UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF AGRICULTURE EDUCATION

DEPARTMENT OF ANIMAL SCIENCE EDUCATION

MAMPONG - ASHANTI

EFFECTS OF STRAIN AND NON-GENETIC FACTORS ON GROWTH AND REPRODUCTION, EGG QUALITY AND CARCASS CHARACTERISTICS OF INDIGENOUS GUINEA FOWL (*Numida meleagris*)

BY

ZAGBEDE GODSON ARYEE

B.Sc. (AGRICULTURE EDUCATION)

JULY, 2016

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF AGRICULTURE EDUCATION

DEPARTMENT OF ANIMAL SCIENCE EDUCATION

MAMPONG - ASHANTI

EFFECTS OF STRAIN AND NON-GENETIC FACTORS ON GROWTH AND REPRODUCTION, EGG QUALITY AND CARCASS CHARACTERISTICS OF INDIGENOUS GUINEA FOWL (*Numida meleagris*)

BY

ZAGBEDE GODSON ARYEE

(8142030001)

(B.Sc. AGRICULTURE EDUCATION)

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF PHILOSOPHY (M.PHIL) IN ANIMAL SCIENCE (ANIMAL BREEDING AND GENETICS)

JULY, 2016

DECLARATION

STUDENT'S DECLARATION

I, Zagbede Godson Aryee, hereby declare that with the exception of references to other people's work which have been duly acknowledged, this thesis is the result of my own work and it has neither in whole nor partially been presented elsewhere.

…………………………………… ………………………

ZAGBEDE GODSON ARYEE DATE

SUPERVISORS' DECLAREATION

I hereby declare that the preparation of this thesis was supervised in accordance with guidelines and supervision of thesis laid down by the University of Education, Winneba.

……………………………. . …………………………......

PROF. S.Y. ANNOR DATE

(SUPERVISOR)

ACKNOWLEGEMENT

To God Almighty I give all the glory for seeing me through this work. I am most grateful to my Supervisor, Prof. S.Y. Annor (Dean of Faculty of Agriculture Education and Graduate School Coordinator) for his constant and continuous fatherly advice to me. He spent his valuable time with me to analyze my results and his periodic visit to my experimental site to see the progress of my work. His pieces of advice, invaluable comments and suggestions indeed gave me the momentum to successfully complete this work. Many thanks equally go to Prof. James Kagya-Agyemang, the Principal, College of Agriculture Education, University of Education, Winneba, Mampong-Ashanti for his constant encouragement. In the same virtue, I thank Mr. F.W.K. Amenyedzi and Mr. Benedict Osei-Owusu for spending valuable time to read through my project work and assist me financially respectively. Similarly, I am thankful to Mr. Thomas Quaye, Mr. Hudu Seidu and Mr. Larry Tay, who enthusiastically offered me help at every moment in time during my practical work from dawn to dusk.

Finally, my thanks also go to fellow postgraduate students Mr. Addison Duodu (PhD student), Rev. Fr. Korankye (PhD student) and Mr. Eric Arhin (MPhil student) for their encouragement, support and above all their valuable criticisms. To all other workers at the animal farm and all who in one way or the other have contributed to the success of this work, I say thank you, and God richly bless you.

DEDICATION

I dedicate this thesis to the Almighty God and My Aunty, Mrs. Juliana Kpekpena Amevorku.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Little scientific research has been carried out on local Guinea fowls to estimate average values of traits and effects of genetic and environmental factors on these traits. The objective of this study was to investigate the effects of strain and non-genetic factors on growth, reproduction, egg quality and carcass characteristics of indigenous Guinea fowl. The study was carried out at the Poultry Section of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti campus, Ghana, from 2015 to 2016. Four strains of local Guinea fowls; namely Pearl, Lavender, White and Black were used. Three non-genetic factors were considered; season of hatch, generation and sex of bird. Data were collected on 603 local Guinea fowls to estimate average values of traits. Data were analysed with the General Linear Procedure (GLM) of SAS. Results obtained showed that parental generation was significantly($p<0.05$) higher than the first filial generation in 6 months body weight, daily feed intake and feed conversion ratio. The female birds had significantly ($p<0.05$) better 6 months weight, daily weight gain and daily feed intake than the male birds. The strains of the birds significantly ($p<0.05$) influenced the growth indicators. Lavender strain had the highest (240.57±9.73) total weight gain compared to black (214.65±12.64), white (212.75±15.06) and pearl (207.265±7.1) strains. Parental generation (37.9±3.98) had significantly ($p<0.05$) better egg weight than the first filial generation (37.64±0.93). Hatchability and fertility were significantly ($p<0.05$) influenced by strain of birds. Pearl had the highest (66.77±1.93) fertility than black (59.36±4.8), lavender (58.11±3.75), and white (56.83±4.59). The highest (27.29±2.05) hatchability was recorded by pearl, followed by black (25.73±5.09), lavender (18.83±3.98) and white (12.5±4.89). Parental generation birds (13.7±0.24) had significantly ($p<0.05$) better yolk weights than first filial generations birds (13.2±0.21). White strains had significantly ($p<0.05$) had highest (79.04±2.49) Haugh unit, followed by lavender (77.67±2.03), black (76.51±2.49) and pearl (71.14±1.2). Generation had significant ($p<0.05$) influence on live and dressing weights. The interaction of sex and strain had significant ($p<0.05$) influence on live, heart and intestine weights. Strain had significantly ($p<0.05$) influence on moisture and carbohydrate. In conclusion, the genetics (strains) and non-genetics factors (Sex, season and generation) influence the growth, reproductive, egg quality and carcass quality of local guinea fowl, hence the effects of these factors must be considered in genetic selection of indigenous Guinea fowls.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Guinea fowl (*Numida meleagris*) is usually kept for both meat and egg production (Smith, 2001). In comparison with other poultry species, the meat production ability of the Guinea fowl is more favourable. Due to dark gamey taste and colour of the meat, it is preferred to other meats. Guinea fowl is a low cost meat resource with a higher carcass yield of 68 to 89 percent (Ayorinde, 1991), which is slightly higher than that of the domestic fowl broiler. Consumption of Guinea fowl products are highly accepted in every cultural setting (Saina *et al.*, 2005). As a result of the wild game flavour of the meat, it sells better at hotels and restaurants than chicken meat (Feltwell, 1992). Guinea fowls also play other important roles in the social life of many tribes. Among the Dagombas and Gonjas in the Northern part of Ghana, Guinea fowls are used for annual Guinea fowl festival (Teye and Adam, 2000). The pure, white fowl is used for religious sacrifices and to perform certain funeral rites. Customarily, the Frafras, Dagabas, and Bulsas use Guinea fowls to welcome mothers-in-law (Teye and Adam, 2000). Guinea fowls are reported to be less susceptible to most poultry diseases (Koney, 1993; Teye and Adam, 2000). The eggs are very popular and common on the market from May to July. Their thicker shells give them an obvious advantage for longer storage and handling with less breakage (Teye and Adam, 2000).

A research by Nsoso *et al.* (2006) indicated that information on Guinea fowl production is rather lacking in Botswana, which hampers rapid development of this industry; this same problem is also noted in Ghana (Teye and Adam, 2000).

The economic importance of production traits such as body weight, feed intake, feed conversion efficiency suggest the need for these traits to be considered in selection objective in breeding programmes. It is therefore necessary to understand the genetic behaviour of these traits and their relationship to other production traits that are used as selection criteria in animal breeding programs (Gaya *et al.*, 2006). Improved local poultry production is necessary to achieve a poultry industry that is both economically viable and self sustaining (Nwachukwu *et al*., 2006). The performance of the local poultry breeds can be improved through directional selection and improved management and nutrition. Selecting and concentrating favourable indigenous poultry genes that confer productive adaptability would greatly enhance productivity (Nwachukwu *et al*., 2006). It is reported that, 90% of phenotypic changes in poultry comes as a result of genetic progress (Havenstein *et al*., 1994). To effectively utilize existing local poultry resources to improve poultry production, knowledge of the degree of genetic variation in productive traits in populations of local breeds such as local Guinea fowls as well as the influence of genetic factors and the non-genetic factors are required (Nwachukwu *et al*., 2006).

1.2 Problem Statement

Guinea fowl production has the potential of becoming an integral part of the Ghanaian local poultry industry, especially in the three (3) northern regions of the country. This is because Guinea fowl is locally accepted as a food product and consumption of its meat and eggs are not restricted by any religious taboos (Saina *et al.*, 2005). Embury (2001) reported that Guinea fowl production has already been proven to be profitable in many European countries like Canada, France and Italy. This is as a result of successful genetic selection for economically important traits which has brought considerable progress in growth rate, body conformation and composition and laying performance of Guinea fowl strains in these regions. Though, there is a ready market for Guinea fowl and its products in Africa (Nahashon *et al*., 2006), studies that aim at improving Guinea fowl are very few in the region.

Moreover, little scientific research has been carried out on local Guinea fowls to estimate average values of traits and effects of genetic and environmental factors on these traits. It is therefore necessary to understand the genetic behaviour of these traits and their relationship to other production traits that are used as selection criteria in animal breeding programs (Gaya *et al*., 2006). Improved local poultry production is necessary to achieve a poultry industry that is both economically viable and self sustaining.

According to Teye and Adam (2000), large-scale commercial Guinea fowl production in Ghana has not been possible due to lack of genetically improved source of good quality day old keets to be distributed to the farmers. Also it has been reported that the small body size of the local Guinea fowl as compared to the bigger body size of the European breeds is a great setback to commercialization of Guinea fowl production in Ghana (Annor *et al*., 2013). To effectively utilize existing local poultry resources such as local Guinea fowl to improve poultry production, there is the need to understand the effect of genetic and environmental factors on growth, reproduction and carcass characteristics of these poultry birds.

1.3 Objectives of the study

1.3.1 Main objective

The present study was conducted to evaluate the effect of strain and non-genetic factors on growth performance, reproduction, egg qualities and carcass characteristics of local Guinea fowl.

1.3.2 Specific objectives

The specific objectives of the study were to evaluate the effect of:

1. strain on growth, reproductive, egg quality and carcass characteristics.
2. sex on growth, reproductive, egg quality and carcass characteristics.
3. generation of bird on growth, reproductive, egg quality and carcass characteristics.
4. season of hatch on growth, reproductive, egg quality and carcass characteristics.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Poultry

Poultry is a group of domesticated birds such as chicken, Guinea fowl, turkeys, ducks, geese etc. that are kept for human consumption. Most at times, their meat and eggs are collected for food and the feathers are collected for other aesthetic purposes. The droppings of poultry birds are also used for fertilizing farm lands. Kwarteng and Towler (1994) describe poultry as domestic fowl in general that are kept for meat or eggs. Smith (1990) defined poultry as those species of birds that provide economic service to man and reproduce unreservedly under the care of man. It can be deduced from the above definitions that, poultry birds do not include birds kept only purposely for companionship and aesthetic values.

2.2 Poultry Classification

Poultry birds were listed and classified into 300 different recognized breeds and varieties (strains) of poultry (Wikipedia, 2008). They are classified into classes, breeds, and varieties. A class of birds has a common origin. Breeds of birds are those birds in the same class with the same general physical features such as body shape, feather colour, number of toes and feathered or unfeathered shanks. Breeds are further subdivided into varieties (strains), based on plumage colour, comb type, and the presence or absence of a beard. Some examples of poultry birds as reported by Smith (1990) are domestic chicken (*Gallus domesticus*), Guinea fowl (*Numida meleagris*), the duck (*Anas platyrhynchos*), turkey (*Meleagris gallopavo*), the pigeon (*Columba livea*).

Table 2.1 Order of Poultry Birds and their examples

ORDER	EXAMPLE(S)
Anseriformes	Waterfowl (ducks, geese, swans)
Apodiformes	Swifts, hummingbirds
Caprimulgiformes	Goatsuckers, nightjars
Charadriiformes	Shorebirds, gulls, alcids, jacanas, skuas, terns, skimmers
Ciconiiformes	Herons, storks, ibis, spoonbills, bitterns
Columbiformes	Pigeons, doves, sandgrouse
Coraciiformes	Kingfishers, bee-eaters, rollers, hoopoes, hornbills, motmots, todies
Cuculiformes	Cuckoos, anis, roadrunners, hoatzins
Falconiformes	Vultures, hawks, eagles, falcons, osprey, secretary birds
Galliformes	Grouse, pheasants, turkeys, quails, megapods, Guinea fowl

Source: Smith (1990)

2.3 Economic Importance of Poultry Production

Poultry meat and its products including manure and feather play an important role in growth of the economy. The poultry sector is progressing rapidly in relation to changes in the global economy and changing societal expectations. Indigenous chickens are kept for meat, eggs, income and socio-cultural roles (Ssewannyana *et al.*, 2001; Halima, 2007). Poultry meat is preferred over most types of meat since it is the second most consumed meat, globally, having overtaken beef-veal in 1996 (William, 1999). Magdelaine *et al.* (2008) also reported that poultry meat has become a mass consumer product throughout the world regardless of the region and the level of development. The human consumption of poultry meat is well attested (Ogunlade and Adebayo, 2009). As indicated by William (1999), poultry is the most dynamic livestock species because of its gain of market share (highly demanded); adaptability to technology for breeding, feeding, production, processing, and marketing and is the most dynamic components of the world agribusiness trade (Oyedeji *et al.,* 2007). African livestock population statistics for 1995 indicated that poultry was the most numerous species of farm animals and the case is the same 2013. More than 80 percent of poultry rearing is found in the rural areas and this contributes substantially to the annual egg and meat production (Aganga *et al.,* 2003; (United States Department of Agriculture (USDA, 2013)). In the rural areas, women and children play an important role in the management of chickens. Village poultry keeping provide employment for women in the rural areas (Aganga *et al*., 2003; Halima, 2007).

2.4 World poultry production and consumption

Research has indicated that since 2005, China has been the leading producer of poultry, producing about 50% of the world's poultry population, followed by United States of America (USA), Indonesia, Brazil, India, Mexico, Russia, Japan, Iran and Turkey. Global poultry meat production increased by 1.6 per cent in 2014 and it is expected to overtake pig meat in 2020. Asia accounts for more than one-third of the world's poultry meat output. According to an outlook report by the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organisation of the United Nations in Wolvertoon and Frimpong (2013), poultry meat production over the 10 years to 2023 will grow at around 2.3 per cent per year to around 134.5 million tonnes making it the largest meat sector from 2020 onwards. Poultry meat is the second largest meat consumed in the world after pork. The estimated per capita consumption of poultry products in Ghana has increased from 4kg in 2010 to 6.6kg in 2012, which is 33% increment (United States Department of Agriculture (USDA, 2013).

