial egg quality traits are of immense importance to poultry breeding industries (Bain 2005). In addition, the interior of hen's egg consists of the yolk and white or albumen. 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).

Table 2: Chemical Composition of Eggs in %.

Product	Percent %	Water	Protein	Fat	Ash
Whole Egg	100	65.5	11.8	11	11.7
Albumen	58	88	11	2	8
Yolk	31	48	17.5	32.5	2

Source :USDA

Yolk colour (YC) is a quality measure in eggs that is quite variable and easily changed (Zeidler, 2002). The diet of the hen has the greatest influence on YC (Galobart *et al.*, 2004). The YC can be easily manipulated by using synthetic additives, and this is frequently done in many countries (Zeidler, 2002). To achieve the basic yellow colour of a typical egg yolk, yellow xanthophylls are needed. Because YC is influenced so heavily

by the diet, the age and breed of then hen has little influence (Galobart *et al.*, 2004).Yolk colour is subjectively determined by the use the Roche colour fan (Vuilleumier, 1968; Stadelman, 1995).

Yolk color is a key factor in any consumer survey relating to egg quality (Okeudo *et al.*, 2003). Yolk quality is determined by the colour, texture, firmness and smell of the yolk (Jacob *et al.*,2000).The determinant of yolk colour is the xanthophyll (plant pigment) content of the diet consumed (Silverside *et al.*,2006). Among feed ingredients, only supplemented maize contributes to improved color intensity of the yolk.

Thus, if a hen has access to green grass or supplemented feed ingredients containing carotenoids/xanthophylls, it will be enough to give the yolk the colour preferred by consumer (Zaman *et al.*, 2004). The yolk of a freshly laid egg is round and firm (Jacob *et al.*,2000). However, as the egg ages and the vitelline membrane degenerates, water from the albumen moves into the yolk and gives green grass during scavenging might be responsible for carotenoid deposits in the yolk, which improves the yolk color(Zaman *et al.*,2004).

Albumin quality is related to the consistency, appearance and the functional properties.it is measured in terms of Haugh Units (HU) proposed by Haugh (1937).calculated from the height of the albumen and the weight of the egg ,However, most eggs leaving the farm should be between 75 and 85 HU (Coutts and Wilson, 1990). (Rajkumar *et al.*,2009) reported that Age of the hen and season of the year can also affect Haugh unit values brown egg layers produced eggs with higher HU. It is generally accepted that the higher the Haugh unit value, the better the quality of the egg. It is also important that all eggs being evaluated at the same internal temperature.

Albumen Height (AH) Albumen refers to the “white” of an egg and consists of a thick and thin portion. The thick albumen is the portion immediately surrounding the egg yolk, whereas the thin albumen comprises the rest of the white portion.The height of the albumen indicates the freshness of the egg and can be measured using a tripod micro

meter. Once the egg is broken onto a flat surface, a tripod micrometre is placed over the thick albumen. The centre pin is lowered until it “kisses” the albumen and the height, typically in mm, can be observed. The thicker the albumen, the better the quality of the egg, with heights of 8 to 10 mm being considered superior interior quality (Zeidler, 2002). While AH can be measured directly, an additional measure of AH, HU, which accounts for WT, can be calculated (Haugh, 1937; Williams, 1992). The calculation for HU is as follows:

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

Where AH is the height of the albumen in mm and EW is the weight of the egg in g. Since the relationship between EW and AH is not constant across breeds of birds, the HU is not appropriate for comparing eggs across breeds (Silversides, 1994).

Eggshell Thickness and Color (EST) The egg shell quality is given through the weight and the percentage of shell, thickness and the strength. The differences in eggshell quality depend on the environmental conditions and the feed quality and also of strain of layers (Zita *et al.*, 2009). On the other hand, (Khan *et al.*, 2004) reported no significant effect of breed on eggshell thickness under semi scavenging condition.

Eggshell thickness is also an important external quality trait for hatchability. And it should be between 0.33 and 0.35 mm and few eggs with a shell thickness less than 0.27mm will hatch. Thickness measurements are typically taken along the midline of the egg and done using a micrometer and can only be evaluated after an egg has been broken. (Khan *et al.*, 2004). An eggshell thickness of at least 0.33 mm has been estimated to be necessary for the egg to have at least a 50% chance of withstanding normal handling conditions without breaking (Stadelman, 1995).

Eggshell colour has always received more attention from the consumer than it deserves. Eggshell colour does give an indication of the breeding history of the hen. White eggs are produced commercially by lines derived principally from the White Leghorn breed, whereas brown eggs are produced by hens derived from a number of dual-purpose

breeds, including Barred Plymouth Rock, Rhode Island Red, Rhode Island White, Australorp, New Hampshire, Oravka, and others (Silversides, 2000).

Egg Weight (EW); Egg weight is a very simple measurement to collect and therefore is frequently analyzed simply by placing an unbroken egg on a scale and recording the value (Zeidler, 2002). Genetics and environment greatly influence egg weight. (Scott and Silversides, 2001). Weights of eggs are divided into 6 size categories. Minimum weight requirements in the United States for these categories are: jumbo (68.6 g), extra-large (61.5 g), large (54.4 g), medium (47.3 g), small (40.3 g) (Zeidler, 2002). Egg weight is also one of the important phenotypic traits that influence egg quality and reproductive fitness of the chicken parents (Islam *et al.*, 2001; Farooq *et al.*, 2001). (Anderson, 2002) provided detailed information on the differences in egg production and quality between different white and brown egg strains and reported the egg weight from brown hens (61.1g) was more than that of white hens (58.3g). (Tixier Boichard *et al.*, 2006) recorded weight of 42.8 g for Fayoumi eggs

Higher weight of egg from commercial strains is not a surprise since such strains submitted to important breeding pressure for egg weight improvement (Hocking *et al.*, 2003). Further, under smallholder farmers condition in northern Ethiopia, egg weight was recorded as 52.5g, 52.1g and 43 g for Rhode island Red, White Leghorn and Fayoumi, respectively (Lemlem and Tesfaye, 2010).

Egg Shape Index (ESI) is a measurement of the overall shape of an egg. The 3 shapes most prevalent in production are classified as sharp (SI of < 72), normal (SI of 72-76), and round (SI >76). Egg shape is important in commercial systems, as shapes outside the normal range do not fit well into pre-made packaging. Also, sharp eggs are not as resistant to the shipping and handling processes, as are their normal counterparts (Altuntas and Sekeroglu, 2007). To calculate shape index, the EW and EL of the egg are measured in cm using calipers. The EW is then divided by the EL and that ratio multiplied by 100 (van den Brand *et al.*, 2004).

Since SI is important for commercial industry, when considering pre-made packaging, normal shaped eggs are ideal for fitting into containers. Normal shaped eggs also provide more strength to the eggshell, compared to sharp eggs, making them more resistant to breakage during shipping and handling (Altuntas and Sekeroglu, 2007). Additionally, uniformity in egg shape is important, as the market for further processed eggs continues to grow. The efficiency of this market is based on the use of automatic breakers, and conformity in egg shape to the characteristics of this machinery is essential. The findings of (van den Brand *et al.*, 2004), lead us to anticipate a decrease in SI, from sharp to normal, as hen's age.

2.10 Effect of breed on egg quality traits

Egg traits are influenced by a variety of factors including genetics, hen age and body weight, diet and length of holding period (Silversides, 1994; Silversides and Budgell, 2004; van den Brand *et al.*, 2004). Genotype has direct influence on egg weight and eggshell characteristics. Many studies showed that hens with coloured feathers lay bigger eggs than hens with white feathers (Halaj and Grofík, 1994; Vits *et al.*, 2005; Halaj and Golian, 2011). The colour of an egg shell is determined primarily by the genetics of the hen, with white feathered hens laying white eggs and brown feathered hens laying brown eggs (Jacob *et al.*, 2000).

Genetic differences in eggshell quality characteristics exist between species, and between breeds, strains and families within the lines (Buss and Guyer, 1982). Egg weight is very different between various lines and eggshell thickness is under great influence of line (Pandey *et al.*, 1986). Egg shell thickness measurement typically has little variation across similar breeds (Potts *et al.*, 1974; Anderson *et al.*, 2004). The yolk % is affected by breed or strain within a breed, age of hen and egg size (Campo, 1995; Suk and Park, 2001). The egg shell quality is given through the weight and the percentage of shell, thickness and the strength. The differences in eggshell quality depend on the environmental conditions and the feed quality and also of strain of layers (Zita *et al.*, 2009). On the other hand, (Khan *et*

al., 2004) reported no significant effect of breed on eggshell thickness under semi scavenging condition.

2.11 Effect of age on egg quality traits

Almost all egg quality traits decline as hens age, with the exception of egg weight, which increases (Ledur *et al.*, 2002; Altunas and Sekeroglu, 2007). The findings of (van den Brand *et al.*, 2004), lead us to anticipate a decrease in shape index, from sharp to normal, as hen's age. One of the main concerns is a decrease in eggshell quality as the hen ages, due to an increase in egg weight without an increase in the amount of calcium carbonate deposited in the shells. For this reason, the incidence of cracked eggs could even exceed 20% at the end of the laying period (Nys, 2001). Egg shell weights have been shown to both increase and decrease as the hen ages, following no specific pattern (Silversides, 1994; Silversides and Budgell, 2004; Popova-Ralcheva *et al.*, 2009).

