AKENTEN APPIAH-MENKAH UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

GROWTH POTENTIAL OF FOUR LOCAL CHICKEN (*Gallus domesticus*) GENOTYPES IN THE SAGNARIGU MUNICIPALITY OF GHANA

YAW AMEVOR

MPHIL (ANIMAL BREEDING AND GENETICS)

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BY

YAW AMEVOR

(8201990006)

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DECLARATION

Candidate's Declaration

I, YAW AMEVOR, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE:……………………………….

DATE:……………………..........................

Supervisor's Declaration

I hereby declare that the preparation and presentation of the research work was supervised in accordance with the guidelines on supervision of thesis, laid down by the Akenten Appiah Menkah University of Skills Training and Entrepreneurial Development.

SUPERVISOR'S NAME: **DUODU ADDISON (PhD)**

SIGNATURE:……………………………………

DATE:…………………………..........................

DEDICATION

I dedicate this work to my wife (Rita Twum Asante) and my lovely children; Julius, Rosaline and Eliana.

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I wish to register my recognition and appreciation to my supervisor, Dr. Duodu Addison for his guidance which pivoted the completion of this work.

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LIST OF ABBREVIATION

BC:	Before Christ
BV:	Breeding Value
BWT:	Body Weight
EBVs:	Estimated Breeding Values
ECI:	Efficiency of Conversion of Ingested Foods
FAnGR:	Farm Animal Genetic Resource
FAO:	Food and Agriculture Organization
FCR:	Feed Convention Ratio
FI:	Feed intake
GLM:	Generalized Linear Model
GEBV:	Genetic Estimated Breeding Value
GS:	Genetic Selection
ND:	New Castle Disease
NRC:	National Research Council
PDIFF:	Probability Difference
RMSC:	Resource and Management Support Centre
SAS:	Statistical Analysis System
SSA:	Sub-Saharan Africa

ABSTRACT

The study was carried out to assess the potential of four Ghanaian indigenous chicken genotypes. One hundred and Twelve (112) made up of 45 males and 67 females These were comprised of 28 each of naked neck, normal feathered, fizzle and silky were reared for 23 weeks. The birds were separated into four genotypes and replicated four times each, using Completely Randomized Design (CRD). Data were taken on production and heat tolerant traits and breeding value. Data were subjected to analysis of variance using Genstat. The results obtained showed that the naked neck recorded the highest body weight and body weight gain throughout the study period. The Frizzle had the highest average daily FI value (55.64g/d), whereas Silky had the lowest (44.77g/d). The feed conversion ratio of the naked neck was better than its counterparts. The body temperature was higher among the normal feathered. Higher pulse rates were also found in the Normal Feathered genotype. Respiratory rate and pulse rate showed a similar pattern. Lower heat stress index was observed among the silky and the frizzle. The brooding and post brooding mortality each was lower (thus less than 10%) for each genotype. Breeding value of the birds also showed significant differences. It is recommended that farmers should use the naked neck genotype for production in order to achieve higher productivity in body weight, body weight gain and feed conversion ratio; the frizzle and the silky could be reared in heat prone zones since they have good characteristics for heat tolerance

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Local poultry especially domestic chicken (*Gallus domesticus*) and Guinea fowl (*Numida meleagris*), play a key role in most parts of Ghana in the supply of meat and eggs. Local chickens are widely distributed in most rural areas in Ghana, where they are raised largely as a source of protein and income for the residents. According to Egahi*et al.* (2010), the indigenous chicken possesses specific adaptation characteristics that enables it to adapt to the local environment more effectively than its foreign counterparts. They form an important sub-sector of poultry production in Ghana and Sub-Saharan Africa (SSA) (Hassaballah, *et al.*, 2015; Khan *et al.*, 2017).

The chicken industry in Ghana has been developing rapidly in recent years. However, similar to other developing countries, the native breeds are given less attention even though they have intrinsic benefits such as greater meat and egg flavour, high adaptation to changing conditions, hardiness, high genetic variability in performance, disease resistance, easy to rear, and have the ability to reproduce(Ngeno, 2015). Indigenous varieties of poultry are hardy with high disease resistance and adaptability to the local harsh environments and have served as poultry meat for the rural population in Ghana (Adomako*et al*., 2014). However, they have poor growth, poor FCR, and late maturity compared to the foreign breeds, (Jatoi *et al.*, 2014).

Local breeds' conservation is an essential part of poultry biodiversity as such, the production of local eggs and meat needs to be increased; though foriegn hybrids have a higher advantage for growth and egg production (Manyelo*et al.,* 2020). Local poultry rearing has been understudied in Ghana, due to the lack of a stable breeding stock (Sumberg *et al.*, 2013). Unfortunately, crossing the local breeds with the foreign type may at long-run result inthe extinction of genetic resources.

Knowledge with respect to the growth performance is a primary contribution to the conservation and improvement of local poultry breeds and will allow breeders to pick breeds that will grow faster and put on heavy weight at slaughter to match market price and reduce production costs, which will help to improve and conserve indigenous poultry breeds (Soglia*et al*., 2020). Breeds on performance are increasingly important because breeding programs depend on the selection of good genotype for the next generation; since performance mainly depends on genetics and other environmental factors (Okogbenin *et al.*, 2012).