Livestock and poultry meat contributes to 40 percent of the total animal protein consumption with the rest coming from fish in Ghana. Ghanaian consumers in urban areas have a high preference for imported frozen poultry products as they are cheaper and are processed as whole chicken or pre-cut. In Ghana local processing of poultry into cut portions to facilitate quick and easy use by consumers is limited. Notwithstanding that, Ghanaians generally prefer the taste of local chicken over imported chicken as it has more flavour and a better structure (Wolvertoon and Frimpong, 2013).

2.5 Guinea fowl

Guinea fowls are terrestrial and prone to run rather than fly when alarmed (Ayorinde, 2004). They are, however, like most short- and broad-winged birds, very agile and powerful flyers, capable of hovering and even flying backwards when necessary (Dei and Karbo, 2004). Guinea fowls are great runners, and can readily cover 10 km and more in a day. They make loud harsh calls when disturbed. Guinea fowls are equipped with strong claws and scratch the soil for food much like domestic chickens. They have well-developed spurs and use these to great effect when fighting (Dei and Karbo, 2004).

Guinea fowls belong to family of insect and seed-eating, ground-nesting birds resembling partridges, but with featherless heads and spangled grey plumage (Martinez, 1994). The Guinea fowls are one of the lesser known poultry species (Wikipedia, 2008) and is a common name for six species of birds native to Africa; one species also occurs on Madagascar and other Indian Ocean islands. The sexes are alike in colour: mostly black, dotted in all except of two species of one genus with small, light-coloured spots. The head and upper neck are bare, but two species of a second genus have a bushy tuft of feathers on the crown (Dei and Karbo, 2004). Historical records indicate that the Guinea fowl derives its name from the Guinea Coast of West Africa (Teye and Gyawu, 2002; Dei and Karbo, 2004) where today some still remain in the wild (Dei and Karbo, 2004). Guinea fowl has ubiquitous distribution in Africa where it has distinct popularity among smallholder farmers (Nwagu and Alawa, 1995). The Guinea fowl is a bird that belongs to a group *Carinatae* (flying birds), order *Galliformes* (includes turkeys, chickens and pheasants), and the family *Numididae* (that is the Guinea fowl of African origin). It belongs to the genus *Numida*. The genus has two types, *Numida ptilorhycha*, that is the blue-wattled Guinea fowl and *Numida meleagris* that is red-wattle Guinea fowl of West Africa. The wild Guinea fowl is native to West Africa but are now kept in many parts of the world (Smith, 1990; Dei and Karbo, 2004).

2.5.1 Guinea Fowl Types/ Varieties

Guinea fowl has been classified into four genera (*Agelastes- Phasiadus*, *Guttera*, *Acryllium* and *Numida*), six species and sixteen subspecies (Ayorinde, 2004). This is a list of Guinea fowl genera, species and subspecies, presented in taxonomic order.

1. Genus Agelastes- Phasiadus

   Eg. Black Guinea fowl, *Agelastes niger*

2. Genus *Numida*

   Eg. Helmeted Guinea fowl, *Numida meleagris*

3. Genus *Guttera*

   Eg. Plumed Guinea fowl, *Guttera plumifera*

4. Genus Acryillium

   Eg. Vulturine Guinea fowl, *Acryllium vulturinum*

   Source: (National Research Council (NRC, 1991)

There are several varieties of Guinea fowl in West Africa especially in Sub-saharan Africa. Some varieties of Guinea fowls plumed, crested, grey-breasted, helmeted and white-breasted Guinea fowls. A research by Jacob and Pescatore (2011) revealed that, the grey-breasted and helmeted Guinea fowls are common varieties found in West Africa. These grey-breasted and helmeted Guinea fowls have several subspecies which differ in terms of the size, shape, and colour of the wattles at the corner of the beak and the size and shape of the helmet on the crown (Jacob and Pescatore, 2011).

Three main varieties of domesticated Guinea fowls are known to be in the United States- Pearl, White and Lavender (Darre, 2007). The family *Numididae* include other species of Guinea fowl; namely the Vulturine Guinea fowl (*Acryllium vulturinum)* and the Crested Guinea fowl *(Guttera spp*).

The pearl Guinea fowl is a well-known subspecies of the helmeted Guinea fowl of the Guinea fowl bird family, *Numididae*, and the only member of the genus *Numida*. It is common in south of Sahara Africa, and has been widely introduced into France (Martinez, 1994).

The pearl Guinea fowl (*Numida meleagris*) has a helmet on top of its head with horny cartilage. All the subspecies of helmeted Guinea fowl has a helmet (Martinez, 1994). In contrast to this finding, Ayorinde (2004) in recent research argues that there are actually only four distinct subspecies of the helmeted Guinea fowl. Each is also characterized by different colouring of the bare parts of the head, wattle and neck feathers, as well as by the absence or presence of conspicuous bristles near the nostrils (Martinez, 1994). The pearl Guinea fowl is a large bird with a round body of 40-71 cm in length, and weigh 700-1600 g and small head (Martinez, 1994).

According to Headley (2003), the pearl Guinea fowl has a round-shouldered, clad in sheer dark feathers with delicate white polka-dots. The body plumage has purplish-gray plumage regularly dotted (Darre, 2007). A recent research by Leach (2009) indicates that, male pearl Guinea fowls parade, chasing each other, to indicate the start of a breeding season.

The white Guinea fowl is also a sub-species of helmeted Guinea fowl. It has pure-white feathers. It has pure white plumage with lighter skin compared to pearl variety. The white Guinea fowl lays and hatches solid white eggs and keets respectively (Darre, 2007).

The white-breasted Guinea fowl (*Agelastes meleagrides*), black with a wide white breast, is considered one of the most endangered species of Africa. The white-breasted Guinea fowl belongs to the genus *Agelastes*. However, Ayorinde (2004) indicates that the white-breasted Guinea fowl is actually not a variety *per se* since it does not breed true and segregates to other colours when mated *inter se*.

The black Guinea fowl (*Agelastes niger*) sometimes (*Phasidus niger*) belongs to the genus *Agelastes*. The black Guinea fowl is completely black except its naked head. It is mostly found in rainforests. They usually live in groups of 15- 23 roosting in trees at night (Martinez, 1994).

The lavender Guinea fowl are subspecies of the helmeted Guinea fowl (Ayorinde, 2004). The lavender Guinea fowls are similar to the Pearl, but with plumage that is light gray or lavender dotted with white (Darre, 2007).

2.5.2 Economic Importance of Guinea fowl

Guinea fowls play a significant role in the lives of people in Northern Ghana, ranging from socio-cultural to economic and religious purposes. There were about four (4) million Guinea fowls in the northern parts of Ghana (Koney, 1993). With the advent of increasing animal source of protein in the diets of the average Ghanaian, it became increasingly important to adopt Guinea fowl production as they have the potential to provide both meat and egg (Biswas, 1999; Koney, 1993).

Guinea fowl is noted for its promising genetic resource for developing a low-input poultry enterprise mostly in developing countries such as Ghana and has the capacity for reducing poverty (Teye and Gyawu, 2002). It is an integral part of equipping people living in the rural areas with a sustainable family income for small, marginal and landless farmers. A research by Argüelles *et al*. (2004), indicates that Guinea fowl as a poultry species is suitable for use in meat production to expand and diversify the local poultry industry due to its consumer acceptance, resistance to common poultry diseases, short reproductive cycles and tolerance to poor management conditions. In a nutshell, Guinea fowls have the potentials of ensuring food security of the farm family and contribute significantly to the socio-cultural practices of farmers such as sacrifices, funerals and payment of dowries (Dei and Karbo, 2004). They are used for the annual Guinea fowl festival by the Dagombas and Gonjas in northern Ghana. The pure, white fowl is used for religious sacrifices and to perform certain funeral rites. Customarily, among the Frafras, Dagabas, and Bulsas; Guinea fowls are used to welcome mothers-in-law (Teye and Adam, 2000). Moreover, in Senegal, almost 20% of the eggs produced are used for annual rituals (Teye and Adam, 2000). During the rituals, ceremonies and festivals, Guinea fowl meat is abundantly served (Saina *et al*., 2005). Furthermore, Guinea fowl production has proven to be one of the most profitable poultry enterprises in low income and poor resourced communities (Saina *et al*., 2005). This is as a result of their ability of low input requirements, greater potential to scavenge for food and high meat and egg quality (Moreki, 2009). Moreover, Guinea fowl eggs are noted to have high chances of virility and sexual potency and are used for scientific research, mostly in animal physiology (Moreki, 2009; Ikani and Dafwang, 2004).

2.5.3 Constraints to Guinea fowl Production

In spite of the potential benefits Guinea fowl farming brings to the farmer and the society at large, there are number of factors that militate against its production. Among the factors are high keet mortality, difficulty in sexing: that is the way the male and female looks alike makes it difficult for the farmer to differentiate the males from the females at early ages; it has been reported that a whole breeding stock may turn out to be males due to inability on part of the farmer to differentiate the male birds from the females (Teye and Adam, 2000).

Absence of source of quality day-old keets is also a problem: Quality day-old keets, though paramount to commercial Guinea fowl production, is lacking in Ghana. The other problems reported are lack of information about nutrient requirements of the local Guinea fowl: lack of information on nutrient requirement contributes to high keets mortality, 70% of farmers keep birds on free range because of inadequate knowledge about their nutrition. Loss of birds and eggs through picking by predators, worm infestation and inability to produce docile birds (Teye and Adam, 2000).

Nwagu and Alawa (1995), also reported problems of low hatchability, high mortality up to eight weeks, inadequate veterinary services and sources of hatching eggs and young stock while working on indigenous Nigerian Guinea fowl. The authors further indicated that poor feed conversion efficiency and high energy output and feed wastage of the local Guinea fowl as a result of the characteristic timid, but very active, flighty and noisy temperament is hindering the prosperity of the Guinea fowl industry.

Eventhough, Guinea fowls are known for their resistance to common poultry diseases such as Newcastle disease, Gumboro and Salmonellosis (Moreki, 2009); Teye and Gyawu (2000) whiles working on indigenous Ghanaian Guinea fowl argued that, the bird which is noted for colossal losses are depriving the farmers of the full benefit of the bird. The authors concluded that, the most important intestinal parasites hindering the optimum performance of the birds are *Eimeria sp*., *Ascaridia galli*, *Heterakis sp*. and *Capillaria caudiflata* and main external parasites are lice (*Damalina sp*. and *Argas persicus*).

2.5.4 Effects of strains on growth performances

Ashok and Prabakaran (2012) reported significant effect of genetic lines on body weight in Japanese quail at various ages. A research by Kumari *et al*. (2008) also recorded similar observations of the significant strain on body weights at different ages. Also, Varkoohi *et al*. (2010) reported that strain had significant influence on the body weight of Japanese quail at various stages of growth. However, a recent study by Mróz *et al*.(2016), reported non-significant effect on average body weight of Guinea fowl and the female birds were heavier than males. Furthermore, a systematic study by Ojedapo *et al*.(2012) on two commercial layer chicken strains revealed that, strains had significantly(p>0.001) influenced body weight. Apata *et al*. (2014) compared the growth performance of duck and Guinea fowl and they concluded that ducks had significantly higher body weights than Guinea fowl. Kasperska *et al*. (2011) reported lower body weights in male Guinea fowls than female Guinea fowls. In contrast, Faruque *et al*. (2013) reported non-significant effect of genotype on matured body weight in Bangledesh native chickens. In another study, Kosarachukwu *et al*. (2010) investigating the influence of broiler strains on growth rate, reported a significant (P<0.05) difference among the broiler strains (Ross, Anak and Abor Acres). The same authors also, found significant differences (P < 0.05) in average feed intake among the strains. Ross strain consumed the best quantity of feed (179.91g/bird/day), followed by Anak (165.05g/bird/day) and Abor Acres consumed least quantity of feed (147.72 g/bird/day).

2.5.5 Effects of strains on Reproduction

A research conducted by Awobajo *et al*. (2009) on two breeds of commercial chicken layers (Rhode Island and White Leghorn), showed that, there was significant differences ($P<0.001$) in the egg hatchability of Rhode Island Red (64.29%) and White Leghorn breeds (68.61%). The White Leghorn had higher egg hatchability percentage than Rhode Island Red. In another study, Obike *et al*. (2014) worked on Nigerian indigenous Guinea fowl by investigating the effects of strains on reproductive performance. The authors reported non-significant effect of strain of birds on fertility and hatchability. They concluded that, genetics does not affect fertility and hatchability, rather they are influenced by management and environmental factors. Islam *et al*. (2012) found a non-significant effect of breed on the hatchability of chicken eggs. Ali *et al*. (1993) also indicated non-significant breed effect on fertility and hatchability of Rhode Island Red (RIR), Fayoumi and RIR x Fayoumi eggs. Obike *et al*. (2014) obtained hatchability percentage of ≥ 70 % obtained for both Pearl and Black Guinea fowl strains and percentage fertility of 75-76 % and 72-90 % for both strains, respectively. The authors made a general conclusion that, the Black strain had better fertility values than the Pearl. Meanwhile hatchability values between 73-90 % (naturally mated) and 70-80 % (artificially inseminated) eggs of different Guinea fowl strains were observed (Fisinin and Zlochevskaya, 2004). In another study Salahuddin *et al*. (1990) reported better values of 80.79 % egg fertility and 71.73 % hatchability of fertile eggs in *deshi* chicken (broiler breeders). Dessie and Ogle (2001) reported higher fertility and hatchability for the local pure bred than in the exotic breeds of chicken, even though Horst (1991) found local birds to have a significantly (P<0.05) better hatchability and percentage fertilities than the exotic ones. Kamble *et al*. (1996) also found 85% fertility in Indian full-feathered Kadaknath chicken, 78% in Dahlem Red and 60% in Indian naked neck and Aseel hen. However, the crosses of those chickens recorded low fertility and hatchability. Notwithstanding that, percentage fertility and hatchability of eggs of 76 % and 48 % respectively in Nigerian Fulani-ecotype chicken was reported (Fayeye *et al*., 2005).

In a recent study by Sola-Ojo and Ayorinde (2011) on exotic dominant black strain crossed with Fulani ecotype chicken, the authors reported significant (P<0.05) effect of genotype on fertility and hatchability of eggs. However, they indicated non-significant (P>0.05) difference in hatch weight of the chicks.

2.5.6 Effects of strains on egg quality

Egg qualities are known to be highly influenced by genetic makeup of the laying birds. It is reported that, coloured laying birds produced heavier and bigger eggs than non-coloured birds (Akram *et al*. 2012). Egg quality as defined by Hanusová *et al*. (2015), is the characteristics of an egg that influences its level of acceptability by consumers and its hatchability. It is the main factor influencing the price of table egg and hatching eggs. Weight of albumen, yolk and shell differ between strains of hens and thickness of egg shell was also significantly influenced by strain of birds. Monira *et al*. (2003) reported a significant influence of breed of laying chickens on egg weight, egg length, egg width, albumen height, Haugh unit and shell thickness. And the authors reported superior performance of white leghorn over Barred Plymouth, Rhode Island Red and White Rock layers in term of egg weight, egg width and egg length. Popovic and Pym(1998) reported a significantly higher egg weight in higher breast weight line of Japanese quail line than lower breast weight line.