The egg size and its component are influenced by a number of genetic and non genetic factors (Washburn, 1990). The yolk % is affected by breed or strain within a breed, age of hen and egg size (Campo, 1995; Suk and Park, 2001). Hen age has been shown to increase yolk weight (Van den Brand *et al.*, 2004) albumen weight (Suk and Park, 2001). Age, feed, protein levels and temperature are some of the factors that affect egg size in chickens (Banerjee, 1992). Economically important egg quality traits such as weight, size, yolk and albumen contents are quantitative traits with continuous variability (Das 1994). The relationship between weight, length and width of eggs has been reported by (Danilov, 2000) who also noted the proportion of yolk, albumen and shell that contribute to the egg weight increases with hen's age, reaching a plateau by the end of the laying cycle.

Egg weight influences the weight of components of eggs especially egg albumen and yolk (Zhang *et al.*, 2005; Aygun and Yetisir, 2010). Thus egg weight is one of the important phenotypic traits which influence egg quality and reproductive fitness of the chicken parents (Islam *et al.*, 2001; Farooq *et al.*, 2001). Eggshell strength is highly

dependent on egg shell thickness. it can either decrease (Anderson *et al.*, 2004) or remain constant as hens age (van den Brand *et al.*, 2004). The thickness of an eggshell can be compromised in a variety of ways, including temperature over 32⁰C, hen age, and dietary calcium levels below 3% (Zeidler, 2002). One of the main concerns is a decrease in eggshell quality as the hen ages, due to an increase in egg weight without an increase in the amount of calcium carbonate deposited in the shells. For this reason, the incidence of cracked eggs could even exceed 20% at the end of the laying period (Nys, 2001).

The length of time a hen has been in continuous production, or has continuously produced eggs without going through a molt, will impact the height of the albumen. Furthermore, AH will decrease as a hen ages (Doyon *et al.*, 1986; Williams, 1992; Silversides, 1994; Ledur *et al.*, 2002; van den Brand *et al.*, 2004). As a laid egg ages, the AH also will decrease (Silversides, 1994; Silversides and Budgell, 2004). Besides SI and WT, (van den Brand *et al.*, 2004) evaluated AH. In the youngest hens, the average AH was 7.27 ± 0.18 mm, while the average AH in the oldest hens decreased by 1.78 ± 0.18 mm ($P < 0.05$).

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Embryonic development of hen's egg is dependent on traits like egg weight, yolk and albumen weights, genetic line and age of the hen (Finkler *et al.*, 1998; Onagbesan *et al.*, 2007). Subsequently, effects of feed (Adedeji *et al.*, 2008; Shapira 2010), hormone (Guzel *et al.*, 2009) and housing system (Pohle and Cheng 2009; Sossidou and Elson 2009; Wang *et al.*, 2009) on egg composition and its quality have been investigated. The age of hen and laid egg are important influences on albumin height.

2.12 Carcass yield characteristics

Poultry meat production has been very dynamic over the last decade during which time it has been greatly diversified with a large increase in the volume of the joints and processed products, This success has been strongly related to the improvement in growth and carcass yield, with a significant increase in the breast muscle proportion. More recently, due to consumer preferences and the industry demands, improvement of the meat quality has become a more prevalent concern (Daum and Kijowski J 1992).

The poultry industry is seeing a continuing trend in consumer preference from whole birds to further/secondary processed products, although in countries where the use of slow growing/indigenous lines is developing as the majority is sold as whole birds (Dransfield & Sosnicki, 1999; Zhao *et al.*, 2012).

Today, the majority of poultry is being marketed in a manner that targets the yield of high value products such as breasts and boneless filets, The poultry carcass can be described as the empty body of the chicken post slaughter, which is used for eating purposes or further processing.(Young *et al.*, 2001). There are numerous configurations that can be obtained when processing a chicken carcass and the portions produced are usually dependent on the value of the cut which is in turn dependent on consumer preference (Owens *et al.*, 2000).

The yield of edible parts can be described as the relative contributions of portions, namely the breast, leg (drumstick), thigh and wing, to the total carcass weight. This is usually represented as a percentage of the carcass weight. In short, carcass composition is effectively described by the dressing %, portion percentage yields, and dissection characteristics of the portions (Zhao *et al.*, 2012).It has been stated that the success of the poultry industry is highly dependent on the ability of producers to increase the proportions of the most relevant parts of the carcass; this includes increasing breast muscle yield and reductions of carcass fat (Guerrero-Legarreta, 2010).

2.12.1 Factors affecting carcass quality

Poultry carcass composition is mostly affected by line and feeding system, these two factors have also been shown to affect meat quality (Jaturasitha *et al.*, 2008b). Growth rate changes are generally associated with changes in carcass composition and yield, the breeding of meat type broilers has resulted in a doubling of the percentage yield of breast meat since the early 1990's (Havenstein *et al.*, 2003a). (Van Marle-Köster & Webb 2006) evaluated the carcass characteristics of South African domestic birds (the Potchefstroom Koekoek, New Hampshire, Naked-Neck, Lebowa-Venda and Ovambo chicken lines) and compared them to that of a commercial broiler line. The birds were grown to an age of 11 weeks (77 days) and maintained on a commercial broiler diet after which ten birds from each line were randomly selected for analyses. The highest dressed carcass mass was obtained by the Ovambo (939.8g) whilst the Naked-neck had the highest breast muscle yield (18.03%).

Carcass quality is potentially affected by management techniques, weather and rearing conditions, genetics, transportation, and the ability of the birds to respond to the environment, and all the variables that may interact, affecting in the production cycle (Bertol, 2004). Most of factors influencing poultry meat quality can be controlled during the different production stages, slaughter, and meat processing. These factors include age, gender, nutrition, management, bird density, harvesting method, environmental conditions, handling, etc (Mendes *et al.*, 2001).

2.12.2 Growth, body composition and carcass traits of dual purpose genotypes

Dual purpose chicken genotypes are increasingly popular in some regions of Eastern and Middle Europe and Asia, where they play an important social role among farmers and have a positive impact on maintaining rural society and traditional form of agriculture as well as gratify certain local traditions (Webb, 2006). Their meat and high number of laid eggs provide enhanced income for small scale family farms. The breeding of dual purpose chickens in Hungary is characterized with cross breeding between colour feathered, meat

type cocks and brown layer dam line selected for egg production (Leenstra and Pit, 1988).

It is well known, that higher abdominal and subcutaneous fat occurs among slow-growing genotypes to a different extent, which needs to be monitored by breeding companies to avoid strains that are more prone to fattening (Ristic *et al.*, 2008). Differentially selected lines or selection based on improved FCR could solve these problems, On the other hand, fat stored intramuscularly is highly regarded by consumers looking for quality and tasty meat products (Zerehdaran *et al.*, 2003).

Selection of meat type chickens has previously focused not only on increased growth performance but also on improved carcass quality. In particular, the emphasis has been on better body composition, with higher breast meat yield and lower abdominal fat. This focus responds to the consumer desire for healthier meat, and to the evolution of the market through a rising demand for portioned and processed product (Jaturasitha *et al.*, 2008b).

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted at the Debre Zeit Agricultural Research Centre (DZARC) poultry farm in Bishoftu town East Shoa zone of Oromia region, Ethiopia, from November 2016 to April 2017. The Center is located at the distance of 45 km southeast of Addis Ababa. The area is situated at 9°N latitude and 40°E longitude at altitude of 1850 meters above sea level in the central high land of Ethiopia. It has an annual rainfall of 866mm of which 84% is in the long rainy season (June to September) the dry season extends from October to February. The mean annual maximum and minimum temperatures are 26°C and 14°C respectively with mean relative humidity of 61.3% (NMSA, 2010).

3.2 Study animals

The Animals (genotypes) used in this study were *Dominant Red Barred* (DRB), *Novo color* (NC), *Koekoek* (KK) which are dual purpose laying type breeds and (*Lohmann brown* (LB) which is an egg type breed

3.3 Management of experimental birds

A wire mesh partitioned deep litter floor house covered with disinfected teff straw was used. The experimental pens, watering and feeding troughs, and laying nests were thoroughly cleaned, disinfected, and sprayed against external parasites. All breeds were randomly assigned to experimental pens according to their type of breed. The house was open type with concrete floor. A standard lightning program was also followed *i.e.* 12 hour sunlight and additional four hours of electric light and eight hours of darkness at night. Fluorescent lamps were placed for the lighting system to increase the lighting period to 16 hour per day in order to increase feed intake and laying (Yasmeen *et al.*, 2008).

The birds were fed a standard ration as per the recommendation of the breeding company. Diets were offered and fresh clean water was provided *adlibitum* in a round feeder and water in a plastic fountain. The contents and nutritional quality were formulated at DZARC the feeds used were analyzed before feeding to the experimental chickens (Appendix 4).

The experimental chickens included in this study were adult layers starting from 25 weeks of age for egg quality analysis and mature birds of 45 weeks of age for carcass characteristics evaluation. The chickens were vaccinated against Newcastle Disease, Gumboro, Fowl Pox and Fowl typhoid as per the vaccination program of the Debre Zeit Agricultural Research Center. (Annex Table 3). Other health precautions and sanitary measures were also taken throughout the study period.

3.4 Experimental design, treatments and birds

A Completely Randomized Design (CRD) was employed in this study. A total of 120 birds of 25 weeks of age were used for egg quality measurement and 24 mature chickens of 45 weeks of age were used for carcass traits evaluation. Birds were sourced from DZARC poultry farm.

Table 3: Layout of the Experiment

Genotypes	Rep.	Number of chicks per replication	
		R ₁	R ₂
T ₁ : DRB(Dominant Red Barred)	2	15	15
T ₂ : LB(Lohmann Brown)	2	15	15
T ₃ : KK(Koekoek)	2	15	15
T ₄ : NC(Novo Colour)	2	15	15

T₁, T₂, T₃ and T₄ =are treatments 1, 2, 3, and 4 Rep=replication; R₁, R₂ = are replications 1, and 2.