The economic importance of growth performance parameters such as feed intake, feed conversion efficienc/ratio, body weight and body weight gainsuggests the need for these traits to be considered in selection objectives in breeding programmes. It is therefore expidient to understand the genetic behaviour of these traitsand other important traits such as heat tolerance, disease resistance, and survivability in local chicken genotypes that are used as the hallmark for selection in animal breeding programs (Aryee *et al.*, 2019).

1.2 Problem Statement

The production of local/indigenous Ghanaian chicken has a number of difficulties or challenges. As a result, full-scale commercialization has not been attempted in Ghana since it appears that little attention has been paid to commercial production, with small flocks maintained under free-range conditions. However, chicken is the most popular source of animal protein in Ghana (400,000 mt imported in 2021) (MoA, 2022). The low production of local poultry in Ghana is due to many challenges such as, seasonal variations, unimproved/poor breeding stock, poor nutrition, worm infestation, poor production, predation, high chicks mortality rate, and low reproductive abilities of the genotypes (Annor*et al.*, 2013; Kyere, *et al*., 2017; Hagan, 2020). With the increasing demand of domestic customers for the meat and eggs of local chicken due to their good taste and high nutritional quality compared to foreign birds, there is the need to study them in various ways to discover the best breeds that can meet the market demands (Sanka&Mbaga, 2014) and to improve the quality of the meat of the chicken as well as conserving rare chicken species to prevent extinction.

There is evidence that different genotypes of animals within breeds exhibit a wide range of performance, notably in terms of growth; however, the indigenous chicken genotypes in Ghana have been given little attention. Inadequate research on local chicken to selectgenotypes that perform better and improve local genotypes genetically is blamed for the significantly low growth rate of local chicken compared to improved birds in Europe (Houndonougbo*et al.*, 2017). Adomako (2009) assessed the productive potential of indigenous chickens and determined the magnitude of improvement that can be obtained by mating them with commercial hybrid layers. Similarly, the effect of the frizzle gene (F) on their egg production and quality of laying hens which are kept in tropical villages was also carried out (Adomako *et al.*, 2014a) and the growth performance of cross-bred normal feathered and naked neck laying hens kept in tropical villages (Adomako *et al.*, 2014b). Again, Duodu (2013) studied the effect of frizzle, normal feather and naked neck genotypes on laying performance and pterylosis of white and brown layer parents. Unfortuntely, most of these studies were carried out in the southern part of Ghana. However, a comparison of their potential in growth performance, survivability and immune responses and the level of heat tolerance have not been less studied especially in the Northern part of the country where temperatures can reach 40^0C. Therefore, this study sought to compare the growth potentials of four genotype of local chicken in the SagnariguMuniciplaity-Northern Ghana.

1.3 Objectives of the study

1.3.1 Main Objective

The main objective of this study was to determine the production and heat tolerance traits and estimated Breeding Values of local chicken genotype

1.3.2 Specific Objectives

The specific objectives were to:

1. determine the effects of local chicken genotypes on body weight, body weight gain, feed intake, feed conversion ratio and mortality rate
2. examine the effects of genotype on pulse rate, respiratory rate, body temperature and heat tolerant index of local chickens
3. assess the breeding value of local chicken genotypes

1.4 Significnce of the Study

Understanding growth performance is essential for the preservation and improvement of native poultry breeds. The study will uncover whether genotype has influence on body weight, body weight gain, feed intake, feed conversion ratio and mortality rate with respect to local chicken; this will help breeders and farmers to be able to select genotypes that will grow more quickly and put on a lot of weight at slaughter to match market demand and lower production costs. Again the research will bring to light the effects of genotype on heat tolerant of local chickens; this will help to know which genotype can best be reared in areas with high ambient temperatures. Moreover, the study will bring to light the estimated breeding values of local chicken genotypes which will give an insight on the genetic capacity of each breed to transfer their genes to future generation. Finally, the research will provide data which will be of significance for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Origin and History of the Domestic Chicken (*Gallus gallus*)

The order *Galliformes,* which includes chickens, is closely linked to the survival of birds when all other dinosaurs run out. Water or ground-dwelling fowl, akin to contemporary partridges, survived the extinction catastrophe that wiped out all tree-dwelling birds and dinosaurs during the Cretaceous-Paleogene period (Pennisi, 2018). Some of these species transformed into the modern *galliformes,* with chickens that have been domesticated serving as a primary model. The chicken is one of the most widely domesticated animals; it is cultivated for both its egg and meat and is said to have originated as a red Junglefowl hybrid (*Gallus gallus*) (Wong *et al.*, 2004). The domestication of Chicken was previously thought to have occurred in the Indus Valley around 2000 BC (West & Zhou,1988), but research indicates chickens have been domesticated across the globe over the last 8,000 years to become one of the most valuable domesticated animals native to multiple regions from Southeast Asia to Southwest China (Liu *et al.*, 2006; Miao *et al.,* 2013). Chicken is a domesticated Junglefowl that have similar characteristics with the wild Junglefowl species like the Ceylon and grey junglefowl (Lawal *et al.,* 2020). The idea that domestic chicken _ descended from the red Junglefowl was first brought by Darwin.According to the earliest archaeological findings, domesticated chickens is thought to have originated from Chinawhere the bones of chicken were dicovered which date back to 10,000 to 8000 years (West &Zhou, 1988; Xiang *et al.,* 2014).

Investigation on the claimed chicken remains in the Indus Valley in northern India indicated that Southern Asia had a large population of domesticated hens 4,000 years ago. However, data from China, redgarding the earlier domestication of poultry is still debatable (Eda *et al.,* 2015; Peters *et al.*, 2016).