Hanusová *et al*. (2015), whiles working on Oravka and Rhode Island Red layers, reported a significant (P≤0.01) influence of breed of birds on egg weight, egg width and egg length, shell thickness, albumen weight, yolk weight and Haugh Unit. The authors further stressed that egg weight is genetically influenced by egg shell, albumen and yolk.

Song *et al*., (2000), in comparing the egg qualities of Guinea fowl, Pheasant, Chukar and Quail; reported significant effect of the species on albumen height with the highest being recorded by Guinea fowl(5.74mm), followed pheasant (4.46mm), chukar (4.04mm) and quail(3.50mm). Haugh Unit was also influenced significantly by the animal species, with quail and pheasant recording the highest (84.19) and lowest (79.64) respectively (Song *et al*., 2000).

2.5.7 Effects of strains on carcass characteristics

A study by Khalid *et al*. (2012) on Sudanese native fowl, indicated that strain had significant effect on heart, gizzard, fat, liver and shanks weight. Also, Vali *et al*. (2005) reported a significant genotype effect on carcass weight, carcass percentage, breast weight, and femur percentage in Japanese (*Coturnix japonica*) and Range (*Coturnix ypisilophorus*) quails.

Furthermore, a study by Musa *et al*. (2006) on two Chinese local chickens (Anka and Rugao) revealed that, live weight, dressing percentage, liver weight and heart weight were significantly($p<0.01$) influenced by the breed of birds. Karima and Fathy (2005) also recorded significant difference in live weight between broiler breeds.

Kosarachukwu *et al*. (2010) reported a significant influence of strain on dressing percentages and abdominal fat in broiler strains. A study by Jaturasitha *et al*. (2008) on carcass and meat quality of four male genotypes namely: Thai native (TH), crossbred (Thai native x Barred Plymouth Rock; THB), Barred Plymouth Rock (BPR) and Shanghai (SH) chickens. The authors reported significant ($p<0.05$) effect of genotype on slaughter weight pH of the meat however, they reported non-significant effect of genotype on dressing percentage, protein, fat and moisture percentage.

2.5.8 Effects of sex on growth performances of Guinea fowl

Sex is well known to have effect on growth performances of poultry birds. In general, it is noted that male birds are heavier than their female counterparts. A systematic study by Kokoszyński *et al*. (2011) on Guinea fowl revealed that, sex had significant influence on the body weight of the birds. They further observed higher body weight in the females compared to the males. Kokoszyński *et al*. (2011) also reported significantly better body weight in female Guinea fowls than males. Ashok and Prabakaran (2012), reported significant effect of sex on body weight in Japanese quail at various ages except hatch weight. Shokoohmand *et al*. (2007) also observed significant effect of sex on body weight of Japanese quail at different ages. Apata *et al*. (2014) reported significantly higher body weights in male ducks than female ducks; however, the authors found a higher body weight in Guinea hens than Guinea cocks. They concluded that female Guinea fowls possess these features for flight and breeding purposes. Khalid *et al*. (2012) also reported higher body weight in male Sudanese native fowl than females.

2.5.11 Effects of sex on carcass characteristics of Guinea fowl

A comparative study by Schneider *et al.* (2009) on effects on sex on carcass composition of broiler birds, indicated that males had higher percentages of carcass protein and ash than females (19.9% and 2.5%; 19.2 and 2.3%, respectively), and females had significantly more carcass fat than males (11.0, 9.0% respectively). Also Khalid *et al*. (2012) found significantly higher carcass values (heart, gizzard, fat, liver and shank weights) in male than female in Sudanese native chicken. However, fat deposition in female birds supposed to be higher than that in males due to some physiological and behavioural aspects (Zerehdaran *et al*., 2004).

Furthermore, Kokoszyński *et al.* (2011) also reported a significantly higher dressing percentage, carcass content, breast muscle and abdominal fat in female Guinea fowls than male birds. A study by Górski (1992) in poultry, indicated that female birds have better dressing percentages because of its associated lower slaughter waste and giblets in the female body. Minvelle *et al*. (1999), observed significant effects of the sex on carcass traits in Japanese quail. In a recent study conducted by Charati and Esmailizadeh (2013) on comparing the carcass characteristics of male and female Japanese quail, the authors observed a significantly higher carcass values in females than males. Also, Musa *et al*. (2006) reported a significantly ($P<0.01$) higher live weight, carcass weight, liver weight in male than in females in Chinese local chicken.

2.5.12 Effects of generation on growth performances of Guinea fowl

In a comparative study of parental, first filial and second filial generations in Japanese quail; second generation had the best body weight than the parental and first generations (Hussain *et al*., 2013). Likewise, Khaldari *et al*. (2010) noted significant body weight in selected Japanese quails than non-selected birds. Khaldari *et al*., (2010) reported a significant genetic improvement of body weight as 9.6, 8.8, and 8.2 g in generation 2, 3, and 4 respectively, in Japanese quails. Akram *et al*. (2012); Varkoohi *et al*. (2010), indicated significant($p<0.05$) differences between two generations (G0 and G1) of Japanese quail being selected for higher four week body weight through mass selection procedures. Also, Hussain *et al*. (2013) observed, a significantly higher body weight gain in generation 2 than in generation 1 in Japanese quail. Moreover, they reported significant influence of generation of birds on feed intake; where second filial generation had a better feed intake than the parental generation due to the increase in body weight of the second filial generation birds. Khaldari *et al*. (2010) also reported better feed intake in selected lines than non-selected lines of Japanese quails. They further stressed that, feed efficiency was better in selected lines than unselected lines. In a recent study by Hussain *et al*. (2013) on different generations of Japanese quail, they concluded that, there was a significant improved feed conversion ratio (2.30) in generation 2 than in generation 1(2.35).

2.5.13 Effects of generation on Reproduction of Guinea fowl

A research conducted by Anjum *et al*.(2012) on Desi local chickens over four generations, indicated that generations 1, 2, 3, and 4 birds had a significantly better egg production abilities than their parental generation birds. Also, Sahota *et al*. (2003) also reported significant ($P<0.01$) drastic improvement in egg yield of desi chicken in generation one compared to their parents. However, Anjum *et al*.(2012) reported non-significant influence of generation on egg size in indigenous desi chickens.

2.5.14 Effects of generation on egg quality of Guinea fowl

Egg and its qualities are well noted to be influenced by both genetic and non-genetic factors; of which generation of birds is no exception (Washburn, 1990). Kumari *et al*. (2008), reported significant ($P<0.01$) differences among the generations Japanese quail for external and internal egg quality traits and percentage albumen, yolk and shell, but not for quality indices. The authors reported significantly ($P<0.01$) higher means for egg length, egg width, shell weight, albumen length, yolk diameter, yolk weight and percentages of yolk and shell in generation 5 birds compared to parental generations.

2.5.15 Effects of generation on carcass characteristics

Charati and Esmailizadeh (2013) reported significantly higher dressing percentage, the intestinal weight and carcass characteristics in Japanese quail. The authors reported higher carcass values in the second filial generation compared to first filial generation. A research by Khaldari *et al*. (2010) reported non-significant($P>0.05$) influence of first filial generation; however from generation 2 to 10, there were significant($P<0.05$) influence on carcass traits such as carcass weight and breast weight in Japanese quail.

2.5.16 Effects of season of hatch on growth performances of Guinea fowl

Reem and Cahaner (1999) reported a negative influence of high temperature on growth rate of poultry and this negative effect is more prominent in fast growing birds. In a comparative study on chicken by Ashok and Prabakaran (2012), the authors recorded significant ($P<0.05$) effect of season of hatch on body weights and the authors concluded that effect of season of hatch might be due to the variation in environmental conditions between the hatches. Also, a systematic study by Hani *et al*. (2011) on chicks hatched at different seasons (Autum, Spring and Summer), found a significant effect of season of hatch on body weight of the birds at various ages of growth. The authors concluded that, these seasonal effects may be due to climatic effects, heat stress, as well as, on the health and feed consumption of chicks.

In another study, Eberhart and Washburn (1993) reported that the effect of heat-stress was more prominent in fast-growing commercial broiler stocks than in non-selected broiler lines. However, Leenstra and Cahaner (1991) found influence of heat stress on broiler lines selected for traits other than growth rate. Natural heat stress also reduces growth rate. A study on commercial Arbor Acres broilers that are reared extensively to sexual maturity and two hatches were produced, in spring and summer, it was concluded from the study that body weight of chicks at 4 week of age was significantly higher in spring than in summer (Settar *et al*. 1999). Plavnik and Yahav (1998) indicated a negative association between body weight of chickens and an increase in temperature.

Dry season couple with abnormal temperatures are reported to decrease feed intake and feed efficiency of broiler chickens (Plavnik and Yahav, 1998). Veldkamp *et al.*

(2005) explained a significantly ($P<0.05$) better feed intake among birds that were subjected to low temperature throughout the rearing period than those exposed to high temperatures. In another study, where Veldkamp *et al.* (2000) compared feed conversion ratio (FCR) of turkey subjected to different seasons, the results revealed feed conversion ratio to be better in turkeys that are under high temperature treatment as opposed to the ones on low temperature. In contrast, the study by Veldkamp *et al.* (2005) revealed a better overall feed gain ratio on birds raised on low temperature compared to those on high temperature.

2.5.17 *Effects of season of hatch on Reproduction*

Seasonal changes is well-noted for its influences on the reproductive performances of poultry birds mainly especially fertility and hatchability values of eggs (Babiker and Musharaf, 2008). Jesuyon and Salako (2013) also reported a significant seasonal effect on fertility and hatchability of eggs in Bovan Nera and Isa Brown Nigerian local chickens. Late-wet season recorded the highest fertility and hatchability than early wet, early dry and late dry seasons in both genotypes (Jesuyon and Salako, 2013). Also, Jayarajan (1992) reported a significant seasonal effect on fertility of eggs; where he noted that, the highest egg fertility was found in white leghorn and White Rock during the cold season and Rhode Island Red during the summer. Ozcelik *et al.* (2006) reported significantly higher percentages of hatchability and fertility of eggs from chickens that are raised in winter than those raised in summer. Garces *et al.* (2001) reported negative effects of high temperature on egg production, egg weight in chicken. However, in another study, Persia *et al.* (2003) explained that heat stress (high temperature) had no significant effect on egg production in chicken.

2.5.18 Effects of season of hatch on egg quality

According to Kumari *et al*. (2008), season of hatch had significant influence on internal and external egg qualities of Japanese quail. The hens of hatch 7 produced significantly heavier eggs and consequently recorded higher means for egg weight (14.37 g), egg length (34.80 mm), egg width (27.36 mm), albumen weight (8.16 g) and yolk height (11.62 mm), while the birds of hatch 8 recorded superior mean shell weight (1.23 g), yolk weight (5.06 g) and percentage yolk (37.37). The significant differences among hatches for egg quality traits may be attributable to the variations in environment as the hatches were spread over a period of two years. Moreover, Marshaly *et al*. (2004) reported a negative effect of high temperature on egg quality.

2.5.19 Effects of season of hatch on carcass characteristics

Seasonal changes significantly affect the carcass parameters in poultry birds. Charati and Esmailizadeh (2013) reported significant influence of season on dressing percentage, liver weight and heart weight in Japanese quail. An increased breast weight in chickens were recorded among chickens kept during the raining season where temperatures were low compared to reduced breast weight reported in during the dry season where temperatures were high (Aksit *et al*., 2006). Also, Rajini *et al.* (2009) reported lower weights of the liver, gizzard and intestines in chickens during hot seasons compared to that recorded during cool seasons. However, Bianchi *et al.*(2007) indicated non-significant effects of season on chemical composition of the chicken carcass except the crude fat content, which was significant.

2.6 Breed

Breeds of animals are those animals in the same class with the same general physical features such as body shape, feather colour, toes number and feathered or unfeathered shanks as a result of their genetic makeup. Breeds are further subdivided into varieties (strains), based on plumage colour, comb type, and the presence or absence of a beard. For instance, the indigenous Ghanaian Guinea fowl breed (*Numida melagris*) has the varieties (Strains): Pearl, Lavender, Black and white Guinea fowls.

2.7 Non-genetic factors

Non-genetic factors are those environmental factors that are easy to measure (Annor *et al*., 2012). These factors among others include generation of birds, sex, age and season of hatch. It is ideal to make comparisons between animals before selecting animals especially when the emphasis is on selecting animals to be used as parents for the next generation. Hence for efficient genetic gain, performance of the bird in relation to specific trait should be estimated for possible known non-genetic factors that may prevent the trait from its full expression. Non-genetic factors are either discrete or continuous; they are estimated using statistical models that best describe the environmental factors that best influence the trait of interest. For instance non-genetic factors that may influence the body weight of a bird include sex, season of hatch, management level and type of housing system.

2.8 Estimation of non-genetics factors

Ideally, models are used in estimating non-genetic factors. The model takes into account all other factors that might influence the trait of interest. Least square analysis is also used to estimate non-genetic factors. Once environmental factors are obtained, data can be corrected for these factors and genetic effects and parameters can be estimated (Willis, 1991).

The statistical models commonly used in animal breeding are linear models, with the set of factors being assumed to additively affect the observations. Linear models are preferred because most economically important traits are linear in nature (Meyer, 1998). In modern animal breeding, non-linear models are being used to evaluate traits that exhibit categorical phenotypes (Ducrocq, 1997) and covariance functions are used in the analysis of longitudinal data (Meyer, 1998).

2.9 Breed x Non-genetic factors on traits

The term genotype by environment (G x E) interaction is most commonly used to describe situations where different genotypes (e.g. breeds, lines, strains) respond differently to different environments. These differences in genotype response not only include changes in mean performance, but also include variability in the performance of different genotypes (Sheridan, 1990). In the presence of significant G x E interactions, some genotypes might be more affected by the environment than others, leading to a change in the ranking of the genotypes from one environment to the other (Mathur, 2003).

2.9.1 *Effects of breed x Season interactions on growth*

A research by Jesuyon and Salako (2013) on two exotic strains of chicken, indicated significant ($P<0.05$) interaction between genotype and season in body weights of birds. Likewise, Ajayi and Ejiofor (2009), also reported a significant genotype and sex interaction effects on body weights in two exotic broiler strains. Furthermore, Settar *et al*. (1999) reported significant influence of genotype x season interactions on body weight gain, body weight and feed conversion ratio in commercial broilers. Again, Benyi *et al*.(2015) reported significant genotype x sex interaction effects on 49-day body weight, body weight gain, feed intake and mortality rate in broiler.

However, Adebambo *et al*.(2006) reported non-significant influence of breed and season interactions on growth performance of birds.