3.4.1 Evaluation of egg quality characteristics

Egg collection continued for the whole of the experimental period . At 25, 27, 29, 31.and 33 weeks. A total of 300 eggs collected from those four strains (15 eggs per treatment) *i.e* a total of 60 eggs at a time were evaluated for both internal and external egg qualities. The external egg quality traits studied included gross Egg Weight (EW), Egg Shell Weight (SW), Shell Thickness (EST), Shell Ratio (SR) and Egg Shape Index (ESI). The internal ones, on the other hand, included Albumen Height (AH), Yolk Height (YH), Yolk Weight (YW), Albumen Weight (AW), Yolk Ratio (YR)and Yolk Colour (YC) were determined at an interval of 15 days.Eggs were numbered first and then weighed and measured using sensitive balance. Subsequently, the length and width of egg was measured by using digital caliper.



Figure 1: Digital caliper

Eggs were broken on a table and its contents poured onto a plate. and immediately measured for shell weight by including the shell membrane using sensitive balance and Shell thickness was taken as the average thickness at the broad, middle and narrow points of the egg using a digital caliper. Albumen and yolk heights were measured by tripod micrometer (calibrated in mm) (Safaa *et al.*, 2008b). Then the yolk was separated from the albumen. Moreover, yolk colour measured by adjusting the egg yolk with the Roche Colour Fan (1 = very pale to 16 = deep orange).

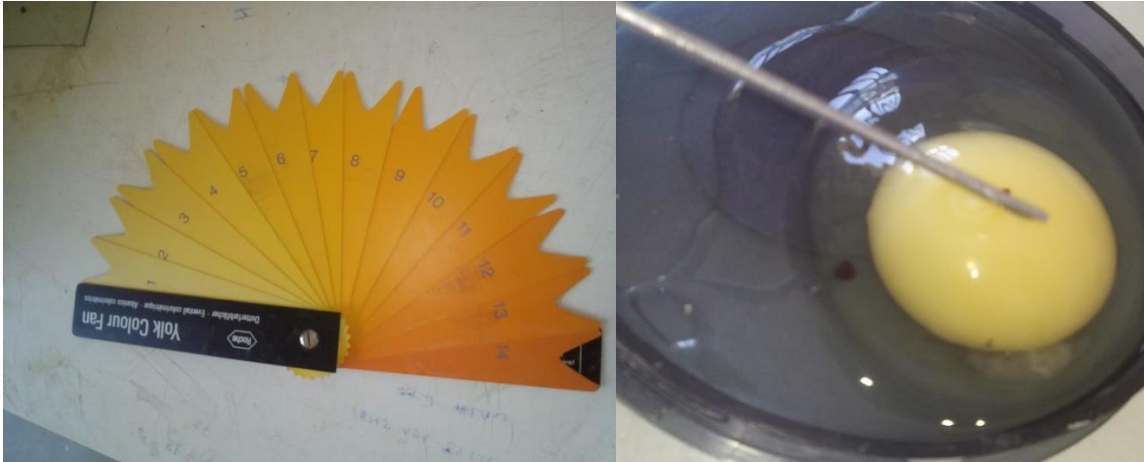


Figure 2 : Yolk Color Fan (left) and Tripod Micrometer (right)

On the basis of the above measurements, the remaining egg quality traits were obtained using the following formulae according to Olawumi and Ogunlade, (2008)

$$SR (\%) = SW/EW \times 100;$$

$$ESI (\%) = W/L \times 100;$$

$$YR (\%) = YW/EW \times 100; \text{ and}$$

$$AR (\%) = AW/EW \times 100.$$

Haugh unit (HU) was calculated using the formula

$$HU = 100 \log (AH - 1.7EW)^{0.37} + 7.57 \text{ (Keener } et al., 2006):$$

Where; h = observed albumen height (mm),

w = weight of egg (g).

Yolk index were computed according to Ebrahimi *et al.*, (2012).

Yolk index = Yolk height/Yolk length

3.4.2 Measurement of carcass yield characteristics

At the end of the study 24 birds wereslaughtered (*i.e.* Two male and four female from each breeds) was selected and starved for 12 hours, and weighed immediately before slaughter which was considered as slaughter weight and then slaughtered by manual neck cut, bled, eviscerated and dressed .

After slaughtering the birds were dry de-feathered by hand plucking, eviscerated carcass cuts and non-carcass include, non-edible and edible offals components were determined according to the procedure described by Kubena *et al.*, (1974) and Kekeocha, (1985).

Dressed carcass weight: was measured after the removal of blood, legs, head and feather and the dressing percentage calculated as the proportion of dressed carcass weight to slaughter weight multiplied by 100.

Eviscerated carcass weight was determined after removing blood, feather, lower leg (shank), head, kidney, lungs, pancreas, crop, proventriculus, small intestine, large intestine, caeca and urogenital tracts from dressed carcass.

Eviscerated percentage was determined as the proportion of the eviscerated weight by slaughter weight multiplied by 100.

The weights and length of the large intestines were weighed. The lengths of the different parts of the (GIT) were measured by using a meter tape. The relative and absolute weight of liver and heart were also noted. Edible offal's (giblets): which include the heart, gizzard and liver, were weighed and percentages were calculated in relation to slaughter weight.

Gizzard and skin are edible in most places in Ethiopia and therefore, it was included in the edible component. Nonedible offal components was determined and Measurement of carcass characteristics was determined according to the procedure described by (Kubena *et al.*, 1974).

From eviscerated carcass weight based on the commercial base; two drumstick, two thighs, two wings, back and breast meat was separated and weighed and their weight and were divided by slaughter weight and multiplied by 100 to determine their percentage weights of each component. Fat around the proventriculus and gizzard and against the

abdominal wall and the cloacae was collected and weighed. Fat percentage was calculated as the proportion of slaughter weight.

3.5 Data Management and statistical analyses

The collected data were entered and stored into Microsoft Excel spreadsheet 2007. The data then thoroughly screened and properly coded before subjecting to statistical analysis. Descriptive statistics and a one-way ANOVA were employed for the analyses of the data using SAS 9.1.2 (SAS, 2004). Mean differences among breeds were tested with a multiple comparison test (Bonferroni Test).

The following statistical model General Linear Model (GLM) was fitted to the data. The Duncan's Multiple Range Test procedure was used to see differences among breeds means.(Duncan, 1955).

$$Y_{ij} = \mu + \alpha_i + e_{ij},$$

Where, Y_{ij} = the measurement for the i^{th} breed and j^{th} week,

μ = overall mean effect,

α_i = the i^{th} breed effect and

e_{ij} = the random error variation

4.RESULTS

4.1 Egg Quality Traits

Results of the different egg quality traits measured are presented in Tables below. Multiple comparisons were done based on mean values of individual egg quality traits, four breeds of chicken namely *Koekoek* (KK), *Dominant red barred*(DRB), *Novo color*(NC) and *Lohmann Brown* (LB) were compared and measurements were taken on week 25,27,29, 31 and 33.

Table 4 : Least square means of egg weight (g) and egg length(mm) values.

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Egg weight(g)					
Wk25	40.94 ^c	53.04 ^a	48.86 ^{ab}	47.904 ^b	***
Wk27	42.04 ^c	54.13 ^a	48.89 ^b	49.47 ^b	***
Wk29	43.46 ^c	54.5 ^a	51.53 ^{ab}	51.08 ^a	***
Wk31	43.39 ^b	55.51 ^a	53.1 ^a	51.48 ^{ab}	***
Wk33	44.16 ^b	56.05 ^a	53.42 ^a	52.41 ^a	***
Over all means	42.798	54.646	51.16	50.47	
Egg length(mm)					
Wk25	49.59 ^{bc}	53.58 ^a	49.86 ^c	53.34 ^{ab}	***
Wk27	49.66 ^b	53.99 ^a	53.11 ^a	53.43 ^a	***
Wk29	49.67 ^a	55.18 ^a	53.06 ^a	53.14 ^a	NS
Wk31	50.59 ^b	55.77 ^a	52.24 ^b	49.04 ^b	***
Wk33	50.59 ^b	57.96 ^a	53.33 ^{ab}	53.53 ^{ab}	*
Overall means	49.62	54.67	49.68	52.28	

Ns: p>0.05; *: p<0.05; **: p<0.01; *: p<0.001. The means of the same line followed by different letters differ significantly at p < 0 .05.**

Results of the study revealed that genotype had significant ($P < 0.01$) effect on traits studied. Result of the analysis showed that significant effect of breed on egg weight. Mean egg weight of DRB (53.04-56.05g) was significantly different ($p < 0.05$) than the rest and has the highest mean egg weight followed by LB(48.86-53.42g), However there was no any significant difference ($p > 0.05$) on egg weight on DRB, LB and NC at week 33. The highest mean egg weight was recorded in DRB on week 33(56.05g) and lowest mean on week 25 in KK(40.9g) .Though Egg length showed an increasing trend no statistically significant difference was observed on week 29.

Table 5: Least square means of Egg width (mm) and Shell thickness (mm) values.