Domestic chickens arrived in the Near East and West Asiaduring the second and third millennia BC, and were later dissiminated to theEuropian territories in the 8thcentury BC by the Phoenicians (Perry-Gal *et al.,* 2015). Historically, chickens had been primarily used as a ceremonial or symbolic animal, as proven by the presence of chickens remains in tombs, clay figurines in early Chinese tradition, and mentions of chickens in the early writings. As chickens flourished throughout Europe, chicken fossils had become more common in archeological evidence and discoveries. This meant that chickens had become an important element of livestock in Europe, and the Sagas claim that some of the chicken were brought by the Vikings when they colonized Iceland in the 10th century.

The earliest Austronesians and farmers, who expanded from the mainland of China through to Island the South-Eastern part of Asia about 5000 years ago are thought to have initiated the movement of chickens from Asia south and eastwards. They brought pottery and agriculture, as well as reared animals such as dogs and pigs, with them (Bellwood *et al.,* 2011). Despite the lack of ancient chicken fossils in this area, it is assumed that chickens were a component of thier agricultural system.Chickens were taken with the Polynesians when they inhabited the Pacific island archipelagos. Chicken remains have been discovered in archaeological studies all across the Pacific, and chickens imported by the Polynesians 800 years ago today run wild on the Hawaiian island of Kauai.

The invention and development of new molecular strategies, such as the analysis of the DNA, allowed scientists to take a fresh look at the domestication of chickens. An early analysis of mitochondrial DNA (mtDNA) revealed that domestic chickens were certainly descended from red junglefowls, implying that just one domestication event occurred in Thailand (Fumihito *et al.*, 1996). Chickens were domesticated in at least three different Asian regions, according to new research (Liu *et al.*, 2006). Domesticatic chickens were crossed with local populations of various wild jungle fowl genotypes resulting in the gene responsible for yellow legs, which is a frequent trait of domesticated chickens and this can be linked back to the grey junglefowl (*Gallus sonneratii*) rather than the red jungle-fowl (*Gallus rufus*) (Nguyen-Phuc & Berres, 2018).

The introduction of chickens in Africa, as well as the routes by which they invaded and disseminated over the continent, varies based on several researchers (Gifford-Gonzalez & Hannotte, 2011). The first arrival of domestic chicken to Africa is thought to have occurred during the third and fourth millennia BC (Chami, 2007). It is widely believed that chickens first arrived in Africa via land through Egypt, then spread south along the coast of the Nile valley through to Nubia, and finally in West Africa along the Sudano-Sahelian corridor. This theory is based on geographic distribution and dating of the allegedly most ancient, uncontested archaeological studies or scientific proof in the dinosaur fossils, pictorial/artistic portrayals, and literary evidence (Houlihan & Goodman, 1986; Prendergast *et al.,* 2017).However, mounting evidence for an earlier route of entry for domestic species along thecoast of East Africa, based mostly on the occurrence of African cultivated species in South and Southeast Asia and Asian plant domesticated in Africa, suggests that the Indian Ocean trading network is older than previously thought (Prendergast *et al.,*2017). The concept that Sub-Saharan African chickens originated in North Africa is challenged by these data. Chickens were already a vital part of West Africa's Iron Age economy by the sixth century AD, if not many centuries before, according to fresh evidence from Kirikongo (Burkina Faso) and Daboya (Dueppen, 2011).

2.2 The Local Chickens

Indigenous chickens (*Gallus domesticus*) are chickens that have evolved to live in harsh environmental conditions such as the free-range, small-scale village, and organic farming systems. Backyard, traditional, village, local, scavenging, or family chickens are all terms used to describe these chickens (Mahendra, 2016). Indigenous African chickens are believed to have originated in Southeast Asia, China, and India (Muchadeyi*et al.,* 2008; Mtileni*et al.,* 2011). While evidence of chicken in the voltaic is limited, researchers in Daboya (Ghana) have suggested that chickens were there throughout the first millennium AD. Until recently, one of the earliest securely identifiable remains are found in Western Africawhich was from Mali, and were dated back to 500-850 AD (MacDonald, 1995). New archeological findings fromBurkina Faso (Kirikongo) and Ghana(Daboya)has confirmed that chickens were already a major component of West Africa's Iron Age Economy by the 6^{th} century AD, if not several centuries earlier. Indigenous chicken are known and reported accross the globe. Naked neck hens with typical frizzle feathers were observed in Nigeria, Ethiopia, and Southern Africa, according to Adelake *et al.* (2011). Mohammed *et al.* (2005) identified Betwil and Baladi chickens as native chickens in Sudan. The most common native chickens are Koekoek, Venda, and Ovambo, with Ovambo being from Namibia's Northwestern Region (Van *et al.,* 2001). According to Alewi *et al*. (2012), the predominant local chicken originating from Ethiopia is the local Kei (a red plumage chicken). Local chickens are more common in developing and undeveloped countries than in developed countries. However, the introduction of local chickens to Africa marked a watershed moment in agricultural history, transforming the way of life in most African societies (Mwacharo *et al.,* 2013).

The most prevalent variances among local chickens include plumage colour, body size, patterns of feathers, comb types, and shank colour. Traditional chicken populations are generally reported and categorised in literature based on their geographic location or morphological characteristics, with only a few breeds or varieties being recognized. (Manyelo *et al.,* 2020). Local chickens are more self-sustaining (thus they are capable of raising their replacement stock), resilient, and able to withstand harsh environments than other breeds. They also have thefeatures or ability to detect danger and respond quickly (Alders & Spradbrow, 2001).