2.9.2 *Effects of breed x Season interactions on reproduction*

Yakubu *et al*. (2007) reported significant genotype by season interaction effects on egg production in chicken. Olawumi and Dudusola (2010) reported non-significant influence of genotype by housing system of bird egg production whiles Yakubu *et al*.(2007) indicated otherwise.

Olawumi and Salako, (2012) reported that season of hatch x breed interactions significantly influence hatchability of eggs. Olawumi (2007) observed significant breed x season interaction effects on egg production, fertility and hatchability rates.

Egg weight of turkey was significantly ($P<0.01$) influenced by the interactions of breed and season (Wondmeneh *et al*. 2016). Sharifi *et al*. (2010) observed significant influence of temperature and genotype on egg production, fertility and hatchability. Also, Olawumi (2015) reported significant ($P<0.01$) strain x season effect on fertility of breeder cocks. In addition, Jesuyon and Salako (2013) reported significant influence of genotype by season interaction on hatchability of egg set and body weight.

2.9.3 *Effects of breed x Season interactions on egg quality*

Islam *et al.* (2002) reported non-significant interaction effect of season and strain for egg weight, egg shell thickness, albumen weight, albumen height, yolk weight and yolk height; however, the authors reported significant (P<0.01) difference on egg shell weight.

2.9.4 *Effects of breed x Sex interactions on Carcass traits*

Interaction of breed by sex is ranking of breeds and sexes on a scale of performance in respect to those traits measured. In an experiment conducted Ojedapo *et al.* (2008), the authors observed non-significant strain x sex interactions on carcass traits such as proportions of total muscle, total meat, shank, thigh and drumstick weights of broiler chickens. Their observation indicated that there was absence of joint effect of breed and sex on birds' performance. Olawumi *et al* (2012) also reported non-significant breed x sex interactions on abdominal fat. However, Ajayi and Ejiofor (2009) whiles working on broiler breeds reported significant genotype x sex effect on live weight and body linear measurements. Likewise, Ojedapo *et al.* (2008) found significant sex x diet interactions on carcass fat and boneless carcass (meat) but an insignificant breed x sex interactions on dressing%. Also, Ojedapo *et al.* (2008) found a significant breed x sex interactions on heart weight. Furthermore, Benyi *et al.* (2015) stressed that, genotype × sex interaction effects significantly influenced carcass, breast, back, wing, leg, and liver weights. According Karima and Fathy (2005), interactions of breed x sex did not significantly influence fat content of chicken carcass. The interaction effects of variety×sex were significant (P<0.05) on body weight, large diameter and length of the tarsus and on the comb length in chicken (Moula *et al.* 2013).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Location and time of study

The study was carried out at the Poultry Section of the Department of Animal Science Education, University of Education, Winneba, Mampong-Ashanti campus, Ghana, from April, 2015 to March, 2016. Mampong-Ashanti lies in the transitional zone between the Guinea savanna zone of the north and the tropical rain forest of the south of Ghana. The climatic, vegetation and demographic characteristics of Mampong-Ashanti have been described by Ghana Districts (2006).

Essentially, Mampong-Ashanti lies between latitude 07° 04' north and longitude 01° 24' west with an altitude of 457m above sea level. Maximum and minimum annual temperatures recorded during the study period were 30.6°C and 21.2°C, respectively (Meteorological Service Department, 2015). Rainfall in the district is bimodal, occurring from April to July (major rainy season) and again August to November (minor rainy season), with about 1224mm per annum. The dry season occurs from December to March. The vegetation is transitional savanna woodland, which guarantees proper poultry keeping.

3.2 Sources of feed ingredients and experimental birds

The feed ingredients used in the experiment that is maize, tuna fish, soya bean, wheat bran, premix and salt were bought from a commercial feed supplier, Agricare Ghana Limited, Kumasi and formulated in The Feed Unit of The Animal Science Farm for optimum growth and performance in Guinea fowl breeders.

The experimental birds (Guinea keets) at day-old were obtained from Akate Farms at Kumasi.

3.3 Experimental Birds and Design

Data were collected on 603 local Guinea fowls to estimate average values of traits. Four strains of local Guinea fowls: namely Pearl, Lavender, White and Black were used. Three non-genetic factors were considered: season of hatch (Major raining season and Minor raining season), generation of bird (parental generation and First filial generation) and sex (Male and Female) of bird. Completely Randomized Design was used in the study.

3.4 Management of Experimental Birds

3.4.1 *Egg collection and Incubation*

A total of 1176 eggs were obtained from Mampong College of Agriculture Guinea Fowl Unit. Eggs were collected, as recommended by Moreki and Mack (2013), in the morning in containers which were cushioned to avoid breaking or shaking. Cracked and dirty eggs were discarded during egg collection. Each egg was identified individually with a marker before incubation and thereafter weighed using an electronic weighing scale. Eggs were incubated at 37.5-37.8 C and 60% relative humidity for 28 days (Tebesi *et al.*, 2012). Candling was done at 14 days after egg set to determine fertile and unfertile eggs.

3.4.2 *Housing of Experimental birds*

Birds were brooded for 6 weeks (Teye and Gyawu, 2002) before transferred to a deep litter floored house each of size of 49.9m x 8.17m x 2.48m. Each room had thirty cages each of size 3.15m x 0.99m x 2.12m. They were individually caged at the ages of three and four months respectively of size 0.68m x 0.595m x0. 44m.

Table 3.1 Composition of feed used in the experiment

Ingredients	Stage of Bird		
	Starter (kg)	Grower(kg)	Breeder(kg)
Maize	57.5	58	53
Wheat bran	11	21	20
Soya bean meal	8.5	5	8
Tuna	11	6	7
Russia fish	9	7	3
Oyster shells	1.5	1.5	7.5
Calcium	0.5	0.5	0.5
Vitamin Premix	0.5	0.5	0.5
Salt	0.5	0.5	0.5
TOTAL	100	100	100

Source: Annor *et al*. (2013)

3.4.3 *Feeding and Watering*

Birds were then maintained at ambient temperatures between 21°C and 30°C until the end of the experiment. Feed (Table 3.1) and water were supplied *ad libitum*. Day old keets were fed ground maize in flat feeders followed by a starter ration from day 2 until 6 weeks of age. This was followed by a grower ration from 6 weeks of age until 21 weeks of age, and then a finisher feed until the end of the experiment. The starter ration contained 22% crude protein and 2,950 Kcal ME/kg diet. The grower ration contained 14% crude protein and 2,800 Kcal ME/kg diet, and the finisher ration contained 17.5% crude protein and 2,800 Kcal ME/kg diet (Annor *et al*., 2013).

3.5 Data collection

The parameters that were measured comprised growth, reproductive, egg qualities and carcass characteristics.

3.5.1 *Growth parameters*

The following growth parameters were measured: Initial body weight (g/bird), final body weight (g/bird), daily feed intake (g), total feed intake (g), daily weight gain (g) and feed conversion ratio.

3.5.2 *Feed intake*

The birds were caged individual at 4 months old. Data on feed intake were taken on individual birds daily for two months. The feed intake was calculated as the difference between the initial feed given to birds in the morning and the feed left over the next morning.

3.5.3 *Body weights*

Each bird was weighed at 6 months and 8 months using sensitive weighing scale of 0.05gm sensitivity. The birds were caged and fed for 2 months at the end of the feed intake trial period. The 6 months body weights were also taken. The final weight gain of each bird was then calculated by subtracting the initial weight (6 months body weight) from their final weights (8months body weight). Arithmetically,

Weight gain (g) = Final weight (g) – Initial weight (kg).

Mean weight gain (kg) = Final mean weight (kg) – Initial mean weight (kg).

3.5.4 *Feed conversion ratio*

Feed conversion ratio is the ratio of the total weight gain in g throughout the experimental period to total feed intake in g. It was expressed as gain to feed ratio. That is,

$$FCR = \frac{\text{Total feed intake(g)}}{\text{Total weight gain (g)}}$$

3.5.5 *Reproductive parameters*

The reproductive parameters studied were: Hatch weight, Fertility% and Hatchability%. Hatch weight was obtained by weighing birds at day old using a electronic sensitive weighing scale.

The percentage fertility was calculated by expressing the total number of fertile eggs as a percentage of the total number of eggs set. However, the percentage hatchability was determined by expressing the total number of eggs (Guinea keets) hatched as a percentage of total number of fertile eggs. Arithmetically,

$$\%\text{Fertility} = \frac{\text{Total number of fertile eggs}}{\text{Total number of eggs set}} \times 100$$

$$\%\ \text{Hatchability} = \frac{\text{Total number of Guinea keets hacthed}}{\text{Total number of fertile eggs}} \text{x}100$$

3.5.6 *Egg Characteristics*

Egg characteristics measured were egg weight, shell weight, shell thickness, yolk weight, albumen weight, yolk height, albumen height and Haugh Unit. The weights of the eggs were determined with the aid of an electronic sensitive scale adjusted to the nearest 0.01 g. The internal traits measured were yolk weight, yolk height, yolk diameter, albumen weight, albumen height, albumen diameter. The above mentioned internal qualities were determined by cracking and breaking gently each into a clean petri dish and measurements were taken with the aid of a venier calliper sensitive to 0.01 mm. Shell weight was calculated as the difference between the egg weight and the weights of yolk and the albumen.

Micrometer screw gauge was used to determine the shell thickness from the broad end, narrow end and the middle of the shell and the average of the three measurements was taken as shell thickness in millimetre.

The Haugh Unit values were calculated for individual egg using the Haugh equation (Monira *et al*., 2003): $HU = 100 \log (H - 1.7w^{0.37} + 7.6)$

where:

HU – Haugh Unit

H – observed height of albumen in mm

w – weight of egg in g

3.5.7 *Carcass characteristics*

The birds per strain were sampled for the carcass analysis. Before slaughtering, the birds were starved overnight but had free access to water. After slaughtering, carcasses were gutted and weighed. The following carcass parameters were studied: Live weight, dressing percentage, weight of heart, weight of lungs, weight of liver, weight of kidneys, intestine with content, and intestine without content. Biochemical analysis of carcass was done at Biochemistry laboratory of Kwame Nkrumah

University of Science and Technology on the following parameters: Moisture %, Protein %, Fat%, Ash%, Carbohydrate%, pH and Energy KJ content of the meat.

3.6 Statistical analysis

Data were analyzed with the General Linear Procedure (GLM) of SAS. According to the model:

$$Y_{ijklm} = \mu + B_i + G_j + H_k + S_l + (GS)_{jl} + (BG)_{ij} + (BH)_{ik} + (BS)_{il} + (SH)_{kj} + (BH)_{ik} + e_{ijklm}$$

Where:

Yijklm = Observation of m^{th} animal in the i^{th} strain in j^{th} generation of i^{th} sex, hatched in k^{th} season

μ = Overall mean

B_i = fixed effect of i^{th} strain (1, 2,3,4)

G_j = random effect of j^{th} generation (1,2)

H_k = random effect of k^{th} season of hatch (1,2)

S_l = random effect of l^{th} sex (1,2)

$(GS)_{jl}$ = random effect of the interaction between j^{th} generation and l^{th} sex

$(BG)_{ij}$ = random effect of the interaction between i^{th} strain and j^{th} generation

$(BH)_{ik}$ = random effect of the interaction between i^{th} strain and k^{th} season of hatch

$(BS)_{il}$ = random effect of the interaction between i^{th} strain and l^{th} sex

$(SH)_{lj}$ = random effect of the interaction between l^{th} sex and j^{th} season of hatch

e_{ijklm} = random error

CHAPTER FOUR

4.0 RESULTS

4.1 Effects of Breed on Growth Performance of Guinea fowl

4.1.1 Effects of strain on body weight

Table 4.1 shows effect of strain on body weight. Strain had no significant (p>0.05) influence on 6 months body weight, 8 months body weight; however, total weight gain and daily weight gains were significantly (p<0.05) influenced by strain of birds. Lavender had the highest total weight gain than Black, White and Pearl Guinea fowl. Likewise, Lavender had better daily weight gain, than Black, White and Pearl.

Table 4.1: Effect of Strain and Non-genetic factors on Body weight and Weight gain

Generation	6MBW	8MBW	TWG	DWG
Parental	1407.58±15.642	1554.39±18.59	146.8±9.96	2.57±0.174
First filial	1298.18± 13.42	1589.00±15.95	290.82±8.55	5.103±0.150
P-values	<.0001	0.0790	<.0001	<.0001
SEX				
Female	1415.43±14.20	1652.60±16.88	237.17±9.05	4.16±0.158
Male	1290.33±12.63	1490.79±15.015	200.45±8.05	3.42±0.1413
P-values	<.0001	<.0001	<.0001	<.0001
Strain				
Black	1335.797±19.84	1550.455±23.56	214.657±12.64	3.765±0.221
Lavender	1356.416±15.28	1596.99±18.16	240.575±9.73	4.220±0.17
Pearl	1353.221±11.14	1560.48±13.25	207.265±7.10	3.634±0.124
White	1366.106±23.63	1578.86±28.09	212.757±15.06	3.731±0.264
P-value	0.707	0.137	0.0038	0.0037
SEASON				
Major Rain	1335.221±9.651	1558.526±11.47	223.204±6.151	3.916±0.107
Minor Rain	1370.549±22.41	1584.872±26.63	214.323±14.28	3.759±0.250
P-value	0.1549	0.3719	0.5702	0.5710

6MBWT= 6 months body weight, 8MBWT= 8 month body weight, TWG= Total weight gain, DWG= Daily weight gain, DFI= Daily feed intake, FCR= Feed conversion ratio

The interaction of Generation x Sex and Generation x Strain significantly ($p<0.05$) affect 6 months body weight, 8 months body weight, total weight gain, total feed intake and feed conversion ratio (Table 4.3). Likewise, the interaction of Sex x Strain significantly ($p<0.05$) affected 6 months body weight, 8 months body weight, total weight gain and total feed intake (Table 4.3). However, Strain x Season had no significant ($p>0.05$) effect on 6 months body weight, daily weight gain, total feed intake and feed conversion ratio (Table 4.3).

4.1.2 Effects of strain on Feed intake and feed conversion ratio

Total feed intake and daily feed intake were significantly ($p<0.05$) influenced by strain of birds (Table 4.2). Black recorded the highest total feed intake than White, Pearl and Lavender strains. Likewise, daily feed intake was highest in black, white, pearl and lavender.