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Egg width(mm)					
Wk25	37.51 ^c	44.10 ^a	42.24 ^{ab}	40.41 ^c	***
Wk27	38.13 ^c	43.29 ^b	40.52 ^{bc}	51.08 ^a	***
Wk29	38.1	42.35	40.3	52.1	Ns
Wk31	39.08 ^c	42.56 ^b	41.10 ^{bc}	50.04 ^a	***
Wk33	38.38 ^c	48.9 ^b	43.21 ^b	52.5 ^a	***
Overall means	38.24	44.24	41.47	49.2	
Shell thickness (mm)					
Wk25	0.36	0.39	0.41	0.38	Ns
Wk27	0.37	0.4	0.35	0.38	Ns
Wk29	0.39	0.39	0.4	0.42	Ns
Wk31	0.33 ^b	0.37 ^a	0.39 ^a	0.41 ^a	***
Wk33	0.35	0.37	0.4	0.39	Ns
Overall means	0.36	0.38	0.39	0.39	

Ns: $p > 0.05$; *: $p < 0.05$; **: $p < 0.01$; *: $p < 0.001$. The means of the same line followed by different letters differ significantly at $p < 0.05$.**

Egg width increases with age and statistically significant higher mean egg width was observed in NC (52.5mm) and the lowest was recorded on week 25 in KK (37.51mm) and there was no statistical significant difference among breeds on week 29.

There was no statistically significant difference ($p>0.05$) among the four chicken breeds on egg shell thickness.

Table 6: Least square means of shell weight (g) and albumin weight (g) values.

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Shell weight(g)					
Wk25	5.04 ^c	6.81 ^a	6.08 ^b	6.31 ^{ab}	***
Wk27	5.61 ^a	6.74 ^a	5.93 ^a	6.72 ^a	Ns
Wk29	5.01 ^b	6.65 ^a	6.24 ^a	6.52 ^a	***
Wk31	5.18 ^b	6.64 ^a	6.26 ^a	6.98 ^{ab}	***
Wk33	5.11 ^b	6.88 ^a	6.77 ^a	6.37 ^a	***
Overall means	5.19	6.77	6.25	6.45	
Albumin weight (g)					
Wk25	24.01 ^b	31.93 ^a	31.74 ^a	26.61 ^b	***
Wk27	25.88 ^c	32.67 ^a	33.10 ^a	29.20 ^b	***
Wk29	23.20 ^c	30.99 ^a	25.77 ^{bc}	29.05 ^{ab}	***
Wk31	24.11	23.66	29.01	25.63	Ns
Wk33	23.6 ^b	31.7 ^a	30.34 ^a	27.9 ^{ab}	***
Overall means	24.16	30.19	29.9	27.67	

Ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$; *: $p<0.001$. The means of the same line followed by different letters differ significantly at $p < 0.05$.**

Shell weight showed an increasing trend however there was no significant difference ($p>0.05$) among DRB, LB and NC at week 29 and 33 and No Statistically significant differences ($p>0.05$) was found on week 27 in all groups studied. KK recorded the lowest shell weight at week 33 (5.01g) which was significantly lower than that of DRB.(6.59g). at week 25. Statistically higher albumin weights was observed in DRB (31.93) followed by LB (31.74). The mean observed values of albumin weight shows fluctuating decreasing trend .The highest albumin weight was recorded on week 25 in all groups and the lowest mean height recorded on week 33. There was no Statistically significant difference ($p>0.05$) among breeds on week 31 .

Table 7 : Least square means of yolk height (mm) and yolk weight (g) values.

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Yolk Height(mm)					
Wk25	18 ^c	19 ^b	21.3 ^a	17 ^c	***
Wk27	19.9	20.7	19.2	20.27	Ns
Wk29	19.7 ^b	20.53 ^{ab}	21.5 ^a	20.3 ^{ab}	**
Wk31	19.27 ^b	20.9 ^a	20 ^{ab}	20.40 ^a	***
Wk33	19.3 ^c	20.47 ^b	21.5 ^{ab}	22.47 ^a	***
Overall means	19.23	20.32	20.35	20.08	
Yolk weight(g)					
Wk25	11.08 ^c	13.23 ^b	10.03 ^c	15 ^a	***
Wk27	11.90 ^b	13.13 ^{ab}	12.29 ^b	14.52 ^a	**
Wk29	13.27 ^b	15.52 ^a	14.95 ^a	15.99 ^a	***
Wk31	13.76 ^b	15.90 ^a	15.2 ^{ab}	16.75 ^a	***
Wk33	13.9 ^b	16.67 ^a	16.24 ^a	17.4 ^a	***
Overall means	12.78	14.89	13.74	15.9	

Ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$; *: $p<0.001$. The means of the same line followed by different letters differ significantly at $p < 0.05$.**

Highest average yolk height was recorded in LB (22.47mm) followed by DRB(20.47mm) Significant difference was observed ($p<0.05$) in LB on week 25. However No Statistically significant differences ($p>0.05$) was found at week 27 in all groups. Yolk height shows an increasing trend as age advances.

Yolk weight increases and statistically higher yolk weight in DRB (16.67g) on week 33.followed by LB(16.24g) and this was statistically lower than that of KK(11.08g) in average yolk weight than the others groups . However, there was no any significant difference ($p>0.05$) on yolk weight between KK, LB and NC on week 29, and week 33.

Table 8: Least square means of albumin height (g) and yolk weight (g)values.

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Albumen height (mm)					
Wk25	9.2 ^b	9.6 ^b	10.8 ^a	9.4 ^b	***
Wk27	10 ^b	11.5 ^a	10.3 ^{ab}	10.2 ^{ab}	**
Wk29	9.8 ^b	11.4 ^a	9.5 ^{ab}	11 ^a	***
Wk31	10.47	11.5	11	11.1	Ns
Wk33	10.6 ^b	11.3 ^{ab}	11.7 ^b	11.2 ^a	***
Overall means	10	11.06	10.66	10.58	
Yolk colour					
Wk25	1.4	1.4	1.46	1.27	Ns
Wk27	1.4	1.3	1.3	1.47	Ns
Wk29	1.27	1.3	1.27	1.2	Ns
Wk31	1.47	1.47	1.3	1.47	Ns
Wk33	1.4	1.53	1.47	1.3	Ns
Overall means	1.38	1.4	1.36	1.34	

Ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$; *: $p<0.001$. The means of the same line followed by different letters differ significantly at $p < 0 .05$.**

The mean observed values for albumen height shows an increasing fluctuating trend and LB(11.7) has the highest albumin height and KK(9.2 mm) showed the lowest albumin height on week 25. However there was no any significant difference recorded ($p>0.05$) on week 25

no statistically significant difference ($p>0.05$) was found in Yolk color among the four breeds.

Table 9 : Least square means of egg shape index and yolk index values..

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Egg shape index					
Wk25	76.5	80.3	79.9	76.78	Ns
Wk27	75.5	80	74.58	74.67	Ns
Wk29	79.07	78.6	76.2	75.6	Ns
Wk31	77.34	76.6	78.8	74.9	Ns
Wk33	76.3	76.2	76.53	74.5	Ns
Overall means	76.94	78.3	77.2	75.3	
Yolk index					
Wk25	0.61 ^{bc}	0.69 ^b	0.58 ^c	0.68 ^a	***
Wk27	0.69 ^b	0.68 ^{ab}	0.58 ^b	0.72 ^a	***
Wk29	0.67 ^b	0.76 ^a	0.78 ^a	0.79 ^a	***
Wk31	0.75 ^b	0.76 ^{ab}	0.7 ^b	0.8 ^a	***
Wk33	0.76	0.78	0.76	0.78	Ns
Overall means	0.69	0.73	0.68	0.75	

Ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$; *: $p<0.001$. The means of the same line followed by different letters differ significantly at $p < 0.05$.**

Though ESI shows a fluctuating trend there was no any significant difference ($p>0.05$) observed among breeds. Yolk index increases and statistically significant higher yolk index recorded on week 33.

Table 10: Least square means of shell ratio and yolk ratio values.

	KK	DRB	LB	NC	
Shell ratio	Mean	Mean	Mean	Mean	P-value
Wk25	12.3	12.86	12.52	13.32	Ns
Wk27	12.7	12.45	11.3	13.2	Ns
Wk29	11.9	12.3	12.9	12.6	Ns
Wk31	11.9	11.8	12	12.3	Ns
Wk33	11.6 ^{ab}	10.93 ^b	12.45 ^a	12.19 ^a	***
Overall means	12.08	12.06	12.23	12.72	
Yolk ratio					
Wk25	27.13 ^b	25.05 ^b	20.62 ^c	31.8 ^a	***
Wk27	27 ^{ab}	24.4 ^{bc}	23.2 ^c	28.4 ^a	***
Wk29	31.6	28.8	31.1	30.89	Ns
Wk31	31.8 ^{ab}	28.5 ^b	29.2 ^b	34.4 ^a	***
Wk33	32.23	30.2	30.55	33.18	Ns
Overall means	29.95	27.39	26.93	31.73	

Ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$; *: $p<0.001$. The means of the same line followed by different letters differ significantly at $p < 0.05$.**

No significant difference ($p>0.05$) was observed among breeds in shell ratio. Both yolk ratio and shell ratio shows fluctuating trend and there was no any significant difference recorded among breeds on week 29 and week 33

Table 11: Least square means of Albumin Ratio and Haugh Unit values.