Mammo *et al.* (2008) opined that local chickens have a significant ability to fly and run away from hazards and predators when compared to commercial hens. These characteristics enable them to thrive and produce despite adverse environmental conditions. Furthermore, Nhleko *et al.,* (2003) reported the features of village chickens, indicating that they are among the most adaptable local birds which have the ability to survive in caged or unsheltered outside, wet or dry settings and roosting on to of trees.

Among chicken species, indigenous chickens have the greatest incidence of population type diversity (Khobondo *et al.,* 2015). Local chickens in African countries such as Ethiopia, Nigeria, Ghana, Malawi, Namibia, Kenya, Southern and Sudan, Africa are differentiated by a wide range of their physical characteristics and production parameters (Kingori *et al.,* 2007). The plumage colouring of most African native chickens is unusual, with some having blackish and brownish colours with extended and pied colorations and standard feather distribution, while others have distinctive traits such as frizzle, naked neck, and silkiness (Khobondo *et al.*, 2015). Local fowl from hot environments have a huge single comb, bare neck, and frizzle feathers (Apuno *et al.*,2011), which allow efficient heat control. Local chickens from cold climates, on the other hand, have a thick layer of feathers covering their bodies, which aids in insulation and protection against losing body heat (FAO, 2010).

2.3 Varieties/Genotypes of Local Chicken

The term "indigenous chickens" is mainly used in this literature review. The primarily free-range (extensive) chicken production method in Ghana is best defined as a low input, low output system. Plumage color, body size, feather patterns, comb styles, and shank colour are the most common differences among local chickens. Local chicken populations are commonly documented and classified in the literature based on geographical location or phenotypic traits (Adelake *et al.,* 2011).

A lot of indigenous or local chickens have been classified and documented all throughout the globe with only a few being classified as ecospecies based on their physical traits. According to Adelake*et al.* (2011) most naked necked chickens with regular frizzle feathers can be found in Nigeria, Southern Africa, and Ethiopia. Mohammed *et al.* (2005), reported the existence of large Baladi and Betwil chickens as native chickens in Sudan. Venda, Koekoek, and Ovambo chickens are the most common native fowl, with ovambo hailing from Namibia's Northwestern Region. Report fromAlewi *et al.* (2012) indicates that the local Kei (a red plumage or feathered chicken) is the chicken that is dorminant in Ethiopia. Local or indigenous fowls are more dorminant mostly in underdeveloped and developing countries than developed countries.

2.3.1 Naked Neck Chickens

The Naked or Bare Neck chicken (Plate 2.1) is a breed of chicken with no feathers on its neck or vent (Mérat, 1986). Transylvania naked necks, turkens, bare necks, rubber Necks and Hacklelessare all names for naked neckhens (Graham, 2006). The African Naked Neck is divided into two variants, both of which are assumed to have originated in Malaysia (Khobondo *et al.*, 2015). In chickens, an autosomal gene which is regulated by anpartially dominant allele (Na) at the middle of Chromosome 3 causes the naked neck trait that identifies this (Warren, 1933). Rossier (2002) claims that because this gene is incompletely dominant, individuals who are either heterozygous (Na/na+) or homozygous dominant (Na/Na) will have the naked neck feature, however, the heterozygous birds would not. Mating between two tasseled birds produces indigenous hens with completely bare necks (Mtileni *et al.*, 2010). Naked neck has a big wattle and a single red comb. Their reddish bay-eyes and earlobes distinguish them. The average weight of roosters and cocks/hens ranges between 1500g-3500g and 1100g-3000g, respectively (Mosoeunyane&Nkebenyane, 2001). Naked neck hens can lay up to 139 eggs each year, with the first egg laid after 128 days. The Venda chickens are a stunning multicoloured breed with significantly white, black, and red colours (Manyelo*et al.*, 2020).

Cockerels and hens weigh between 2.9 and 3.6 kg and 2.4 and 3.0 kg, respectively. Venda hens produce large, delicately pink-tinted eggs that typically weigh 53 grams. By the time they are five months old, they are sexually matured (Grobbelaar *et al,* 2010; Manyelo*et al.*, 2020). Indigenous naked neck birds can defend themselves and their young ones from predators because of their alertness and combative skills. They are able to thrive in a wide range of conditions, including poor housing, management, and feeding, as well as temperature and relative humidity fluctuations (Adomako, 2009). Because they have fewer nutritional (Protein) requirements, feather pecking and cannibalism are less common among them (Merat, 1990). According to Akhtar-Uz-Zaman (2002), naked neck birds' reduced feather coverage allows them to receive more sun rays, potentially increasing their viability. When fast-growing bare neck and feathered birds were kept at high or moderate ambient temperatures, the naked neck birds exhibited a faster growth rate or body weight gain and meat yield than the normal feathered chicken (Cahaner *et al.,* 1993; Eberhart & Washburn, 1993). Similarly, the naked neck birds perform bettercompared to the normal feathered birds for growth rate, feed convention efficiency, immune-competence, blood biochemical parameters carcass characteristics, viability, and survivability (Patra *et al.*, 2002).

Plate 2.1: The Naked Neck chicken

Source: Adelake*et al.*, (2011).