Table 4.2: Effect of Genetic and Non-genetic factors on Feed intake and Feed Conversion ratio

Generation	TFI	DFI	FCR
Parental	4150.769±81.53	72.820±1.43	27.55±1.42
First filial	4394.73±67.4	61.311±1.184	15.455±1.181
P-values	<.0001	<.0001	<.0001
Sex			
Female	3642.11±72.27	63.89±1.26	21.335±1.264
Male	4003.38±70.59	70.235±1.23	21.674±1.235
P-values	<.0001	<.0001	0.7865
Breed			
Black	3945.0±114	69.22±2.00	21.866±1.99
Lavender	3575.088±79.88	62.72±1.40	19.732±1.39
Pearl	3849.903±59.17	67.54±1.03	22.243±1.03
White	3920.306±134.89	68.77±2.36	22.177±2.36
P-value	0.0032	0.0032	0.3955
Season			
Major Rain	3827.91±50.81	67.15±0.89	20.750±0.889
Minor Rain	3817.59±110.27	66.97±1.93	22.259±1.929
P-value	0.9310	0.9311	0.4696

TFI= Total feed intake, DFI=Daily feed intake, FCR= Feed conversion ratio

Table 4.3: Interaction effect of Strain and non-genetic factors

FACTORS	6MBWT	8MBWT	TWG	DWG	TFI	DFI	FCR
Generation*Sex	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.017
Generation*Strain	0.048	0.0036	0.0750	0.075	0.0006	0.0006	0.504
Sex *Strain	0.0076	0.0553	0.8940	0.894	0.0085	0.0085	0.906
Sex *Season	0.2410	0.7306	0.0170	0.017	0.891	0.8912	0.260
Strain*Season	0.1138	0.4899	0.1048	0.104	0.761	0.7616	0.653

6MBWT= 6 months body weight, 8MBWT= 8 months body weight, TWG= Total weight gain, DWG= Daily weight gain, DFI= Daily feed intake, FCR= Feed conversion ratio

4.2 Effect of Non-Genetic Factors on Growth Performances

4.2.1 Effects of Sex on body weight

Sex had significant ($p<0.05$) effect on 6 months body weight, 8 months body weight, total weight gain and daily weight gain (Table 4.1). At 6 months, female birds had a higher body weight than males. Also, 8 months body weight was found to be better in female than in male bird. Furthermore, total weight gain and daily weight gain were higher in females than in males (Table 4.1).

4.2.2 Effects of Sex on feed intake and feed conversion ratio

Sex had significant ($p<0.05$) influence on total feed intake and daily feed intake. Male birds had a higher total feed intake than female birds. Likewise, daily feed intake was higher in male birds than in female (Table 4.2).

4.2.3 Effects of Generation on body weight

Generation had significant ($p<0.05$) influence on 6 months body weight, total weight gain and daily weight gain. However, 8 months body weight was not significantly ($p>0.05$) influenced by generation. At 6 months, the parental generation had a better body weight than the first filial generation. Meanwhile, first filial generation recorded a higher total weight gain than parental generation. Also daily weight gain was higher in first filial generation than the parental generation (Table 4.1).

4.2.4 Effects of generation on feed intake and feed conversion ratio

Generation had significantly ($p>0.05$) influenced feed intake (total feed intake and daily feed intake) and feed conversion ratio. First filial generation had a higher total feed intake compared to parental generation. Daily feed intake was higher in parental generation than first filial generation (Table 4.2).

4.2.5 Effects of season on body weight of Guinea fowl

Season had no significant($p>0.05$) effect on 6 months body weight, 8 months body weight, total weight gain and daily weight gain (Table 4.1).

4.2.6 Effects of Season on feed intake and feed conversion ratio

Season had no significant ($p>0.05$) influence on total feed intake, daily feed intake and feed conversion ratio. However, major rainly season had a higher total feed intake than minor rainly season (Table 4.2).

4.3 Effects of strain and non-genetic factors on reproduction of Guinea fowl

4.3.1 Effects of strain on fertility, hatchability and Egg weight

Table 4.4 shows fertility and hatchability as affected by strain. Fertility and hatchability of eggs were significantly ($p<0.05$) influenced by strain of birds. Pearl had the highest fertility compared to black, lavender and white. Also, hatchability was highest in pearl compared to black, lavender and white. Egg weight was not significantly ($p>0.05$) influenced by strain of bird (Table 4.4).

Table 4.4 Effects of strain and non-genetic factors on reproduction

Strain	**Egg weight**	**Fertility**	**Hatchability**
Black	23.82±0.66	59.36±4.8	25.72±5.09
Lavender	24.42±0.26	58.11±3.75	18.83±3.98
Pearl	24.99±0.74	66.77±1.93	27.29±2.04
White	23.53±0.42	56.83±4.59	12.50±4.87
P-value	0.20	0.056	0.023
Generation			
Parental	40.09±0.66		
First filial	35.45±0.56		
P-value	<.0001		
Season			
Major Season	24.36±0.30		
Minor Season	24.02±0.40		
P-value	0.424		

4.3.2 *Effect of Generation and Season on Egg weight*

Generation significantly ($p<0.05$) affected egg weight. Parental generation had a higher egg weights than the first filial generation. Season had no significant ($p>0.05$) influence on egg weight (Table 4.4).

4.4 Effect of strain on carcass characteristics

Strain had no significant (p>0.05) effect on live weight and dress weight (Table 4.5a).

However, intestine weight was significantly (p<0.05) influenced by strain of birds.

Table 4. 5a Effects of strain and non-genetic factors on Carcass Characteristics

Factor						
Generation	**Live weight (g)**	**Bled weight (g)**	**Dressed weight (g)**	**Breast weight (g)**	**Wing weight (g)**	**Head weight (g)**
Parental	1429.1±34.72	90.99±1.24	58.95±3.25	20.11±0.73	4.33±0.12	2.58±0.07
First filial	1291.2±60.14	94.04±2.15	91.32±5.14	22.66±1.26	5.36±0.21	2.67±0.13
P-value	0.057	0.23	<.0001	0.093	0.0003	0.566
Sex						
Female	1370.2±45.93	91.70±1.64	74.24±4.31	21.15±0.96	4.67±0.16	2.25±0.10
Male	1350.2±45.93	93.34±1.64	76.03±4.31	21.62±0.96	5.02±0.16	3.00±0.10
P-values	0.74	0.452	0.753	0.712	0.1165	<.0001
Strain						
Black	1369.27±62.6	94.79±2.24	77.67±5.87	21.35±1.32	4.75±0.22	2.58±0.13
Lavender	1342.39±62.6	92.46±2.24	70.20±5.87	20.76±1.32	4.82±0.22	2.66±0.13
Pearl	1389.27±62.6	93.25±2.24	70.87±5.87	21.89±1.32	4.82±0.22	2.58±0.13
White	1339.89±62.6	89.58±2.24	81.81±5.87	21.53±1.32	4.98±0.22	2.68±0.13
P-value	0.927	0.396	0.418	0.935	0.880	0.926

Table 4.5b: Effects of strain and non-genetic factors on Carcass Characteristics

Factor						
Generation	**Neck(g)**	**Thigh(g)**	**Heart(g)**	**Gizzard(g)**	**Intestine(g)**	**Whole Crop(g)**
Parental	3.92±0.10	5.39±0.21	0.57±0.02	1.40±0.07	1.684±0.06	1.95±0.164
First filial	4.35±0.18	10.19±0.3	0.56±0.04	1.97±0.13	1.726±0.11	0.52±0.28
P-value	0.0543	<.0001	0.294	0.0011	0.7407	0.0002
Sex						
Female	3.90±0.14	7.65±0.28	0.42±0.03	1.775±0.1	1.83±0.08	1.68±0.217
Male	4.37±0.14	7.92±0.28	0.65±0.03	1.603±0.1	1.574±0.08	0.79±0.217
P-values	0.020	0.483	<.0001	0.2105	0.00227	0.0042
Strain						
Black	4.19±0.19	7.60±0.3	0.57±0.04	1.58±0.13	1.795±0.11	1.517±0.296
Lavender	3.79±0.19	8.062±0.3	0.513±0.04	1.79±0.13	1.561±0.11	1.548±0.296
Pearl	4.04±0.19	7.90±0.3	0.497±0.04	1.74±0.13	1.926±0.11	1.187±0.296
White	4.51±0.19	7.58±0.3	0.573±0.04	1.63±0.13	1.537±0.11	0.712±0.296
P-value	0.079	0.767	0.428	0.6675	0.0473	0.1606

Pearl had the highest intestine weight, followed by black, lavender and white (Table 4. 5b). Strain had significant ($p<0.05$) influence on moisture, fat and carbohydrate. The carcass of pearl had the highest moisture content than black, white and lavender. Lavender recorded the highest fat, followed by white, black and pearl. White had the highest carbohydrate content followed by lavender, black and pearl (Table 4.8). Also, strain significantly influences the ash%, pH and cholesterol% content of the carcass. Pearl strain had the highest ash% and White strain had the least Ash% content. The highest pH and cholesterol% were obtained in the lavender strain of birds (Table 4.8).

4.5 Effect of Non-genetic factors on carcass characteristics

4.5.1 Effects of sex on carcass characteristics

Live weight and dressing percentage were not significantly ($p>0.05$) influenced by sex of birds (Table 4.5a). However, head and heart weights were significant ($p<0.05$) (Table 4.5a & 4.5b). Male birds had a higher head weight than female birds. Heart weight was higher in male than in female. Sex had significant ($p<0.05$) influence on moisture, fat and energy, Protein, Ash and Cholesterol content of carcass. Female birds had higher moisture content than male birds. Male birds had a higher fats and protein content than female birds, the energy content was higher in male birds than in female birds. However, ash and cholesterol content were higher in female birds than in male birds (Table 4.8).

4.5.2 Effect of generation on carcass characteristics

Generation had significantly ($p<0.05$) affected live weight, dress weight and wing weight. The interaction of sex x strain was significant on live weight. Parental generation had a better live weight than first filial generation. Dress weight was higher in first filial generation than parental generation (Table 4.5a).

Table 4.6 Interaction effects of strain and Non-genetic factors on carcass

Factors	Live weight(g)	Dress weight(g)	Wing (g)	Head (g)	Neck (g)	Shank (g)	Thigh(g)	Intestine (g)	Live (g)
Generation*Sex	0.078	0.100	0.0229	<0.0001	0.018	0.0066	0.187	0.314	0.0522
Generation*Strain	0.344	0.331	0.310	0.081	0.01	0.432	0.69	0.0016	0.21
Sex*Strain	0.044	0.088	0.545	0.126	0.03	0.045	0.07	0.049	0.93

Table 4.7Interaction effects of strain and Non-genetic factors on Biochemical properties of Carcass

Factors	%moisture	%protein	%fat	Ash	Carbohydrate	pH	Energy	Cholesterol
Generation*Sex	<0.0001	<0.0001	<0.0001	<0.0001	0.0006	<0.0001	<0.0001	<0.0001
Generation*Strain	0.0004	<0.0010	<0.0001	<0.0001	0.0216	<0.0001	0.0005	<0.0001
Sex*Strain	<0.0001	0.0004	0.055	<0.0001	0.0493	<0.0001	0.1452	<0.0001

Table 4.8: Effects of strain and non-genetic factors on biochemical composition of Guinea fowl carcass

Factors generation	**Moisture %**	**Protein %**	**Fat%**	**Ash%**	**Carbohydrate %**	**pH**	**Energy KJ**	**Cholesterol %**
Parental	74.76±0.08	13.16±0.08	2.995±0.03	1.54±0.04	7.53±0.046	4.29±0.02	459.20±2.56	2.28±0.30
First filial	74.76±0.08	13.16±0.08	2.995±0.03	1.54±0.04	7.53±0.046	4.29±0.02	459.20±2.56	2.28±0.30
P-values	1.00	1.00	1.00	1.00	1.00	0.919	0.139	1.00
SEX								
Female	74.96±0.08	12.90±0.08	2.87±0.037	1.68±0.04	7.557±0.042	4.26±0.20	447.36±2.56	2.37±0.030
Male	74.55±0.08	13.43±0.08	3.11±0.037	1.41±0.04	7.48±0.042	4.33±0.20	465.58±2.56	2.20±0.030
P-values	0.0009	<0.0001	<0.0001	0.0002	0.138	0.0229	<0.0001	0.0004
Strain								
Black	74.82±0.11	13.23±0.11	2.97±0.052	1.50±0.06	7.47±0.06	4.29±0.02	457.99±3.62	2.25±0.043
Lavender	74.49±0.11	13.30±0.11	3.069±0.05	1.49±0.06	7.63±0.06	4.37±0.02	462.70±3.62	2.72±0.043
Pearl	74.99±0.11	13.04±0.11	2.87±0.052	1.72±0.06	7.36±0.06	4.21±0.02	451.24±3.62	2.39±0.043
White	74.72±0.11	13.09±0.11	3.065±0.05	1.47±0.06	7.64±0.06	4.32±0.02	453.93±3.62	2.23±0.043
P-value	0.029	0.372	0.038	0.034	0.0041	0.0030	0.1439	0.0431

Table 4.9: Effects of strain and non-genetic factors on egg qualities factors

Generation	Albumen Height(mm)	Albumen Weight(g)	Yolk Weight(g)	Yolk Height(mm)	Shell Thickness(mm)	Egg Diam(mm)	Shell Weight(g)	Haugh Unit
Parental	22.59±0.733	13.70±0.24	13.70±0.24	19.91±0.59	0.095±0.004	36.81±0.44	9.11±0.44	75.76±1.7
First filial	21.57±0.62	13.21±0.21	13.21±0.21	18.41±0.51	0.098±0.003	35.35±0.38	5.87±0.37	76.40±1.4
P-values	0.1597	0.0064	0.0424	0.0117	0.5327	0.0010	<0.0001	0.7064
Strain								
Black	22.181±1.063	16.95±0.48	13.47±0.35	19.144±0.867	0.088±0.006	36.06±0.64	7.42±0.63	76.51±2.49
Lavender	20.24±0.512	17.06±0.23	13.49±0.17	17.94±0.41	0.110±0.003	35.90±0.30	8.07±0.30	71.14±1.20
Pearl	23.12±1.064	16.53±0.48	12.91±0.35	19.66±0.86	0.084±0.0063	36.33±0.64	7.42±0.64	79.00±2.49
White	22.78±0.86	16.74±0.394	13.93±0.29	19.88±0.70	0.10±0.005	36.04±0.52	7.06±0.52	77.67±2.03
P-value	0.0019	0.625	0.1019	0.0138	<0.0001	0.9130	0.1879	0.0003
Season								
Major Rain	22.195±0.43	16.80±0.198	13.55±0.146	19.389±0.35	0.1003±0.0026	35.86±0.26	7.55±0.26	76.52±1.26
Minor Rain	21.97±1.04	16.84±0.472	13.36±0.349	18.93±0.84	0.093±0.006	36.30±0.62	7.43±0.62	75.64±2.44
p-value	0.8404	0.9277	0.6082	0.6096	0.2932	0.5034	0.859	0.7344

Moisture, fat and carbohydrate were not significantly (p>0.05) affected by generation of birds (Table 4.8). The interactions of Generation x Sex, Generation x Strain and Sex x Strain were significant (P<0.05) on Moisture, Fat, Ash, Protein, Carbohydrate, PH and Cholesterol. Energy was significantly affected by the interactions of Generation x Sex and Generation x Strain (Table 4.7).