	KK	DRB	LB	NC	
	Mean	Mean	Mean	Mean	P-value
Albumin ratio					
Wk25	58.69 ^{ab}	59.88 ^{ab}	65.3 ^a	56.17 ^b	***
Wk27	58.6 ^{bc}	60.3 ^{ab}	62.3 ^a	57.14 ^c	***
Wk29	55.1	57.12	53.19	56.01	Ns
Wk31	55.27	59.62	55.43	52.24	Ns
Wk33	54.13	56.61	56.75	53.07	Ns
Overall means	56.35	58.7	58.58	54.92	
Haugh Unit					
Wk25	73.2 ^b	74.63 ^b	82.48 ^{ab}	73.25 ^b	**
Wk27	77.9 ^b	78.9 ^b	83.3 ^a	80.8 ^b	**
Wk29	79.86	80.1	82.8	82.5	Ns
Wk31	80.4	81.8	83	81.9	Ns
Wk33	80.7	81.3	83.8	82.4	Ns
Overall means	77.8	78.8	83.07	79.21	

Ns: $p>0.05$; *: $p<0.05$; **: $p<0.01$; *: $p<0.001$. The means of the same line followed by different letters differ significantly at $p < 0.05$.**

No significant difference was found among breeds in week 29,31,33 in the mean albumin ratio values recorded. Non-significant difference ($P>0.05$) was observed in the mean Haugh unit values of the four varieties on week 29,31 and 33. The Haugh unit values obtained in this study is higher than the 70% benchmark noted for quality eggs (Adeogun and Amole 2004). They also reported that the higher the yolk index and Haugh unit, the higher the quality of the eggs.

4.2 Carcass Characteristics

Meat quality characteristics are affected, among others, by genetic factors such as appropriate choice of breed/line or commercial hybrid (Berri *et al.*, 2005; Bianchi *et al.*, 2006; Jaturasitha *et al.*, 2008 a, b; Dal Bosco *et al.*, 2012; ; Zhao *et al.*, 2012; Riedel *et al.*, 2013; Umayá, 2014) and the sex of birds (López *et al.*, 2011).

Another important determinant of meat quality is the slaughter age of birds (Díaz *et al.*, 2012; Tougan *et al.*, 2013). With respect to that, the proportions of major basic carcass parts which are considered as highly valued edible carcass cuts (breast, drumstick and thigh) and less valued carcass parts (wings, back and neck) (Elamin *et al.*, 2014) as well as the presence of certain tissues in them are regarded as vital parameters determining broiler meat quality (Lewis *et al.*, 1997; Sütö *et al.*, 1998; Holcman *et al.*, 2003; Ristic, 2003). The above-mentioned quality traits depend on a number of factors. Of the biological ones, the greatest impact is produced by genotype, sex and age (Lewis *et al.*, 1997; Bokkers and Koene, 2003; Hellmeister *et al.*, 2003

The carcass data of the four breeds is given in (table 12) below. The result showed effect of genotype and sex had significant effect on carcass characteristics evaluated. Mean live weight and highly valued carcass weight (Breast muscle, Thigh and Drumstick leg) were compared and for live weights at the same age, there were highly significant differences among genotypes. The average live weights of *Koekoek*, *Dominant Red Barred*, *Lohmann Brown*, and *Novo Color* are presented in (table 13).

The result of the analysis showed that there were significant differences ($P < 0.01$) among breeds. Exotic meat strains, *Koekoek*, *Dominant Red Barred* And *Novo Color* showed significantly ($P < 0.01$) higher average values for growth, live weight, and carcass cuts percentages (Breast, Thigh and Drumstick) in comparison with the layer type breed Lohmann Brown. Since the goal of genetic selection in modern poultry has been to increase the growth rate and final weight, these results were consistent with the report of (Bramfeld *et al.*, 2003)

Table 12 : Analysis on sex mean and Live weight of the four breeds

Breed	Sex	Mean	Mean \pm SE	CV(%)
KK	M	2206		
	F	1999	2068 ^{ab} \pm 206.21	29.29
DRB	M	2065		
	F	1806	1719 ^c \pm 173.18	17.53
LB	M	1516		
	F	1515	1515 ^a \pm 162.06	14.42
NC	M	2034		
	F	1546	1958 ^c \pm 124.36	24.76

***Means with the same superscript letter in a row are not significantly different; while means with different super script letter in a row are significantly different ($P < 0.01$).**

Table 12 showed the mean live weight of KK (2,068g) were significantly different and higher than that of DRB (1,719g) and LB (1,515g). LB showed the least live weight among the others, it can be explained by the difference in genotypes because Lohmann Brown is a layer so they were not selected for meat type this goes in line with the findings of (Kasetsuwan, 1995). There was no any significant differences ($p > 0.05$) between DRB and NC.

Analysis on sex mean of liveweight showed sex had highly statistically significant effect on body weight in all breeds This goes in line with the findings of (López *et al.*, 2011). Mean body weight of male Koekoek (2,206) was higher than that of females (1,999) followed by Dominant Red Barred which is (2,065) and (1,806) respectively. It could be

concluded that the male chickens had heavier carcasses compared to the female ones. The difference exhibited in terms of the sex influence was statistically highly significant for almost all the traits.

Table 13: Least square means of drumstick breast and thigh muscles.

Breed	Drumstick leg		Breast muscle		Thigh Muscle	
	Mean \pm SE	CV(%)	Mean \pm SE	CV(%)	Mean \pm SE	CV(%)
KK	180 ^a \pm 59.13	25.34	254 ^a \pm 84.12	33.54	129.3 ^b \pm 19.47	35.37
DRB	198 ^a \pm 77.66	34.09	296 ^{ba} \pm 92.36	37.19	116.6 ^{bc} \pm 23.06	32.45
LB	194 ^a \pm 76.67	32.24	255 ^a \pm 89.12	32.33	99.3 ^b \pm 47.67	24.77
NC	178 ^a \pm 48.44	23.01	233 ^a \pm 48.57	21.98	108 ^b \pm 14.00	18.19

***Means with the same superscript letter in a row are not significantly different; while means with different superscript letter in a row are significantly different (P < 0.01).**

The analysis of the significance of differences between the trial chickens in the breast and thigh proportions that the differences was not statistically significant (P > 0.05) in all breeds. The analysis of the significance of differences between the trial chicks in the drumstick and thigh proportions showed that the differences was not statistically significant (P > 0.05) in all breeds. A somewhat higher breast muscle was recorded in DRB and the result showed breast weight of DRB (296g) were statistically different (p<0.05) than the other breeds compared followed by LB

5. DISCUSSION

These breeds (DRB, LB, NC and KK) are hybrid chicken breeds with dual purpose characteristics. They are synthesized from different chicken breeds and are expected to compete with other exotic dual purpose strains. Therefore comparison of our result was made with dual purpose and layer breed used as a reference.

5.1. Egg Quality Parameters

Economically important egg morphometric parameters such as weight, size, albumen and yolk contents are quantitative traits that show continuous variability (Chatterjee *et al.*, 2007; Islam & Dutta, 2010). Egg quality has a genetic basis and the parameters of egg quality vary between strains of hens (Pandey *et al.*, 1986; Silversides *et al.*, 2006), as well as the age of the laying hens (Silversides *et al.*, 2006). Egg traits are influenced by a variety of factors including genetics, hens age, body weight, diet and length of holding period (Silversides, 1994; Silversides and Budgell, 2004; van den Brand *et al.*, 2004).

Genotype has direct influence on egg weight and eggshell characteristics. It is also an established fact that the weight of an egg is a direct proportion of shell, albumen and yolk that it contains and this varies significantly between strains of the bird species (Jones *et al.*, 2010; Momoh *et al.*, 2010). Many authors point out that egg weight depends on genetic and environmental factors (Romanov, 1995; Islam *et al.*, 2001) and nutrition (Melluzi *et al.*, 2000).

The findings are presented and discussed according to the genetic group for overall period, at 25 weeks, 27 weeks 29 weeks 31 weeks and 33 weeks of age. The analysis of variance revealed that the genetic group had significant effect ($P < 0.01$) at different ages on all fifteen traits studied.

Result of the analysis showed egg weight were influenced highly significantly ($P \leq 0.01$) by genotype. The average egg weight of DRB were significantly different ($p > 0.05$)

followed by LB. The genetic differences between breeds for egg weight was also reported by Carter and (Jones 1970), (Potts *et al.*, 1974), and (Arafa *et al.*, 1982) in Barred Plymouth Rock (BPR), and White Leghorn (WL). The highest egg weight of White Leghorn layers is also supported by Amer (1965); Salahuddin and Howliger (1991). It is an established fact that the weight of an egg is a direct proportion of albumen, yolk and shell that it contains and this varies significantly between strains (Pandey *et al.*, 1986). This is due to the significant effect of chicken genotype on specific gravity of the eggs, this findings also reported by Yeasmin and Howliger (1998), and Islam (2006) for indigenous, Nahar *et al.*, (2007), for broiler parent stock and synthetic broiler Onagbesan *et al.*, (2007), Jones *et al.*, (2010) and Momoh *et al.*, (2010) for White Leghorn, RIR and indigenous, and Miazi (2008) for Fayoumi and Sonali chickens. This findings support the present study result.

Results on egg weight also conform to those reported earlier by Islam (2006), Chatterjee *et al.*, (2006; 2007), Niranjana *et al.*, (2008), in naked neck chicken, Olawumi and Ogunlade (2008) for chickens of Nigeria and Jones *et al.*, (2010) for single comb White Leghorn chickens. As regards the other external egg traits, age and strain of the chicken affected egg weight (Finkler *et al.*, 1998; Yeasmin and Howliger (1998); Silversides *et al.*, 2006), feed (Adedeji *et al.*, 2008).