2.3.2 .Ovambo Chickens

The Ovambo chickens (plate 2.2) is believed to have originated from the northern part of Namibia and Ovamboland in Africa. It is a popular indigenous chicken breed in Africa (Van Marle-Koster& Nel, 2000). The Ovambo is competitive, dual-purpose, belligerent, swift, with predominantly dark red, brown, and black feathers that helps it to camouflage predators, making it popular among rural poultry farmers for rearing (Van Marle-Köster& Casey, 2001). Similar to guinea fowls, this chicken can avoid predators by flying and climbing to the top of trees (Chikumba & Chimonyo, 2014). It is understood to be very competitive and agile because of its dependancy of catching and consuming mice and younger rats. Among the indigenous African breeds, Ovambo chickens have the largest processed carcass weight (Van Marle-Koster& Webb, 2000). Because of these advantages, the Ovambo breed is widely sought after for meat production.Sexual adulthood is attained at 143 days with an average weight of approximately 2.16 kg and 1.54 kg for males and females respectively (van Marle-Koster and Nel, 2000).

Plate 2.2: The Ovambo Chicken

Source: Mohammed *et al.* (2005).

2.3.3 The Frizzle

The Frizzle is a chicken (Plate 2.3) genotype with one of a kind curled or frizzled plumage. When the chicks are first hatched, they seem to be completely feathered, but as they become older, their wing plumage grow swiftly and bend outwards. (Anonymous, 2005). They have legs that are entirely devoid of feathers. They have huge erect tails and long wings. This chicken comes in a variety of colours and three different plumage patterns. Frizzled, excessively frizzled, and flat-coated plumage are the three varieties of plumage. Red coloured eyes, a moderately big red coloured single comb, and red earlobes are present in all colour variants. Their wattles are a vivid scarlet colour (Egahi *et al.*, 2010).

Frizzling is mediated in chickens by the *F* gene, which is an incompletely dominant autosomal gene, which regulated by an *x-linked* recessive modifier called mf (Landauer& Dunn, 1930). According to Somes (1990), Davenport was the first to claim that the frizzle gene was dominant after it was initially identified by Aldrovandi in 1600. The rachises of all plumage are extensively re-curved in unaltered homozygous frizzled birds, and the barbs are also abnormally curled (Landauer, 1933; Adomako, 2009). Studies revealed that, the frizzled genotype’s plumage is as a result of a mutation in the keratin gene KRT75. The splicing wasadvancedwith the aid of getting rid of a part of exon 5 and intron 5 (Chen *et al.*, 2012).

Because the gene responsible for the curling of feathers is only partly dominant over normal appearance, not all individuals of the race have frizzled feathers. Frizzled birds are polymorphic for the gene, which suggests that when two of them are bred, their offspring inherit the gene in a 1:2:1 ratio. 50% of the birds are heterozygous and frizzled like their parents, 25% have normal feathering, and 25% have "over-frizzled" plumage that resemble pipe cleaners (Ebegbulem & Asanga, 2018).

According to studies, birds with the frizzle gene do perform well in hot, humid environments (Gowe and Fairfull, 1995). Horst *et al.* (1990) discovered that frizzling feathered layers performed better in terms of egg production than their typically feathered counterparts when reared at high temperatures. The Frizzle chicken is a robust and fast-growing poultry breed. The hens are good layers and the breed is friendly. Hens lay medium-sized coloured or white eggs, and they commonly go broody. The frizzle genotype, according to Oke *et al.* (2012), grows faster among the indigenous chicken that could be used in selection and breeding for producing native breeding stock for meat-type chicken production in the humid tropical zones.

Plate 2.3: The Frizzle Chicken

Source: Polutry site, 2020

2.3.4 Silky Chicken

The silkie chicken got its name from its fluffy feathers, which is seen to feel silky. Silky is another name for the breed. They have hair-like plumage that resembles that of mammals. Silkies are classified as either bearded or non-bearded. Under the beak, there is an extra muff of plumage that covers the earlobes of bearded silkies (Graham, 2006).

It is uncertain when or where these unusual fowl first appeared, but ancient China is the well-documented source. Other Southeast Asian countries that have been considered as options include India and Java. Some Silkies fowls (Plate 2.4) migrated to the West most likely through the Silky Route and marine trade. In 1874, the genotype was formally recognized in Northern part of America when it was accepted into the benchmark of Perfection. They are one of thefamous and extensivelyavailable chicken breeds in the 21st century. Backyard keepers regularlymaintain them as decorativechicken or puppy hens (Ekarius, 2007).

One of the most popular and well-liked decorative chicken breeds is the Silkie. It is also currently one of the most exciting birds to watch. They are also separated into colour groups. Silkie colours that are used for competitive showing include blue,black, buff, partridge, grey, and white. Cuckoo, lavender, red, and splash are among the other color options. To be deemed faultless, Silkies must have a maple comb, dark papules, and accented with blue earlobes.

Other breeds with this unusual features include the Faverolles, Sultan, and Dorking (Graham, 2006). Colour-coded silkie chickens are also separated. White, blue black, buff, and grey silkie chicken colours are acceptable for competitive showing. Red, Splash, Cuckoo, and Lavender are among the additional colour options.