4.7 Effects of strain on Egg Qualities

Strain had significant (p<0.05) influence on albumen height. However, Albumen weight was not significantly (p>0.05) influenced by strain. Pearl had the highest albumen height compared to white, black and lavender (Table 4.9).

Yolk weight, Egg diameter and shell weight were not significantly (p>0.05) influenced by strain of birds.

Shell thickness and Haugh Unit were significantly (p<0.05) affected by strain of bird. The highest shell thickness was recorded by lavender followed by white, black and pearl. However, pearl had the highest Haugh Unit than white, black and lavender (Table 4.9; page 45).

4.8 Effects of non-genetic factors on Egg Qualities

4.8.1 Effects of Season of egg Qualities

Albumen height, albumen weight, yolk height were not significantly (p>0.05) influenced by season of hatch. Also, shell thickness, egg diameter, shell weight and Haugh unit were not significantly (p>0.05) influenced by season of hatch (Table 4.9).

4.9 Effects of generation on egg Qualities

Albumen height, shell thickness and Haugh unit were not significantly (p>0.05) influenced by generation of birds. However, Yolk weight and height as well as albumen weight were significantly (p<0.05) affected by generation. Parental generation had a better yolk weight and albumen weight than first filial generation. Yolk weight and height were higher in parental generation than in first filial generation.

Likewise egg diameter was higher in parental generation than in first filial generation. Shell weight was also higher in parental generation than in first filial generation (Table 4.9).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effects of Strain on Growth Performance of Guinea Fowl

5.1.1 Effects of strain on body weight

The significant difference in weight gain obtained in this study (Table 4.1) could be due to variation in the genetic makeup of the strains. This is because the different strains of Guinea fowls were made up of different genotypes and hence the difference in weights. Also, these results demonstrate that different Guinea fowl strains exhibit different growth performances such as body weight, resulting in variation among the strains. This result is comparable to the study of Giordani *et al*. (1993) who observed significant differences in the growth performance of different strains of local chicken. Also, Ojedapo *et al*. (2012) had significant ($p<0.05$) effect of strain on body weight of commercial layer chicken.

5.1.2 Effect of strain on Feed intake and feed conversion ratio

The higher feed intake recorded in the black strain (Table 4.2) may be attributed to higher body weights in black strain birds. The current study indicated that black strain birds had the highest feed intake followed by white, pearl, and lavender strains. Similar result was reported in Japanese quail (Devi *et al*., 2012).

Feed conversion ratio was not significantly ($p>0.05$) affected by strain. Similar result was reported by Reem and Cahaner (1999) that feed consumption was non-significant ($p>0.05$) in chicken genotypes.

5.2 Effects of Non-Genetic Factors on Growth Performance

5.2.1 Effects of Sex on body weight

The significantly better performances of the female birds than their male counterparts recorded in the study (Table 4.1) may be due to the aggressive nature of the male birds than female birds; hence, the male birds used most of their nutrients in running and flight activities. Also, the female birds possessed the heavy weights for reproductive purposes. It was observed during the study that male Guinea fowls bully/prevent females from getting access to feed when it was in short supply. In addition to that, Genetic makeup of female birds could have resulted in providing more potential for gaining more weight compared to males. Similar result was reported by Baeza *et al.* (2001) and Kokoszyński *et al.* (2011), who observed that female Guinea fowls were significantly heavier than the male Guinea fowls. The result of the current study disagrees with the findings of Apata *et al.* (2014), who reported higher body weights in males than in female ducks. The difference between the current study and that of Apata *et al.* (2014) could be due to the differences in the genetic makeup of Guinea fowls and ducks.

5.2.2 Effects of sex on feed intake and feed conversion ratio

The higher total and daily feed intake recorded in male birds (Table 4.2) may be due to the fact that the male birds need to take in more feed to maintain their high metabolic and flight activities. Also, because the male birds were more aggressive and vociferous than female birds when fed with feed in the same pen. This trend deviates from that of most domestic poultry species such as turkey, ducks and chicken for which males have heavier body weights than females. A study in ducks by Apata *et al.* (2014) support this trend. The better feed conversion ratio in male birds means efficient use of feed in male birds than their female counterparts. The current result contradicts the findings of Devi *et al.* (2012) in

Japanese quail, where female birds had significantly higher feed intake than the male birds. This difference observed in the current study could be attributed to the differences in species and the environment of the study.

5.2.3 Effects of Generation on body weight

Generally, the higher body weight and body weight gain recorded in the first filial generation (Table 4.1) indicates that the selection for body weights has improved the productive performance of the birds. It may also be due to the fact that selection for higher body weight showed positive response to selection. Similar result was reported by Hussain *et al*. (2013) who showed that, generation in which broiler chickens are hatched significantly affect body weight. Also, Sola-Ojo and Ayorinde (2011) reported that, first filial generation had significantly better weight gain than base generation in Japanese quail; likewise, second filial generation had significant improvement in body weight.

5.2.4 Effects of generation on feed intake and feed conversion ratio

The significantly higher total feed intake recorded in first filial generation in the current study (Table 4.2) could be attributed to positive response of higher body weight to selection. More so, higher body weight means higher feed intake to account for higher nutrient requirement to maintain metabolic activities. The heavier weight gain in the first filial generation birds had resulted in the better feed conversion ratio found in first filial generation than parental generation birds. The result of the current study is comparable to study of Khaldari *et al*. (2010); Hussain *et al*. (2013), that selected line had better feed intake than that of control line in Japanese quail.

5.2.5 Effects of season on body weight of Guinea fowl

The non-significant (p>0.05) effect of season on 6 months body weight, 8 months body weight, total weight gain and daily weight gain obtained in the current study (Table 4.1) may be due to the fact that the two seasons considered in this study do not differ that much in terms of general average temperature and this means the feed intake and hence body weights of birds were not affected, hence the non-significant different. The current result is comparable to the study by Ali (2006), that body weights of broiler chicks hatched in different seasons were not significant.

5.2.6 Effects of Season on feed intake and feed conversion ratio

The non-significant effect of season on feed intake and feed conversion ratio in this study (Table 4.2) may be due to the fact that the seasons considered in this study does not differ that much in terms of average temperature and this means the feed intake and body weight gains of birds were not affected, hence the non-significant different. The result of the current findings differs from that of Yakubu *et al*. (2007), who observed that chicken performed significantly better in the wet than hot-dry season with respect to feed intake. This could be that during the minor raining season, there was little amount of rain.

5.3 Effects of strain and Non-genetic factors on reproduction of Guinea fowl

5.3.1 Effects of strain on fertility and hatchability

The significant influence of strain on fertility and hatchability of eggs (Table 4.4) in the current study may be due to genetics of the birds. This result is comparable to those obtained by Obike *et al*. (2014) who obtained fertility of (49-67%) and hatchability of (68-70%) in indigenous Nigerian Guinea fowl strains (Black and Pearl). The higher fertility (57-67%) and lower hatchability (13-27) obtained in the current study may be due to differences in management practices and environmental conditions. Also, Islam *et al*. (2012) observed that strain had little effect on hatchability of chicken egg.

5.3. 2 Effects of Generation and Season on Egg weight

The significant effect of generation on egg weight (Table 4.4) could be due to positive response of body weight to selection, as body weight has positive influence on egg weight. That is increasing body weight leads to increasing egg weight. Egg weight in birds has been reported to be influenced by body weight (Lacin *et al*. 2008). The non-significant effect of season on egg weight (Table 4.4) means that season has no influence on egg weight. The report in the current study contradicts the results of Yakubu *et al*. (2007), who show that birds hatched in wet season performed significantly better in egg weight than those hatched in hot-dry season. The difference in the current study and that of Yakubu *et al*.(2007) was probably due to that fact that, the current study was conducted during the major raining and minor raining seasons but Yakubu *et al*.(2007) conducted theirs during major raining (wet) and hot-dry season, hence the difference.

5.4 Effects of Non-genetic factors on Egg Quality

5.4.1 Effects of strain on Egg Quality

The significant effects of strain of birds on egg qualities such as yolk height, albumen height, shell thickness and Haugh unit (Table 4.5b) may be attributed to the size of the egg, as egg size directly influences egg characteristics. Generally, the bigger the egg, the more the contents (albumen and yolk height) in size. Moreover, different strains have variant genetic makeup, hence differences in the egg qualities. Also, the higher calcium content of the feed of birds used in the study could be a contributing factor as calcium is used to form the egg shells. Higher calcium inclusion levels in diets leads to thicker egg shells.

Moreover, it could also be due to the genetics of the birds studied. Egg quality of birds are known to be influenced by factors such as strain of birds (Hanusova *et al*., 2015). This is a general trend in poultry birds, where genotype of birds influence egg quality as noted by Oroian *et al*. (2002 and Kumari *et al.* (2008).

5.4.2 Effects of Season on egg characteristics

The non-significant effect of season on egg characteristics (Table 4.9) could be due to the fact that season did not influence body weight of birds as body weight influences egg weight. The current study differs from Yakubu *et al.* (2007) who reported that, birds performed significantly better in the wet than hot-dry season on egg weight. The non-significant influence of season in the current study could be due to differences in species and the study environment.

5.4.3 Effects of generation on egg characteristics

The significant influence of generation on egg characteristics (Table 4.9) may be due to positive response of body weight to selection and higher body weight directly influences egg characteristics. First filial generation birds were better than parental generation birds and body weight influences egg characteristics. The result of the current study is comparable to earlier studies by Kumari *et al*.(2008), that there were significant ($p<0.01$) influence of generation for external and internal egg quality traits and percentage albumen, yolk and shell thickness.

5.5 Effect of Strain and Non-genetic factors on carcass characteristics

5.5.1 Effects of strain on carcass characteristics

The significant influence of strain on chemical composition of meat (Table 4.5a) may be due to genetic variations of the birds. Strains are genetically distinct. They result from different selection goals; as strains overlap in a definite management system, the strain differences are mostly genetic, hence their influence on chemical composition meat also differ. Chemical compositions of meats are influenced by hormones whose secretions are affected by genes. The result of the current study is comparable to the findings of Fratczak *et al*. (2002) who reported that genotype of Guinea fowl had significant influence on meat composition.

5.5.2 Effects of sex on carcass characteristics

Live weight and dressing weight were not significantly ($p>0.05$) influenced by sex of birds (Table 4.5a). This is because at maturity, the weights of male and female Guinea fowls are similar. Moreover, dressing weight is a function of live weight and as live weight is not significantly influenced, so was the dressed weight. Similar result was reported by Ogah (2013) in indigenous Guinea fowl in Nigeria. The current finding contradicts the result of Baeza *et al.* (2001), that sex had significant effect on live weight and dressing weight of Guinea fowl. This difference could be due to the management of birds and environment of the study.

5.5.3. Effects of Sex on Biochemical Parameters

The significant higher protein, fat and energy content of the carcass recorded in the male birds than female birds (Table 4.8) could be due to the fact male birds use more energy as well as protein and fats for flight activities and protection of the female birds. Furthermore, this could be due to the fact that male birds were aggressive than female birds during feeding in the same pen, hence male birds took in more feed resulting into higher protein, fat and energy content than female birds. Baeza *et al*. (2001) also reported similar findings in Guinea fowl.

5.5.4 *Effect of generation on carcass characteristics*

The significant influence of generation on dressing percentage (Table 4.5a) may be due to better body weights recorded in birds in first filial generation compared to parental generation; thus better response of body weight to selection. The body weights might have influenced the carcass characteristics. This result is comparable to the findings of Charati and Esmailizadeh (2013) who observed that generation had significant effect on live weight and dressing percentage in Japanese quail.

5.6 Interaction effects of strain and non-genetic factors on carcass characteristics

The significant influence of Sex x Strain interaction on live weight, neck weight, shank and intestine weight (Table 4.7) may be due to interaction of genetics and environmental factors on carcass characteristics. This means that even though sex alone did not influence carcass characteristics, the combining effects of sex and strain influenced carcass characteristics. This implies that effect of sex is dependent on strain. The current result confirms the findings of Moula *et al*. (2013), that sex x strain interaction significantly affect carcass characteristics in chicken.

5.7 Interaction effects of strain and non-genetic factors on biochemical properties of carcass

The significant influence of sex x strain interaction on percent moisture, protein, ash, cholesterol and pH (Table 4.8) observed could be attributed to the combined effects of sex and strain on biochemical properties of carcass characteristics. This indicates that the influence of sex on these biochemical properties of carcass is dependent on strain of birds and the differential responses in these traits could be more important than the main effects.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

It can be concluded from the study that:

- Strain influenced growth and weight gain. Lavender performed best, followed by black, white and pearl strain of birds.
- Fertility and hatchability of eggs were influenced by strain of birds. Pearl birds had the best percent fertility and hatchability, followed by black, lavender and white birds.
- Strain influenced intestine weight as well as moisture, fat and carbohydrate content. The carcass of pearl had the highest moisture content than black, white and lavender. Lavender recorded the highest fat, followed by white, black and pearl. White had the highest carbohydrate content followed by lavender, black and pearl.
- Strain had influence on albumen height. Pearl had the highest albumen height compared to white, black and lavender. Yolk weight was influenced by strain. White had best yolk height than pearl, black and lavender.
- Shell thickness and Haugh Unit were influenced by strain of bird. The highest shell thickness was recorded by lavender followed by white, black and pearl. However, pearl had the highest Haugh Unit than white, black and lavender
- Sex influenced total weight and daily weight gain. Female birds were heavier than the male birds.
- Female birds had higher moisture content than male birds. Male birds had a higher percent fats than female birds, the energy content was higher in male birds than in female birds
- First filial generation birds had a significantly better body weight, total weight and daily weight gain as well as feed intake than parental generation birds.

- Egg weight was influenced by generation. Parental generation had a higher egg weight than the first filial generation. Season did not influence the reproductive traits studied.
- Parental generation had a better significant live weight than first filial generation.
- Season had no influence on body weight, feed intake as well as feed conversion ratio.
- Season had no significant influence on egg quality traits studied.

6.2 Recommendation

It can be recommended from the study that:

1. Genetic as well as non-genetics factors should be considered in designing breeding programmes that aim at improving the indigenous Guinea fowl.
2. Also, the study should be repeated for more than three generations of birds to evaluate the consistent in weight gain from one generation to the other.
3. Other non-genetic factors such as feed and type of housing units should also be investigated to determine their effects on reproduction as well as growth performances of indigenous Guinea fowl.

REFERENCES

Adebambo, A.O., Ozoje, M.O., Funmi, A. and Abiola, S. (2006). Genetic variations in growth performance of Giriraja, Indian White Leghorn and improved indigenous chicken breeds in South West Nigeria. *Nigerian Journal of Genetics*, 20: 7-16.