The findings are presented and discussed according to the genetic group and age for the overall period, at 25, 27, 29, 31 and 33 weeks of age. The analysis of variance revealed that the genetic group had significant effect ($P \leq 0.01$) at different ages in all fifteen traits studied. Egg weight variations in different genetic groups were reported by many authors (Washburn 1990; Padhi *et al.* 1998; Chatterjee *et al.*, 2007a). The egg weights gradually increased as age increases showing the positive correlation between egg weights and age. The genetic differences between strains for egg weight was also reported by Carter and Jones (1970); Potts *et al.*, (1974); Arafa *et al.*, (1982).

Generally, the standard chicken egg weight is 61g (Arthur and Sullivan 2005) however, the weight may differ from one region to another. For instance, medium EWT for US and

Africa is 55-65g and 49-56g ,respectively (FAO 2000).This goes in line with the present findings,of mean egg weight (40-56g). The egg weights gradually increased as age increases showing the positive correlation between egg weights and age Onunkwo and Okoro (2015). The increase in EWT has affected the eggs to become more round (Monira *et al.*, 2003; Anderson *et al.*, 2004). Minimum weight requirements in the United States for these categories are: jumbo (68.6 g), extra-large (61.5 g), large (54.4 g), medium (47.3 g), small (40.3 g) (Zeidler, 2002).The result disagree with the findings of Fletcher *et al.*,(1983) which showed that as egg size increases, so does the percentage of albumen. The mean egg length recorded in the present study were (49.59-57.96) . The result showed an increasing trend in egg length which again may be due to genetic reasons and age effect .This goes in line with the findings of Chineke (2001) and Oke *et al.*,(2004) in Olympia Black laying variety and Pearl variety of guinea fowl reported an increasing trend in egg length with age and an increase in egg weight The following Researchers have also reported increases in egg length as age increases Gerstmayr and Horsli (1990); Olori and Sonaiya (1992); Austic and Neslieim (1990); Asuquo (1994)in Olympia Black laying variety;.

The values obtained in the study for yolk index ranged from(0.6-0.78) This value was higher to the value reported Oluyemi and Robert (2000) who reported that the yolk index which is a measure for determining the quality of an egg yolk should be between (0.30-0.50). Yolk index value recorded in the present study was higher than this range.

The mean average yolk weight ranged from (10-17g) in this study Nobakht and Mehmannaavaz (2010) reported that increasing yolk weight was the main reason for the increment in albumen .Nobakht and Moghaddam (2012) also noted a positive correlation between Haugh unit and quality of egg components (yolk and albumin). Egg albumen height and egg weight are indices for evaluation of Haugh unit. Indeed, increase in egg weight is related to increase in albumen weight and yolk weight. The present result showed an increase in yolk weight which confirmed the above findings.

Haugh unit is the measure of albumin quality which determines the quality of the egg. and in this study, genotype had significant ($P < 0.01$) effect on Haugh unit. A Haugh Unit value of 79 and above is an indication of good quality, Brandt *et al.*, (1991) also reported that eggs of inferior quality have Haugh Unit of less than 40%. The higher the value of the Haugh unit, the better the quality of eggs, which are classified according to the United States Department of Agriculture (USDA) as AA (100 to 72), A (71 to 60), B (59 to 30) and C (below 29) (USDA, 2000), in which the refrigerated eggs are classified as AA. Oluyemi and Robert (2000) also reported that unit score of 72 and above has been graded as the best quality.

The quality of the egg regarding the Haugh unit in the current study was (73.2-82) shows an increasing. A decrease in Haugh unit towards later part of the laying cycle were reported by (Niranjan *et al.*, 2008) and Rajkumar *et al.* (2009), which is inconsistent with the findings. Decrease in Haugh unit score at later part of the egg laying in broiler breeder also reported by Tumova and Gous (2012).

Nobakht and Moghaddam (2012) reported a positive correlation between Haugh unit and quality of egg components (yolk and albumin) this goes in line with our findings. Egg albumen height and egg weight are indices for evaluation of Haugh unit. The Haugh units reported for this study are in disagreement with Chatterjee *et al.* (2006) who reported lower Haugh unit values; (59.62 to 71.62) for the White Leghorn strains. This study also indicates that Haugh unit differ significantly ($P < 0.05$) at different ages at different genotypes.

Egg shell weights have been shown to both increase and decrease as the hen ages, following no specific pattern (Silversides, 1994; Silversides and Budgell, 2004; Popova-Ralcheva *et al.*, 2009). The present study on shell weight differ significantly ($p < 0.05$) at different age of measurement, however it shows an increasing fluctuating trend following no specific pattern and the mean egg shell weight recorded ranged from (5.04-6.88). Increase in shell weight with age advances were reported by (Rajkumar *et al.*, 2009).

Similar shell weight in Korean native chicken was reported by Suk and Park (2001), and in Naked neck birds by Rajkumar *et al.*, (2009).

Egg width shows an increasing trend in all weeks and the average egg mean egg width ranged from (37.51-52.5).The following Researchers reported increases in egg width: with age advances Gerstmayr and Horsli (1990); Olori and Sonaiya (1992; Austic and Neslieim (1990); and Asuquo (1994) in Pearl variety.

The egg shell quality is given throw the weight and the percentage of shell, thickness and the strength. The differences in eggshell quality depend on the environmental conditions and the feed quality and also of strain of layers (Zita *et al.*, 2009). One of the main concerns is a decrease in eggshell quality as the hen ages, due to an increase in egg weight without an increase in the amount of calcium carbonate deposited in the shells. For this reason, the incidence of cracked eggs could even exceed 20% at the end of the laying period (Nys, 2001).

Good shell thickness is an important bio economic trait in commercial egg production as it may help to reduce the percentage of cracked eggs and decrease the rate of loose for producers.. In the present study, shell thickness was in the range (0.35-0.38)while shape index was (74-80) which is almost close to the reports of ISA (2009), reported that the minimum shell thickness of 0.35 and shape index of 74 is indicators of quality egg. Also according to Oluyemi and Roberts (1979) factors like nutrition and environment may affect shell thicknessScott and Silversides (2000) also reported the structural quality of the shell egg is important to the processor because eggs that are structurally sound will arrive to the consumer in the best condition.

Furthermore, high interior quality is of importance to egg products manufacturers because it allows for better separation of components without crossover contamination. The shell thickness values reported in this study (0.35 – 0.38mm) is close to the values (0.35 – 0.37 mm) reported by (Oluyemi and Roberts 2000). However the present finding shows a decreasing trend in all weeks. And there was no significant effect in all breeds

except week 31.(Khan *et al.*,2004) reported no significant effect of breed on eggshell thickness under semi scavenging condition. (Potts *et al.*, 1974; Anderson *et al.*, 2004) also reported that Egg shell thickness measurement typically has little variation across similar breeds.An eggshell thickness of at least 0.33 mm has been estimated to be necessary for the egg to have at least a 50% chance of withstanding normal handling conditions without breaking (Stadelman, 1995). The study also goes in line with the findings (Chatterjee *et al.*,2007b)for different chickens of Bangladesh. (Parmar *et al.*, 2006) reported that Non significant variation in shell thickness between reciprocal crosses of ILI 80 and Brown Nicobari was observed . Oke *et al.*,(2004) reported values which portrayed a decreasing trend in Pearl variety. Findings of Oke *et al.*,(2004) agrees with the present findings.The study is in contrast with The findings of Chineke (2001) who reported similar trends in the shell thickness of the Olympia Black laying.

Albumen weight showed significant ($P < 0.05$) difference between genotype as age advances. A decreasing trend in albumin weight were also found. The mean albumin weight recorded in this study ranged from (23.2-31.93g).Decrease in albumen weight at 40 weeks compared to 28 weeks also reported by Rajkumar *et al.*, (2009) this goes in line with the present findings the study and disagree with observation with (Zhang *et al.*,2005) ,(Aygün and Yetisir 2010) and (Oke *et al.*,2004) whose values showed an increasing trend in guinea fowls and Chineke (2001) who also reported increases in albumen weight in the first three weeks of egg production in Olympia Black laying variety. An increase in albumen weight with increase in age was reported by Silversides *et al.*,(2006) and (Parmar *et al.*, 2006) reported albumin weight of 20.74 g in Kadaknath birds which was significantly lower than the present findings. The study disagree with reports of (Harms and Hussein, 1993) that albumin weight had been reported to be more closely associated with egg weight than yolk weight.

It is accepted that the lesser the surface of egg white dense and the more its height, the better is the egg. The height of egg white (albumen) in fresh egg should not be less than 0.5cm ((Maria and Dmowski 2005).The thicker the albumen, the better the quality of the egg, with heights of 8 to 10 mm being considered superior interior quality (Zeidler,

2002).in the present findings there were significant differences ($P \leq 0.01$) on genotype, and the mean albumin height recorded ranged from (8.8-12.73mm) an increasing fluctuating trend were also found in LB. The height of the inner thick albumen when the egg is broken onto a flat surface has largely defined the quality of sound eggs for many years because it is easily measured and relates well to the freshness of the egg. The Haugh unit (Haugh, 1937) exemplifies measures of albumen height. A study by Solomon (1991) confirmed the known fact that egg quality deteriorates with the age of hens. In our study, regardless of hen's genotype, eggs from young hens were characterized by significantly higher Haugh units and albumen height, which is indicative of their better quality and agrees with the findings of (Van den Brand *et al.*,2004) with L and C dual purpose lines in Netherlands and Czaja and Gornowicz (2006) found differences between hen varieties. poor quality of albumen at 72 weeks of age with Ross 308.