According to Mandy (2019), all silky hens have a little walnut comb that is a deep mulberry nearing black, they have small and brown wattles and turquoise blue earlobes with majority having downy, white-silky plumage. They have black skin and bones, and instead of the usual four (4) toes, they have five (5). Silkies lay a lot of cream-coloured eggs, but due to their great predisposition to go broody, production is sometimes halted; in an ideal year, a hen will lay 100 eggs. The ability of Silkies to incubate is frequently utilized by poultry farmers by enabling them to rear the progenies of some other birds (Graham, 2006).

Plate 2.4: The Silkie Chicken

Source: Source: Polutry site, 2020

2.4 Poultry/Chicken Production in Ghana

Poultry has been reared and used as meat in Ghana for many years. The production of poultry was recognized by the Ghana government as having the greatest promise for alleviating the severe shortage of animal protein and creating jobs in the late 1960s and launched an integrated poultry project in Ghana-Accra (FAO, 2014a). The improvement of the industry was slow due to the inadequate supply of day-old-chicks and other production inputs coupled with the outbreak of the New Castle Disease (ND) discouraged potential farmers. These obstacles were eventually overcome, and by the 1970s, the chicken industry had become established, aided by the elimination of customs tariffs on the inputs of poultry (drugs, vaccines, etc.). In the beginning of 1960, the Nkrumah administration's greatly failed efforts to construct large-scale, mechanized national farms affected the production of poultry in the country (Due, 1969; Hinderink & Sterkenburg 1983). Poultry farming in Ghana was highlighted as a prospective field for innovative business ventures at the same time that the state farms were being decommissioned. Since then, the poultry industry has had to deal with the political and economic challenges that plagued the country's first four decades after independence.

Modern, commercial, intense, or semi-intensive farmers on the one side, and small-scale, backyard, extensive poultry keepers on the other, are the two different segments of the industry. While these may appear to be separate entities, there are connections between them, such as transmission of disease and the transfer of essential inputs, outputs, and raw materials (e.g. day-old chicks, poultry feed, etc.) (Sumberg *et al.,* 2013).

Commercial poultry production operations exist in Ghana consisting of small scale, medium scale and large scale representing less than 10,000, 10,000-50000 and over 50,000 respectively. These commercial farms are mostly owned byindividuals or by families. Kusi (2020) and Naggujja *et al.* (2020), opined that in Ghana, there are currently Twenty-Nine large-scale commercial chicken farms which are dispersed in the Greater Accra areas (14%), Brong Ahafo (41%) and Ashanti (45%)and they account for around 20% of the entire poultry farms and mostly produce eggs.

The small-scale and middle-scale groups account for Eighty percent of the total poultry industry, and obtain their brooding stock feed from the from other commercial farms especially outside the country.Local chicken growers who primarily raise broiler chickens and keep some indigenous poultry are also included in the small-scale group, which practices limited biosecurity.This sometimes gives room for different birds in the free-range zone and other wild birds to get access to these poultry pens, exposing them to Avian diseases (Ministry of Foreign Affairs, 2019).

Although day old chicks are produced locally in Ghana, it is usually of poor quality makingpoultry farmersto import day-old chicks particularly layer chicks. In the year 2018, about 511,966 broiler chicks and 7,131,000 layer chicks were imported by Ghana (Adams *et al.*, 2021). Local hatcheries are now subject to little regulation as a result of the governmentof Ghana’s failed attempt to fully enact a hatchery bill that will assure the production and supply of quality day-old chicks from our local hatcheries.

The Government of Ghana abolished custom’s tariffs on inputs ofpoultry such as additives, medications, and feeds in 2013 to help the local poultry business, and has enhanced access to veterinary or chicken health services. Furthermore, the revitalization agenda of broilers was estavblishedon 5thJuly, 2014, with the goal of increasing the production of local broilers in Ghana. As part of the effort to lessen the country's dependency on foreign chicken meat, a new livestock and poultry procurement policy was devised.. Imports are limited to 60% of total production, which means importers must source 40% of their produce locally. Available Despite the fact that this project had little impact on the industry, there was a decrease in the importation of chicken meat in 2015 and 2016. However, in 2017, data shows that over 135,000 tonnes of frozen chicken, which translates into approximately 112 million birds, was recorded to have been imported from the European Union. This figure was a 76% greater than what was imported in 2016 (Daily Graphic, 2019).

On June 25, 2019, President of Ghana launched the "Rearing for Food and Jobs" agenda, which maily meant to revamp the the poultry industry to make it competitive and efficient and to create jobs particularly for the youth. According to the Minister for Food and Agriculture, this agenda is eminent to the country because it will help the country to reduce the continues importationof USD380 million worth of poultry meat anually when the country was known to have exported poultry meat to her neighbours 20 years ago (Daily Graphic, 2019).

Athough there is anincreasing trends of poultry production, the production is still largely dominated by the commercial egg productionchain representingapproximately 60% of the poultry population in Ghana (Naggujja *et al.,* 2020). Industrial layers and broilers are produced are predorminant in the Ashanti and Brong Ahafo regions possibly due to their tropical and subtropical agro-climate, couple with the fact that they are a major maize production region, which means that layers and broilers may get plenty of cheap poultry feed. Guinea fowls and traditional/local chickens also play an important role in Ghana's poultry industry, particularly in the Northern and Upper East areas (Andam *et al*., 2017). Unfortunately,inefficiencies across several stages of the value chain, including inadequate company coordination and shortcomings in the enabling environment, such as quality standards and inspection, all hamper the overall performance of the Ghana-poultry business. However, improving the poultry sector's competitiveness without a comprehensive strategy that boosts production efficiency and lowers retail prices while maintaining good product quality is challenging. High costs of excellent blended feed, inefficient feed management procedures and improved local breeds are of the industry's biggest issues (ACDI/VOCA, 2016).