Aganga, A.A., Tshenyane, S.O. and Molefhe, L. (2003). Influence of feed type on egg production of Tswana laying chicken. *International Journal of Poultry Science*, 2: 256-258.

Ajayi, F. O. and Ejiofor, O. (2009). Effects of Genotype X Sex Interaction on Growth and Some Development Characteristics of Ross and Anak Broiler Strains in the High Rainforest Zone of Nigeria. *Asian Journal of Poultry Science*, 3: 51-56.

Akram, M., Hussain, J., Sahota, A. W., Ahmad, S., Jatoi, A. S., Ali, A. and Dawood, M. (2012). Genetic gain in 4 week body weight through mass selection in 4 close-bred stocks of Japanese quail. *Book of abstracts. 32nd Congress of Zoology, Lahore, Pakistan.*

Aksit, M., Yalcin, S., Ozkan, S., Metin, K. and Ozdemir, D. (2006). Effects of temperature during rearing and crating on stress parameters and meat quality of broilers. *Poultry Science*,85: 1867-1874.

Ali, E.A. (2006). *Effect of dietary supplementation with organic chromium on productive, physiological and immunological traits of three hybrids of Broiler chicken*. M.Sc. Thesis, College of Agriculture, Baghdad University, Iraq.

Ali, M.I., Wahid, M.A., Howlider, R.M.A. and Peasmin, T. (1993). Reproduction and growth of Rhode Island Red (RIR), Fayoumi (FO) and RIR x FO chickens in Banglandesh. *Poultry Adviser*, 26: 47-50.

Anjum, M. A., Sahota, A. W., Akram, M., Javed, K. and Mehmood, S. (2012). Effect of selection on productive performance of desi chicken for four generations. *The Journal of Animal & Plant Sciences*, 22(1):1-5.

Annor, S.Y., Ahunu, B.K., Aboagye, G.S., Boa-Amponsem K. and Cassady, J.P.(2012). Non-Genetic Factors Affecting Grasscutter Production Traits. 1. Growth Traits. *World Applied Sciences Journal*, 18 (10): 1412-1424.

Annor, S.Y., Apiiga, S.Y. and Ahiaba, J. (2013). *Guinea Fowl production: A handbook*. Accra, Ghana: Quality type Ltd.

Apata, E. S., Koleoso, I. M., Taiwo, B. B., Okubanjo, A. O. and Tijani, L. A. (2014). Comparative Effects of Breed and Sex on Carcass and Organ Profiles of Duck (*Anas plantrynychos*) and Guinea Fowl (*Numidia meleagris*) in Abeokuta, Ogun State, Nigeria. *Sustainable Agriculture Research*, 3 (4): 107-112.

Argüelles, M., Santiago, H. L. and Rodriguez, A. A. (2004). *The Effects of Inclusion of a Fermented Fish By-Product Meal in Guinea Fowl (Numida meleagris) Diet on Performance and Carcass Quality*. Department of Animal Science, University of Puerto Rico- Mayaguez Campus, Mayaguez.

Ashok, A. and Prabakaran, R. (2012). Effect of Non-Genetic Factors on Growth Traits in Short Term Selection for Different Ages in Japanese quail. *Journal World's Poultry Research*, 2(2): 28-32.

Awobajo, O. K., Mako, A. A., Abiola-Olagunju, O. I., Ogunwole, O.A., Hamzat, R. A., Igbosanu, A. O. and Ettu, R. O. (2009). Comparison of egg hatchability between two breeds of layers. *In Abstracts: International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia*. Pp. 23.

Ayorinde, K. L. (1991). Guinea fowl as a protein supplement in Nigeria. *World's Poultry Science Journal*, 47(1): 21-26.

Ayorinde, K. L. (2004). *The Spice of Life*. 71st Inaugural Lecture, University of Ilorin, Ilorin, Nigeria.

Babiker, J.M.S. and Musharaf, Z.N.A.(2008). Effect of season on hatchability and fertility of egg-type parent stock (Bovans) in Sudan. *Research Journal of Poultry Science*, 2(1):5-8.

Baéza, E., Juin, H., Rebours, G., Constantin, P., Marche, G. and Leterrier, C. (2001). Effect of genotype, sex and rearing temperature on carcass and meat quality of Guinea fowl. *Poultry Science*, 42: 470-476.

Benyi, K., Tshilate, T.S., Netshipale, A.J. and Mahlako, K.T.(2015). *Tropical Animal Health Production*, 47(7): 1225. doi:10.1007/s11250-015-0850-3.

Bianchi, M., Petracci, M., Sirri, F., Folegatti, E., Franchini, A. and Melazzi, A. (2007). The influence of season and market class of broiler chickens on breast meat quality traits. *Poultry Science*, 86: 959-963.

Biswas, E. R. I. (1999). Guinea Fowl. *Ghana Journal of Science*,7:88-89.

Charati, H. and Esmailizadeh, A. K. (2013). Carcass traits and physical characteristics of eggs in Japanese quail as affected by genotype, sex and hatch. *Journal of Livestock Science and Technologies*, 1 (2): 57-62

Darre, M. J. (2007). *Guinea Fowl Management Extension Poultry Specialist*. Department of Animal Science, University of Connecticut. Storrs CT 06269-4040.

Dei, H. K. and Karbo, N. (2004). *Improving Smallholder Guinea Fowl Production in Ghana*. A Training Manual. Cyber Systems, Tamale, Ghana. P. 27.

Dessie, T. and Ogle, B. (2001). Village Poultry Production System in the Central Highlands of Ethiopia. *Tropical Animal Health and Production*, 33: 521-537.

Devi, K. S., Gupta, B. R., Prakash, M. G. and Rajasekhar, A. (2012). Genetic parameters of feed efficiency and daily weight gain in Japanese Quails. *Department of Animal Genetics and Breeding, College of Veterinary Science Rajendranagar, Hyderabad-500030(AP)*, *8*(1), 6–13.

Ducrocq, V. (1997). Survival analysis, a statistical tool for longevity data. In: *48th Annual meeting of the European Association of Animal Production*. Vienna, Austria. Pp. 1–14.

Eberhart, D.E. and Washburn, K.W. (1993). Assessing the effects of the naked neck gene on chronic heat stress resistance in two genetic populations. *Poultry Science*, 72:1391-1399.

Embury, I. (2001). *Raising Guinea fowl*. New South Wales Agriculture Publications, New South Wales, USA. Pp.4.

Faruque, S., Islam, M.S., Afroz, M. A. and Rahman, M. M. (2013). Evaluation of the performance of native chicken and estimation of heritability for body weight. *Journal of Bangladesh Academy of Sciences*, 37(1): 93-101.

Fayeye, T.R., Adeshiyan, A.B. and Olugbami, A.A. (2005). Egg traits, hatchability and early growth performance of Fulani-ecotype chicken. *Livestock Research and Rural Development*, 17:8.

Feltwell, R. (1992) Small-scale Poultry Keeping. A Guide to Free Range Poultry Production. Faber and Faber Limited. pp142-143.

Fisinin, V.I. and Zlachevskaya, K.V. (2004). *The Guinea fowl*. Animal Genetic Resource. FAO Corporate Repository document.

Frątczak, M., Rutkowski, A. and Józefiak, D. (2002). Comparison of several diet formulas used in rearing guinea fowl. *Roczniki Naukowe Zootechniki suplementary*,16: 205-210.

Garces, A., Casey, N.H. and Horst, P. (2001). Productive performance of naked neck, frizzle and dwarf laying hens under various natural climates and two nutritional treatments. *South African Journal of Animal Science*, 31 (3): 174-180.

Gaya, L.G., Ferraz, J. B. S., Rezende, F. M., Moura˜o, G. B., Mattos, E. C., Eler, J. P. and Michelan-Filho, T. (2006). Heritability and Genetic Correlation Estimates for Performance and Carcass and Body Composition Traits in a Male Broiler Line. *Poultry Science*, 85:837–843.

Ghana Districts (2006). A repository of all districts in the Republic of Ghana. Public – Private Partnership Programme between Ministry of Local Government, Rural Development and Environment &Maks Publications &MeAdia Services. Retrieved January 15, 2016 from, http://www.ghanadistricts.com/districts/?news&r=10&_=47

Giordani, G., Meluzli, A., Cristofori, C. and Calini, F. (1993). Study on the performance and adiposity of modern broiler: Comparison among strains. *Animal Breeding Abstracts*., 61: 581-596.

Górski, J. (1992). Effect of age, origin and sex of the Pekin ducks on their slaughter value. *Rocz. Nauk. Zoot*., 19: 77-85.

Halima, H.M. (2007). *Phenotypic and genetic characteristics of indigenous chicken population in North-West Ethopia*. PhD Thesis. Faculty of Natural and Agricultural Sciences, Department of Animal, Wildlife and Grasslands. University of Free-State, Bloemfontein, South-Africa.

Hani, N.H., Kamarn, A. A., Aram, A. M., Tahir, R. A., Shayma, M. A. and Dastan, A. H. (2011). *Effect of genetic lines and season on body weights of chicks*. College of Agricllture, University of Salahaddin, Erbil, Kurdistan Region, Iraq.

Hanusova, E., Hrnčá, C., Hanus, A., Oravcová, M. (2015). Effect of breed on some parameters of egg quality in laying hens. *Acta fytotechnica et zootechnica*,18(1):20-24.

Havenstein, G.B., Ferket, P.R., Scheideler, S.E. and Rives, D.V. (1994). Carcass composition and yield of 1957 vs 1991 broilers when fed "typical" 1957 and 1991 broiler diets. *Poultry Science*, 73:1805-1812.

Headley, D. (2003). Early Birds: Guinea Fowl. *SPPA Bulletin*, 8(3): 8-9.

Horst, P. (1991). Native fowl as a reservoir for genomes and major genes with direct and indirect effects on productive adaptability and their potential for tropically oriented breeding plans. *A review of Animal Research and Development*, 33: 63-79.

Hussain, J., Akram, M., Sahota, A. W., Javed, K., Ahmad, H.A., Mehmood, S., Ahmad, S., Sulaman, R., Rabbani, I. and Jatoi, A. S. (2013). Selection for higher three week body weight in Japanese quail: effect on growth performance. *The Journal of Animal & Plant Sciences*, 23(6):1496-1500.

Ikani, E. I. and Dafwang, I. I. (2004). *The Production of Guinea Fowls in Nigeria*. National Agricultural Extension and Research Liaison Services, Ahmadu Bello University, P.M.B. 1067. Extension Bulletin No. 207, Poultry Series No. 8.

Islam, M.A., Bulbuli, S.M., Seeland, G. and Islam, A.B. (2012). Egg quality of different chicken genotypes in summer and winter. *Pakistan Journal of Biological Sciences*,4: 1411-1414.

Islam, M.S., Howlider, R.M.A., Kabir, F. and Alam, J. (2002). Comparative assessment of fertility and hatchability of Barred Plymouth Rock, White Leghorn, Rhode Island Red and White Rock hen. *International Journal of Poultry Science*, 4: 85-90.

Jacob, J. and Pescatore, T. (2011). *Keeping Guinea Fowls*. Cooporative Extension Service. University of Kentucky. College of Agriculture. Lexington, KY, 40546.

Jaturasitha, S., Kayan, A. and Wicke, M. (2008). Carcass and meat characteristics of male chickens between Thai indigenous compared with improved layer breeds and their crossbred. *Archiv fur Tierzucht Dummerstorf*, 51(3): 283-294.

Jayarajan, S. (1992). Seasonal variation in fertility and hatchability of chicken eggs. *Indian Journal of Poultry Science*, 27: 36-39.

Jesuyon, O.M.A. and Salako, A.E. (2013). Effects of season on the reproductive performances of Bovan Nera and Isa Brown Parent -stock Chickens in a Hot Humid Environment. *International Journal of Animal and Veterinary Advances*, 5(6):212-215.

Kamble, K.D., Singh, D.P., Jori, D.C. and Sharma, R.D.(1996). Reproductive performance of various Indian native breeds and their crosses with Dahlem Red. *Proceedings of the World`s Poultry congress*, New Delhi, India, 2-5 September. pp. 36.

Karima, A.S. and Fathy, A.E. (2005). Effects of breed, sex and diet and their interactions on carcass composition and tissue weight distribution of broiler chickens. *Archiv fur Tierzucht Dummerstorf*, 48:612-626.

Kasperska, D., Korytkowska, H. and Kokoszyński, D. (2011). Effect of age and sex on bodyweight and body dimensions of pearl grey Guinea fowl (*Numida meleagris*). *Acta Scientiarum Polonorum, Zootechnica*, 10 (3): 39–44.

Khaldari, M., Pakdel, A., Yegane, H.M., Javaremi, A. N. and Berg, P. (2010). Response to selection and genetic parameters of body and carcass weights in Japanese quail selected for 4-week body weight. *Poultry Science*, 89 (9): 1834-1841.

Khalid, A.M., Yousif, I.A., Omer, M.I. and Elamin, K. M. (2012). Genetic variability of body composition traits in Sudanese Native large Beladi Chicken. *Agriculture and Biology Journal of North America*, *3*(2):69–76.

Kokoszyński, D., Bernacki, Z., Korytkowska, H., Wilkanowska, A. and Piotrowska, K. (2011). Effect of age and sex on slaughter value of guinea fowl (*Numida meleagris*). *Journal of Central European Agriculture*,12(2):255-266.

Koney, E.B.M. (1993). *Poultry Health and Production*. Advent Press, Accra-Ghana. Pp. 104 – 107.

Kosarachukwu, C. O., Iheshiulor, O.O.M., Omede, A. and Ogbuewu, P.I. (2010). Effect of strain on growth, carcass characteristics and meat quality of broilers reared for 12 weeks. *New York Science Journal*, 3(5):112-116.

Kumari, B. P., Ramesh Gupta, B. R., Prakash, M.G. and Reddy, A.R.(2008). A study on egg quality traits in Japanese quails (*Coturnix coturnix japonica*). *Tamilnadu Journal of Veterinary & Animal Sciences*, 4 (6): 227-231.

Kwarteng, J. A. and Towler, M. J. (1994). *West African Agriculture*. Macmillan Press Ltd. London and Basingstoke. P. 321.

Lacin, E., Yildiz, A., Esenbuga, N. and Macit, M. (2008). Effects of differences in the initial body weight of groups on laying performance and egg quality parameters of Lohmann laying hens. *Czech Journal of Animal Science*, 53: 466-471.

Leach, T. (2009). *Helmeted Guinea Fowl*. Oxford Scientific Films/ BBC Natural History Sound Library.

Leenstra, F.R. and Cahaner, A. (1991). Genotype by environment interactions using fast-growing, lean or fat broiler chickens, originating from The Netherlands and Israel, raised at normal or low temperature. *Poultry Science*, 70:2028–2039.