This findings goes in line with our findings a decrease in albumen height as the age advances ,also reported by (Rajkumar *et al.*,2009). Silversides and Scott (2001) showed that albumen height is biased by the age and strain of hen. Decrease in albumen height and increase in albumen width as the age advances also reported by Rajkumar et al., (2009).Albumin height will decrease as a hen ages (Doyon *et al.*, 1986; Williams, 1992; Silversides, 1994; Ledur *et al.*, 2002; van den Brand *et al.*, 2004). As a laid egg ages, the AH also will decrease (Silversides, 1994; Silversides and Budgell, 2004). Besides shape index and egg weight, (van den Brand *et al.*, 2004).

Yolk colour is subjectively determined by the use the Roche colour fan (Stadelman, 1995; Vuilleumier,1968).And is influenced so heavily by the diet, the age and breed of then hen has little influence (Galobart *et al.*, 2004).Egg yolk color is a very important factor in consumer satisfaction and influences human appetite (Amerine *et al.*, 1995), with a preference for golden yellow to orange yolk color (Hasin *et al.*, 2006). Similarly.(Jacob *et al.*,2000) noted that yolk color is a key factor in any consumer survey relating to egg quality. consumer preferences for yolk colour are highly subjective and vary widely from country to country. Yolk color is used as a quality determination factor but is nearly entirely dependent on the diet and is easily manipulated (Hunton, 1995). In

the present study There were no significant differences in yolk colour for all the groups according to Roche yolk colour fan assessment.

The colour of the yolk scores indicated very light (Pale) coloration this could be attributed to the nature of management of the laying hens. Previous researches have indicated that yolk colour of an egg depends on the type of diets (Garba *et al.*.,2010), system of production and housing system (Hasin *et al.*., 2006). The yolk colour values found in the current study for the four genotypes was in disagreement with the reports by (Niranjan *et al.*, 2008) and (Rajkumar *et al.*, 2009) that yolk colour showed significant ($P<0.05$) difference between different age of measurement and more intense colour was observed at 64 weeks of age variation in yolk colour at different ages. The present study was inconsistent with variation in yolk colour at different ages which was reported by Niranjan *et al.*, (2008) and Rajkumar *et al.*, (2009). (Oluyemi and Roberts 2000) reported that yolk has been reported to be affected by environmental factors than genetic factors.

Hen age has been shown to increase yolk weight (Van den Brand *et al.*, 2004) albumen weight (Suk and Park, 2001). the present findings in yolk weight showed significant ($P<0.05$) differences at different age of measurement and as the age advances along with egg weight the yolk weight increases. Increase in yolk weight with increase in age in chickens were reported by (Suk and Park, 2001; Silversides *et al.*, 2006; Niranjan *et al.*, 2008; Rajkumar *et al.*, 2009). The average values for yolk weight of those four chicken breeds in this study were significantly different. And the mean yolk weight recorded ranged from (11.08-16.75g). The DRB birds produced heavier yolk followed by NC and these results goes in line with the findings of Silversides and Scott (2001) and Silversides *et al.*, (2006) who observed that yolk weight of different breeds differed significantly.

The present findings also agree with the reports of Nobakht and Mehmannaavaz (2010) which showed an increasing yolk weight was the main reason for the increment in albumen weight in their report. The study also goes in line with The findings of (Tulin and Ahmet 2009), (Parmer *et al.*, 2006) and (Chatterjee *et al.*, (2007a) reported higher yolk weights in Naked Neck, Barred Desi and Frizzle Fowl From yolk characteristics of

eggs, breed significantly affected yolk weight ($P \leq 0.01$). The height of yolk over 1.6cm and its spherical shape characteristics indicates a freshness of an egg (Maria and Dmowski 2005). According to Pandey *et al.*, (1986), the weight of an egg is a direct proportion of albumen, yolk and shell that it contains and this varies significantly between strains of hen. Oke *et al.*, (2004) reported values that showed somewhat increasing trend which agreed mostly with the present report for Pearl variety. This study reported mean yolk height values ranged from (1.7-2.2cm) which is greater than 1.6cm, therefore likely confirmed freshness of the egg samples used during the study period.

Egg shape is an important parameter in the poultry industry for uniformed package of eggs during transportation over long distances by reducing possible breakage of eggs. Eggs with higher shape index percentages are more circular in shape than that of eggs with lower shape index percentages (Silversides, 1994). However, the shape index was not referred to be a good estimator for the shell thickness and the shell ratio the egg shape index would be used as a criterion for determining the stiffness of eggshell. Yannakopoulos, A. and Tserveni-Gousi, A. (1986). The findings of (van den Brand *et al.*, 2004), lead us to anticipate a decrease in SI, from sharp to normal, as hen's age. Shape index is the ratio of the width to length of the egg.

According to Nikolova and Kocevski (2006), aging hens tend to lay elongated eggs, the shape indices of the four breeds had no significant difference ($P < 0.05$) in the present study. The decreased shape index with increasing egg weight in this findings was supported by Reddy *et al.*, (1979). The genetic difference between strains for shape index was reported by Potts *et al.*, (1974); Arafa *et al.*, (1982). This is in agreement with the findings of Belyavin and Boorman (1981) who observed that elongated (low index) and heavier eggs were more prone to cracking.

The present study finds the shape index values observed among those four breeds in the present study did not showed any significant ($P < 0.05$) difference between different age of measurements shape index shows a fluctuating trend in all weeks.. This goes in line with the findings of Tumova and Gous (2012) reported no significant effect of age on shape

index in broiler breeder and laying hen. The present study is in agreement with (Bekele *et al.*,2010) who reported for crosses Fayoumi with naked neck and RIR with local White feathered chickens. According to (Romanoff & Romanoff 1949), the standard eggs from hens had a shape index of 74% with blunt and pointed ends elongated eggs have lower shape index while rounded eggs have higher value. In this study the shape index ranged from (74-80).

Lower shape indices of 74.35 and 75.52 were reported by Parmar *et al* (2006) in Kadaknath and Shakuntaladevi and Reddy (2004) in White Leghorn layers, respectively. Chatterjee *et al.*,(2006) observed higher shape index, 80.76 ± 1.32 for IWK and lower indices for IWI (73.77 ± 3.08) and IWH (72.67 ± 7.56) strains of White Leghorn. Padhi *et al* (1998) reported lower shape indices in White, Brown, Black Nicobari birds. Chineke (2001) reported an egg index with similar trend in Olympia Black laying variety. Oke *et al.*, (2004) reported egg index values in Pearl variety of guinea fowl which increased for about six weeks after the onset of lay and fluctuated thereafter. This observation contradicts the report of this study.

Yolk index values range from 0.36 to 0.46 further indicated freshness characteristics of eggs from species of the laying hens. Since, according to Maria and Dmowski (2005) yolk index not lower than 0.30 characterize a fresh egg. Oluyemi and Robert (2000) reported that the yolk index which is a measure for determining the quality of an egg yolk should be between 0.30-0.50. which is lower than the present study i.e.(0.58-0.8). Yolk index showed significant ($P < 0.05$) difference between different age of measurement. However,Fluctuating trends was observed in LB Yolk index values were higher than the report of Chatterjee *et al.*,(2007) and Rajkumar *et al.*,(2009).

In Lohmann Brown The yolk indices were significantly higher in all weeks except at week 33. Yolk index (YI) varied ($P < 0.05$) in each of the four strains. The result showed a fairly increasing trend with slight fluctuations. The similarity in trend may again be due to genetic reasons (Chineke, 2001).’ (Adeogun and Amole 2004). They also reported that the higher the yolk index and Haugh unit, the higher the quality of the egg. Yolk index values

were significantly influenced by the genetic groups ($P < 0.01$) in all ages. This increased trend observed in the yolk index in this findings implies that the yolk height increased as the yolk diameter decreased over time.

The percent of yolk differ significantly ($P < 0.05$) between different age of measurement and as the age advances the yolk % increases in the eggs. This indicates that in later part of egg laying the egg contain more yolk compared to albumen so the eggs are more useful for the product which needs more yolk. However, the lower yolk % at early ages may be suitable for the consumer who needs less yolk % and can be use for table purpose. This study finds an increase in yolk ratio and an increasing trend in all weeks and the average yolk ratio ranged from (27-33). An Increase in yolk % compared to early ages is in agreement with the reports of Silversides and Scott (2001) and Tumova and Gous (2012). The yolk % is affected by breed or strain within a breed, age of hen and egg size (Campo, 1995; Suk and Park, 2001).

This study findings led to conclude the albumen% decreases as the age of measurement increases. Decrease in albumen % as age advances is in agreement with the report of Silversides and Scott (2001). However, the % of albumen was lower in the present findings. Tumova and Gous (2012) reported lower albumen % in broiler breeder than the laying hens. Shell ratio did not showed significant ($P < 0.05$) difference between different age of measurement. Yolk to albumen ratio differ significantly ($P < 0.05$) between different age of measurements and the ratio increases as the age advances indicating the yolk contents increases as the age advances compared to the albumen content. The present finding is in agreement with the report of Suk and Park (2001) in Korean native fowl. The eggs with heavier yolk and larger Yolk: albumen ratio are likely to contain more cholesterol, however these eggs on per gram of yolk basis may not differ in the levels of cholesterol in the yolk (Suk and Park, 2001).

5.2 Carcass Traits

Carcass yield is affected by a number of factors including genetic factors such as appropriate choice of breed/line or commercial hybrid (Berri *et al.*, 2005; Bianchi *et al.*,

2006; Jaturasitha *et al.*, 2008 a, b; Dal Bosco *et al.*, 2012; Zhao *et al.*, 2012 ;Riedel *et al.*, 2013; Umayya, 2014;), feed, slaughtering conditions, live weight and sex (Young *et al.*, 2001; Havenstein *et al.*, 2003). Some of the most important factors affecting the quality of poultry meat are origin and slaughter age.)the result showed drumstick weight of DRB(198gm)was statistically different ($p<0.05$) than the other breeds compared ,(Brickett *et al.*, 2007). and the sex of birds (López *et al.*, 2011).