2.5 Importance of Keeping Local Chickens

Local Chickens have a wider range of uses and advantages in underdeveloped and developing countries. In the tropics, there are variations in the use of local chicken from one area to anothereven within the same region (Mahendra *et al.,* 2016). Chickens are kept by small landowners in the tropics for socioreligious purposes such as traditional ceremonies and rituals (Conan *et al.*, 2012). This is because the quality of the offering that fulfills the receiver's distinctive morphological traits of the chicken determines an individual's dedication to a certain spiritual being, deity, or season, as well as customary and/or religious festivals (Dessie *et al.*, 2012). In tropical and subtropical environments, native chickens' small body size is a favorable trait. One of the most important advantages of local chickens is their capacity to withstand extreme weather conditions and insufficient husbandry techniques (temperature, handling, hydration, and feeding) without experiencing major output losses.

According to Hailu *et al.* (2013), raising local chickens increases the amount of animal protein in people's diets in rural regions by allowing them to consume surplus eggs and chicken meat since home consumption ranges from 19 to 44%. Zewdu *et al*. (2013), disclosed that in the Northwestern part of Ethiopia, monetary gains was ranked as the main reason local famers rearing birds since 93% of respondents aserted to that.Local birds, do not only offer the protein requirement of the family, but also serve as a "poor man's bank" and animals for sacrifices, feasts, and gifts. The marketing of chickens and eggs for family income coversabout 72% of their utilization in Rwanda (Mbuza*et al.*, 2016). The research of Hirwa *et al.* (2019) supports this purpose, whereas Mahoro*et al.* (2017) claim that the primary function of raising local chicken are egg production (47%) and home consumption (39%).

In rural areas, free-range poultry is common; chicken is an important component of 'traditional' recipes such soup and for many people, a chicken is the centerpiece for Christmas and other festival feasts and continues to be of significant importance to some people's and places' traditional sacrifices(FAO, 2014b). According to Ekue *et al.* (2002), the primary goal of indigenous fowls among farmers in Cameroun was to sell for profit and to eat at home. Adomako *et al.* (2009) supported the idea that rural poultry production in Ghana serves as a reliable source of income for the local farmers and their families. According to Das *et al.* (2008), production of local birds, especiallychicken, guineafowls and duck is significant in the socio-economic gowth of Bangladesh. They indicated that close to90 percent of all rural households keep a number of local hens and ducks in the form of traditional free-scanvenging or semi-scavenging systems. They stated that poultry is mainly kept by local women and their children to generate income and provide adequate eggs and meat for their own household use. Local chicken in Kenya possessed a number of unique features that is suitable for their growth and survival in the country's socioeconomic, climatic, and cultural settings.They provide nutritional and economic value to the farmers and their household with little or no input in the local free-range production (Magothe *et al.,* 2012).

Indigenous chickens are less susceptible to local poultry diseases than hybrid birds. Furthermore, native birds are better acclimated to the local climate and hard ecological conditions, and they make better use of rubbish than hybrid chickens, making them ideal for large-scale poultry farming. They are recognized for their tropical adaptation and illness resistance, as well as the coluor of their feathers, which aids in predator protection. They provide the family with financial security while also ensuring food availability. Poultry farming is also a viable option for unemployed men and women their income for survival (Mahendra *et al.,* 2016).

Ancestors play a role in daily life in Mamprusi society and other northern societies. Sacrifice is a simple method to appease them while also requesting a favor. The most widely used sacrifice animals are local fowl cocks. At burials, sacrifices are made to appease the deceased's ancestors. Prognosticators and traditional practitioners also recommend making a sacrifice to heal a sick person or request a safe voyage. The duty of a cock in judgment is a fascinating reality.Forinstance, an acusstion of a woman or manof evildoing, calls for theleader of the community or village to scrifice a cock and allows it to run. The demise of the cock on his back, side or breast confirms the claim is true or not (Kees,1987).

Finally, FAO (2013) indicated that chicken meat can make a substantial difference in the meals of low-income people. Chicken flesh, while not all meat is healthful, is, and it is often less expensive than other meats. It is always low in saturated fats and great quality, can be supplemented with some vital nutrients, and it is highly sought for around the world.

Table 2.1: Ranking the Reasons of Keeping Indigenous Birds

Purpose	Percentage	Position
Consumption	100.0	1
For sale	87.41	2
Honourvisitors	72.59	3
For Ritual	48.15	4
Aesthetic Value	11.85	5
Announce the Presence of Dangerious Animals such as snake	1.48	6

Source: Adomako, 2009

2.6 Growth Performance Trait in Local Chicken

2.6.1 Feed Intake (FI) in Local Cicken

The nutritional content of the feed, as well as the amount of feed consumed or feed intake, have an impact on the nutritional requirements of chickens of all ages. The optimal nutritional intake for commercially grown chicken is determined by the poultry enterprise's commercial aims. Feed intake (FI) increases with age in all birds; the increased demand for protein and energy required for growth (Mwale *et al.*, 2008) results in increased feed intake during the final stages(7 to 13 weeks) (Nobo *et al.*, 2012). Controlling poultry nutrient intake can be done by limiting the availability of feed for consumption, changing the nutritional content of the feed to match consensual diet intake, or adjusting the lighting schedule by decreasing or increasing the time of darkness.Providing chickens with as much feed and allowing them to eat as they desireis called *ad libitum* feeding. According to Mbajiorgu *et al.* (2011), stress factors such as increasing density, high temperatures, and decreased general health, as well as genotype, age, and accessibility, influence feed intake and, consequently. In addition, dietary parameters such as energy density, excesses or deficits of nutrients such as protein, minerals, and carbohydrates might influence poultry feed intake.