Leterrier, C., Baéza, E., Rebours, G., Constantin, P., Marche, G. and Jamenot, P. (1999). Label production of guinea fowl and carcass quality. *Proceedings of the XIV European Symposium on the Quality of Poultry Meat*. Bologne-Italy. Pp.265-270.

Magdelaine, P., Spies, M.P. and Valceschini, E. (2008). Poultry meat consumption trends in Europe. *World Poultry Science*, 64: 53-64.

Marshaly, M.M, Hendricks, G.L., Kalama, M.A., Gehad, A.E., Abbas A.O. and Patterson, P.H. (2004). Effect of heat stress on production parameters and immune responses on commercial laying hens. *Poultry Science*, 83: 889-894.

Martinez, I. (1994). Family Numididae (Guinea Fowl) Pp. 554- 570 in: Del Hoyo, Elliott, A. and Sargatal, J. Handbook of the Birds of the World, Vol. 2. New World Vultures to Guinea Fowl. Lynx Editions, Barcelona, ISBN 8487334156.

Mathur, P.K. (2003). Genotype-environment interactions: Problems associated with selection for increased production. Pages 83-99 *in: Poultry Genetics, Breeding and Biotechnology*. Eds. W.M. Muir and S.E. Aggrey. CABI Publishing, Wallingford, UK.

Meteorological Services Department (MSD) (2015). *Annual Reports*. Mampong Municipal Assembly, Mampong-Ashanti, Ashanti Region, Ghana.

Meyer, K. (1998). Modelling `repeated' records: Covariance functions and random regression models to analyse animal breeding data. *Proceedings of the 6th World Congress on Genetics Applied to Livestock Production*, 25:517–520. University of New England, Armidale, Australia.

Minvelle, F., Hirigoyen, E. and Boulay, M. (1999). Associated effects of roux plumage colour mutation on growth, carcass trait, egg production and reproduction of Japanese quail. *Poultry science*, 78: 1479-1484.

Monira, K. N., Salahuddin M. and Miah, G. (2003). Effect of Breed and Holding Period on Egg Quality Characteristics of Chicken. *International Journal of Poultry Science*, 2 (4): 261-263.

Moreki, J. C. (2009). Guinea Fowl Production. *Reach Publishers, Wandsbeck, South Africa*, 3631: 7–31. Retrieved from http://www.gov.bw/Global/MOA/Guinea Fowl Production.pdf

Moreki, J. C. and Mack, N. (2013). Effect of storage time and egg position on hatchability of guinea fowl eggs. *Journal of Animal Science Advances*,2(5):259-261.

Moula, N., Michaux, C., Philippe, F.X., Antoine-Moussiaux, N. and Leroy, P. (2013). Egg and meat production performances of two varieties of the local Ardennaise poultry breed: silver black and golden black. *Animal Genetic Resources*, 53: 57–67.

Mróz, E., Tomaszewsk, K., Michalik, D., Makowski, W., Stępińska, M. and Kubińska, M. (2016). Effect of genotype, sex and age on plumage maturity, and body weight of guinea fowl *(Numida meleagris)*. *Annals of Animal Science*, 16(1): 245–257.

Musa, H.H., Chen, G.H., Cheng, J.H., Li, B.C. and Mekki, D.M. (2006). Study on Characteristics of chicken breeds raised under the intensive condition. *International Journal of Poultry Science*, 5(6):530-533.

Nahashon, S. N., Aggrey, S. E., Adefope, N. A. and Amenyenu, A. (2006). Modeling growth characteristics of meat-type Guinea fowl. *Poultry Science*, *85*(5): 943.

National Research Council (NRC) (1991). *Guinea Fowl- In Micro Livestock. Little Known Small Animals with a Promising Future*. National Academy Press, Washington D. C. Pp. 113- 123.

Nsoso, S.J., Mareko, M.H.D. and Molelekwa, C. (2006). Comparison of growth and morphological parameters of guinea fowl (*Numida meleagris*) raised on concrete and earth floor finishes in Botswana. *Livestock Research for Rural Development*, 18: (12).

Nwachucku, E. N. (1998). Sexual dimorphism of some conformation traits and carcass composition of Muscovey duckling raised intensively. *Proceedings of Silver Anniversary of Nigerian Society of Animal Production of West African Society Animal Production Inaugural Conference*. March 21-28.

Nwachukwu, E.N., Ibe, S.N. and Ejekwu, K. (2006). Short term egg production and egg quality characteristics of main and reciprocal crossbred normal local, necked and frizzle chicken X exotic broiler breeder stock in a humid tropical environment. *Journal of Animal and Veterinary Advances*, 5(7): 547-551.

Nwagu, B. I. and Alawa, C. B. I. (1995). Guinea fowl Production in Nigeria. Poultry research programme, National Animal Production Research Institute. *World Poultry Science Journal*, 51: 260-270.

Obike, O. M., Nwachukwu, E.N. and Ukewulonu, I. E. (2014). Effect of strain and associations of some fertility and hatchability traits of indigenous guinea fowls raised in the rain-forest zone of South-East Nigeria. *Global Journal of Animal Breeding and Genetics*, 2 (7): 098-102.

Ogah, D. M. (2013). Variability in body shape characters in an indigenous Guinea fowl (*Numida meleagris* l.). *Slovak Journal of Animal Science*, 46(3): 110-114

Ogunlade, I. and Adebayo, S.A. (2009). Socio-economic status of women in rural poultry production in selected areas of Kwara state, Nigeria. *International Journal of Poultry Science*, 8 (1): 55-59.

Ojedapo, L.O., Akinokun, O., Adedeji, T.A., Olayeni, T.B., Ameen, S.A. and Amao S.R.(2008). Strain and sex on carcass characteristics of three commercial broilers reared in deep litter system in the derived savannah area of Nigeria, *World Journal of Agricultural Sciences*, 4: 487-491.

Ojedapo, L.O., Amao, S.R., Ameen, S.A., Adedeji, T.A., Ogundipe, R.I. and Ige, A.O. (2012). Prediction of Body Weight and other Linear Body Measurement of Two Commercial Layer Strain Chickens. *Asian Journal of Animal Sciences*, 6: 13-22.

Olawumi, S.O. (2007). Genotype x Season interaction effects on reproductive performance of two breeds of layers breeders in humid zone in Nigeria. *Applied tropical Agriculture*, 12(2):78-82.

Olawumi, S.O. (2015). The effect of seasonal variability on fertility and mortality rates of two strains of breeder cocks in the humid tropics. *Journal of Animal and Veterinary Sciences*, 2(5): 43-46.

Olawumi, S.O. and Dudusola, I. (2010). Effects of Genotype and Housing on reproductive performance of two strains of commercial layers in the derived savannah zone of Nigeria. *Production Agricultural Technology Journal*, 6(1): 102-109.

Olawumi, S.O. and Salako, A.E.(2011). Study on Reproductive Traits of Barred Plymouth Rock and White Plymouth Rock Parent Stock (Female Breeders) in the Humid Zone of Nigeria. *World Journal of Agricultural Sciences*, 7 (1): 96-99.

Olawumi, S.O., Fajemilerhin, S.O. and Fagbuaro, S.S. (2012). Genotype × sex interaction effects on carcass traits of three strains of commercial broiler chickens. *Journal of World's Poultry Research*, 2: 21-24.

Oroian, T., Vlaic, A. and Cighi, V. (2002). Some aspects concerning the egg production performances in two Japanese quail varieties. *CAB Abstracts*.

Oyedeji, J.O., Orheruata, A.M. and Omatsuli, M. (2007). Effects of feed rationing on the laying performance of 40weeks in lay hens. *Journal of food, Agriculture and Environment*, 5: 301-303.

Ozcelik, M., Gerit, H., Ekmen, F. and Dogan, I. (2006). Effect of the hatching month as an environmental factor on the hatching features on bronze turkeys. *Turkey Journal of Veterinary Animal Science*, 30: 243-249.

Persia, M.E., Utterback, P.L., Biggs, P.E., Koelkebeck, K.W. and Parson, C.M. (2003). Interrelationship between environmental temperature and dietary non-phytate phosphorus in laying hens. *Poultry Science*, 82: 1763-1768.

Plavnik, I. and Yahav, S. (1998). Effect of environmental temperature on broiler chickens subjected to growth restriction at an early age. *Poultry Science*, 77: 870-872.

Popovic, B. and Pym, R.A.E.(1998). Reproductive performance in Japanese quail selected for breast meat yield. *Proceedings of Australian Poultry Science Symposium.*

Rajini, R.A., Narahari, D. and Kumararaj, R. (2009). Influence of season, form of feed, dietary energy, age and sex on broiler organ biometry. *Indian Journal of Poultry Science*, 44 (15).

Reem, Y. and Cahaner, A. (1999).The effects of naked-neck (Na) Frizzle (F) genes on growth and meat yield of broilers and their interactions with ambient temperatures and potential growth rate. *Poultry Science*,78: 1347-1352.

Sahota, A.W., Bhatti, B. M. and Akhtar, L. A. (2003). Comparative productive performance of Desi parent chickens and their first progeny maintained on deep litter system. *Pakistan Veterinary Journal*, 23 (1): 7-10.

Saina, H., Kusina, N.T., Kusina, J.F., Bhebhe, E. and Lebel, S. (2005). Guinea fowl production by indigenous farmers in Zimbabwe. *Livestock Research for Rural Development*, 17(9).

Salahuddin, M., Barua, A., Rashid, N. and Howlider, R.M.A. (1990). Relationship between fertility and hatchability with egg weight of free range native Bangladeshi chicken. *Poultry guide*, 28: 34-36.

Schneider, B. L., Zuidhof, M. J., Renema, R. A., Betti, M. and Carney, V. L. (2009). Effect of sex, protein and energy level on broiler carcass. Poultry Research Centre, Edmonton, AB, Canada. *In Abstracts: International Poultry Scientific Forum Georgia World Congress Center, Atlanta, Georgia.*

Settar, P., Yalçin, S., Türkmut, L., Ozkan, S. and Cahanar, A. (1999). Season by genotype interaction related to broiler growth rate and heat tolerance. *Poultry Science*, 78(10):1353-1358.

Sharifi, A.R., Horst, P. and Simianer, H. (2010). Effects of naked neck gene and ambient temperature and their interaction on the reproductive traits of heavy broiler dams. *Poultry Science*, 89:1360-1371.

Sheridan, A. K. (1990). Genotype x environment interaction. Pages 897-912 *in: Poultry Breeding and Genetics*. Ed. R. D. Crawford. Elsevier, Amsterdam, The Netherlands.

Shokoohmand, M., Emam, J.K.N. and Emami, M.M.A.(2007). Estimation of heritability and genetic correlations of body weight in different age for three strains of Japanese quail. *International Journal of Agriculture & Biology,* 9 (6):945-947.

Smith, A. J. (2001). *Poultry: The tropical Agriculturalist* (revised edition). London, U.K: MacMillan with CTA.

Smith, A.J. (1990). *Poultry Production*. London: MacMillian publishers Ltd.

Sola-Ojo and Ayorinde, K.L. (2011). Evaluation of Reproductive Performance and Egg quality Traits in Progenies of Dominant Black Strain Crossed with Fulani Ecotype Chicken. *Journal of Agricultural Science*, 3(1): 258-265.

Song, K.T., Choi, S.H. and Oh, H.R. (2000). Comparison of egg quality of Pheasant, Chukar and Guinea fowl. *Asian-Australasian Journal of Animal Science*, 13(7): 986-990.

Ssewanyanna, E., Onyait, A.O., Ogwal, J., Mukasa, B., Nsamba, P. and Masaba, J. (2001). Characteristics of rural chicken in Apac and Kumi districts of Uganda. *Paper presented at the NARO Scientific Conference*, 5-10 December 2001, Kampala, Uganda.

Tebesi, T., Madibela, O. R. and. Moreki, J.C. (2012). Effect of storage time on internal and external characteristics of Guinea fowl (*Numida meleagris*) eggs. *Journal of Animal Science Advances*, 2(6):534-542.

Teye, G. A. and Gyawu, P.(2002). *A guide to Guinea fowl production in Ghana*. University for Development Studies, Tamale.

Teye, G.A. and Adam, M. (2000). Constraints to Guinea fowl production in northern Ghana: A case study of the Damongo area. *Ghana Journal of Agriculture Science*, 33:153.

United States Department of Agriculture (USDA) (2013). *Ghana Poultry Report Annual*. Global Agricultural Information Network Reports, No. 1303.

Vali, N., Edriss, M. A. and Rahmani, H. R. (2005). Genetic parameters of body and some carcass traits in two quail strains. *International Journal of Poultry Science*, 4:296–300.

Varkoohi, S., Babak, M. M. S., Pakdel, A., Javaremi, A. N., Zaghari, M. and Kause, A. (2010). Response to selection for feed conversion ratio in Japanese quail. *Poultry Science*, 72:1005-1011.

Veldkamp, T., Ferket, P.R., Kwakkel, R.P., Nixey, C. and Noordhuizen, J.P.T.M. (2000). Interaction between ambient temperature and supplementation of synthetic amino acids on performance and carcass parameters in commercial male turkeys. *Poultry Science*, 79: 1472-1477.

Veldkemp, T., Kwakkel, R.P., Ferket, P.R. and Verstegen. M.W. A. (2005). Growth responses to dietary energy and lysine at high and low ambient temperature in male turkey. *Poultry Science*, 84: 273-282.

Washburn, K. W. (1990). *Genetic variation in egg composition*. *In Poultry Breeding and Genetics.* Edited by Crawford, R. D. Elsevier Science Publishers. B.V. Netherlands.

William, P. R. (1999). World poultry consumption. *Poultry Science,* 78: 722-728.

Willis, M.B. (1991). *Dalton's introduction to practical animal breeding*. 3rd edition. Blackwell scientific publication.

Wikipedia, (2008). *Guinea fowl.* The free encyclopaedia. Wikimedia, Foundation, Inc. US registered.

Wolvertoon, A. and Frimpong, S. (2013). Consumer Demand for Domestic and Imported Broiler Meat in Urban Ghana: Bringing Non-price Effects into the Equation. *British Journal of Marketing Studies*, 1(3):16-31.

Wondmeneh, E., Van der Waaij, E.H., Udo, H.M.J., Tadelle, D. and Van Arendonk, J.A.M. (2016). Comparison of different poultry breeds under station and on-farm conditions in Ethiopia. *Livestock science, 183:* 72–77.

Yakubu, A., Salako, A.E. and Ige, A.O.(2007). Effects of Genotype and Housing System on the Laying Performance of Chickens in Different Seasons in the Semi-Humid Tropics. *International Journal of Poultry Science*, 6 (6): 434-439.

Zerehdaran, S., Vereijken, A.L.J., van Arendonk, J.A.M. and van der Waaij, E.H. (2004). Estimation of genetic parameters for fat deposition and carcass traits in broilers. *Poultry Science*, 83: 521-525.