Genotype and age , These two main factors have also shown to influence the carcass traits of breast and thigh meat (Andrassy-Baka *et al.*, 2003).In commercial chickens the yield of most carcass parts depends on the slaughter age. Brake *et al.*, (1993) and Young *et al.*, (2001) noticed larger parts of breasts in older chickens. In addition, several studies have shown that low live weight has been associated with low carcass yield (De Marchi *et al.*, 2005; Fanatico *et al.*, 2005b; Moujahed and Haddad, 2013). Nielsen *et al.*, (2003) reported that slow-growing chickens were characterized by a significantly lower breast yield, but higher yield of thigh and drumstick muscles than fastgrowing chickens. In a similar study, breast and drumstick leg yield of slow-growing chicken ranged from 10.4% to 26.0% and 24.6% to 37.4%, was relatively lower than those of other breeds such as Padovana (De Marchi *et al.*, 2005) and Tunisian local chickens (Moujahed and Haddad, 2013). Because four genotypes used in this study were raised under identical rearing and feeding conditions, low carcass yield and parts of our study are attributed to low live weight of chickens.

In this study there were highly significant differences among genotypes. Jaturasitha *et al.* (2008) also reported that a liveweight of 1,100 g at 16 weeks of age in the indigenous strain of Thailand crossbred chicks (TH x Rhode). These results are expected since the goal of genetic selection in modern poultry has been to increase the growth rate and final weight (Bramfeld *et al.*, 2003).

Meat from hen was rougher in texture and tougher than those of female (Jacob And Mather, 2000). Based upon the data in this study (Table12) The differences exhibited in terms of the sex influence were statistically highly significant. It could be concluded that

the male chicks had heavier carcasses compared to the female ones. This goes in line with the carcass weight in the studies by Bilgili *et al.*, (1992), Moran (1995), Ristic (1995), Melo *et al.*, (1996), Ozkan *et al.*. (1997) as well as by a large number of other authors was significantly higher in the male chicks compared to the female ones, being the result of large differences in body weight. Horn *et al.*, (1998) stressed that the coefficient of live weight variation increased more in male chicks compared to the females with the less pronounced increase. for live weights at the same age, In commercial chickens the yield of most carcass parts depends on the slaughter age. Brake *et al.*, (1993) and Young *et al.*, (2001) noticed larger parts of breasts in older chickens. Likewise, Young *et al.* (2001), who studied Ross × Ross chickens at 37, 39, 42, 44, 46, 49 and 51 days of age, found that the yields of thighs, forequarters, breasts, and fillets increased as slaughter age increased.

In this study, the results showed that Koekoek, and Dominant Red Barred had significantly ($P < 0.01$) higher average values for growth, carcass weight, and carcass cuts percentages (breast, thigh and drumstick) in comparison with the Lohmann Brown . These are in agreement with the previous studies conducted by); Sharma *et al.*, (1971); Chhabrad and Sapra (1973) Tibin and Mohamed (1990) ; Hassan *et al.*, (2006). with exotic meat strain of Hybro and Hubbard and . although Hubbard exhibited higher dressing percentage than Hybro, the two strains showed similar results for breast, drumstick and leg. Most dual purpose breeds had a significantly higher percentage of edible products than layer hybrids. both Hybro and Hubbard exhibited higher average values for growth, carcass weight, and carcass cuts percentages in comparison with Bare-neck, Large Beladi and Betwil Thai chicken ecotypes, This was also confirmed by Rizzi *et al.*, (2007) who found that at 44 week of age, on 2 Italian dual-purpose breed they had significantly heavier breasts, thighs, and drumsticks than hybrid hens. However in contrast with the present result, Franco *et al.*, (2012) in their work with the native Mos rooster and the hybrid Sasso T-44 concluded that although live weight and carcass weight were higher in the hybrid line, Mos breed had a significantly higher percentage of edible products than Sasso T-44.

In this study, although KK exhibited higher live weight than DRB, the two strains showed similar results for drumstick, and thigh muscles and the proportion of the highly valued edible carcass cuts (breast, thigh and drumstick) is relatively low in LB. On the other hand, significant differences ($P < 0.01$) were observed among the Dual purpose breeds for live weight, thigh and drumstick weight. This variation indicates that selection for increased body weight and carcass characteristics among these breeds is possible. Breast yield was not significantly different among breeds, as thigh and drumstick yield was higher in KK than in DRB.

Sabbioni *et al.* (2006) Reported that Carcass characteristics ,Carcass weight and carcass yield of white-mini broiler were greater than the carcass yield of silky fowl. The carcass yield of 4 breeds of local chicken was slightly lower than that reported for Italian local chickens (De Marchi *et al.*, 2005) and Benin local chickens (Youssao *et al.*, 2012), and markedly lower than that reported for commercial broilers (Zhang *et al.*, 2010; Panda *et al.*, 2010).

6. CONCLUSION AND RECOMMENDATIONS

A statistically significant difference was found aboth in egg quality and carcass traits evaluated. Genotype affected both the external and internal egg quality traits and highly valued carcass cuts between the different dual purpose laying type breeds.

The result showed that egg quality characteristics and carcass traits vary from breed to breed. This indicates not all chicken genotypes perform the same. Dominant Red Barred eggs were heavier than Lohmann Brown eggs. The differences were also found for egg shell, albumin and yolk weights. though yolk colour was not affected by breed. The carcass data shows statistically significant differences were found on live weight and carcass cut parts this is mainly due tosex and genotype.

In conclusion genetic variation significantly affected both the external and internal egg qualities and highly valued carcass cut parts (breast ,thigh and drumstick) . Some of the major egg quality traits (i.e., Egg weight albumin and yolk weight) were better in the dual purpose layer type breeds.

Based on the above conclusion, the following recommendations are forwarded:

- ❖ Further studies are required to assess the genotypic effect between different breeds which will help in determining the best selection program for production of eggs with optimum quality and carcass traits.
- ❖ As dual purpose chicken had good egg and carcass traits, they can be used in semi-commercial poultry production system.
- ❖ It is therefore recommended to use breeds with better egg and carcass traits for production.
- ❖ Further, researches should be conducted to compare the effect of environment, management (feed) and breed.

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8. APPENDICES



Appendix Figure 1 : Double yolk (left) and Egg quality measurement instruments



Appendix Figure 2 : Dominant Red Barred (left) and Koekoek (right)



Appendix Figure 3: Novo color



Appendix Figure 4 : Dressed Carcass Weight



Appendix Figure 5 : Birds dry de-feathered by hand plucking,

Appendix Table 1 : Egg quality parameter data collection sheet

Date of hatch _____

Week _____

	DRB	LB	NC(novo color)	KK
External egg quality parameter	Egg no	Egg no	Egg no	Egg no
Egg weight (gm)				
Egg length (cm)				
Egg width (cm)				
Egg shell color				
Shell weight (gm)				
Shell thickness (mm)				
Internal egg quality parameters				
Yolk color (1-15)				
Albumen height (mm)				
Yolk height (mm)				
Albumen weight (gm)				
Yolk weight (gm)				
Presence of meat spot and blood spot				

Appendix 2 : Carcass measurement data collection sheet

Date-----

Date of hatch-----

Breed		Week		
Body parts	Male	Female	Female 3	
Live weight (kg)				
Slaughter weight(kg)				
Dressed weight(kg)				
Blood weight(kg)				
Feather weight(kg)				
Head weight(kg)				
Shank weight(kg)				
Skin weight(kg)				
Wing weight (kg)	Right			
	Left			
Thigh and drumstick(kg)	Right			
	Left			
Thigh weight(kg)	Right			
	Left			
Drumstick weight(kg)	Right			
	Left			
Breast weight(kg)				
Neck weight (kg)				
Back weight(kg)				
Spleen weight(gm)				
Giblets weight (kg) (liver ,gizzard and heart)				
Length of intestine (kg)				
Fat weight (if any) (kg)				

Appendix 3 : Time schedule for vaccination

Day	Week	Name and type of vaccination	Route of administration
0	1	Marek's	Subcutaneous
0	1	NCDV(HB1)	Ocular(eye droplet)
7	1	Gomboro	Drinking water
21	3	Gomboro	Drinking water
27	3	NCDV(lasota strain vaccine)	Drinking water
45	6	Fowl typhoid	Subcutaneous
63	8	NCDV(lasota strain vaccine)	Drinking water
90	12	Fowl typhoid	Subcutaneous
105	14	Fowl pox	Wing-web
120	16	NCDV(lasota strain vaccine)	Drinking water

Appendix 4 : Ingredients of the starter, grower and layer diets

Ingredients	Chicken age group		
	Starter	Grower	Layer
Maize	44.3	57.36	49.25
Nuge cake	8.2	9	9
Wheat bran	23.2	22	23
Soya been	20	7	6.50
Salt	0.4	0.4	0.4
Lime stone	0.7	0.7	7
Vitamin	0.5	0.5	0.5
Meat and bone meal	2	2	4
Lycin	0.25	0.28	0.28
Methionin	0.15	0.1	0.7

ME=2,750 Kcal ME/Kg, CP=17.5%

Source: DZARC

STUDY ON MEAT AND EGG QUALITY OF DIFFERENT CHICKEN BREEDS AT
DEBREZEIT AGRICULTURAL RESEARCH CENTER

Submitted by: Lishan Takele Alemu _____

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