Furthermore, some feedstocks, poor feed composition, or feed infection may have a detrimental impact on deliberate feed intake by birds as a result of poor taste or introduction of hazardous compounds. Access to feed is frequently overlooked as a limiting factor, and it can be caused by a lack of feeding space due to overcrowding or high stock densities or by improperly fitted feeding equipment. The height of the feeding troughs should be modified according to the ageof the birds to ensure that all of the birds have easy access to the feed (Parsons *et al.,* 2006).The key factors determining intake include those that control the poultry's feeding urge, such as hunger and satiety, as well as the influence of the meal's physical form (Amerah *et al.,* 2007). However, studies on the best grain size, specifically corn particle size, have produced mixed findings. An understanding of particle size of grain and the texture of pellet is critical for the development of feed manufacture strategies that optimize poultry feed consumption and performance (Parsons *et al.,* 2006).

According to Nsoso*et al.* (2006), theBare Neck and frizzle chicken consume much more feed per kilogram (0.7kg/day) than their typical feathered counterparts, despite the fact that the former hens were more productive and biologically efficient. Chimenem-Amadi *et al.* (2021) reported feed intake among local chicken breeds with the highest feed intake (3630g) associated with the Normal Feathered. Even though there was no major differences in feed consumed or tkenbetween frizzle and naked neck chicken breeds, naked neckbirds consumed 3553g of feed, whereas Frizzle chickens consumed 3530g. Generally, the daily, weekly and montly feed intake of the chicken can fluctuate over a giventime. The feed intake increased slightly in the cold season to be able to enhance egg-laying. This, therefore, confirms as stated by Oluyemi *et al.* (2009) that cold weather or low temperature increases feed intake.

Oke*et al.* (2012) developed three biological groups using day-old indigenous chickens developed from direct cross and reciprocal crossing of native chickens which possess some significant genes (naked-neck (*Na*), frizzle (*F*), and normal feathered gene (*na*)): homozygosity naked neck, Na/na, and frizzle (F/Na), mutual recognition Naked Neck (*Na/F*), and normal feathered chicken (*na/na*).At week 8, there was a substantial distinction in daily feed intake across the three genotypes, with the Na/F genotypes consuming more feed than the other genotypes. Mondal *et al.* (2015) observed that the daily feed consumption of typical plumage traditional birds under farming environment was 33.90 g/day/bird at 83 days of age (12 weeks) which was lower than 34.1-34.5 g/day/bird). that reported by Khairunnesa *et al.* (2016). On the contrary, Faruque*et al.* (2017) and Akhter *et al* .(2018) conducted an experimentsusing local Bangladesh's chicken genotypes and found a result of a non-significant variations in the total feed utilization.

In a study conducted by Duodu (2013), on the effect of the naked neck, frizzle and normal feather genotypes on their laying capacity and pterylosis of whiteand brown layer parents disclosed that feather type and feather colour influenced the pooled feed intake. He reported feed intake of 119g, and 111g, 138g, for the Frizzle (*Ff*), the Normal feathered (*na*) and the Naked Neck (Na), respectively showing no substential differences between the Frizzle (*Ff*) genotype and that of the Normal feathered genotype.

2.6.2 Feed Conversion Ratio (FCR)

Feed operational expenses accounts for almost 70% of the total cost of chicken production (Williams *et al.*, 2013), hence boosting feed utilization rates is one strategy to save feed costs. Birds that can efficiently convert their feed into body mass/weight help to cut the cost of production. The ratio of feed comsumptionfeed (FCR) is a measurement of how well birds gain weight on a given particular. Diet, environmental factors, genotype, and other factors all have an impact (Nakkazi *et al.*, 2015).The rate of feed convention ratio/rate is a measure of how well animals convert feed into the desired output. For example, milk, meat, eggs or feathers. The mass of the feed consumed divided by the mass of the output is the FCR. Feed efficiency, is the reverse of the FCR, which is defined as the output or feed consumed divided by the input (thus the inverse of FCR), is utilized in several industries. These concepts are also closely associated with the efficiency of conversion of ingested feeds (ECI) (Hutjens, 2012). Since the 1970s, the RFI has been utilized as a product quality assessment indicator for layer chickens to compensate for the flaws in FCR estimates. The FCR cannot be used as a selection indicator to detect whether Feed Intake (FI) or Body Weight Gain (BWG) predominate, which minimizes the differences in the group selection and impacts selection efficiency (Yuan *et al.,* 2015).In meat animals, the FCR is a proportionality feature with a non-normal measure of dispersion that is determined using FI and BWG. The degree of abnormal distribution is directly proportional to the variable coefficient of the denominator, the mean values, and affects the actual statistical significance of standard deviation. The FCR is a slightly genetic characteristic that is utilized as a predictor of the results of other genetic enhancements in population genetics (Li *et al.,* 2013).

The effect of genotypes on the laying performance of frizzle, normal feathered and the naked neck was studied by Duodu (2013) and disclosed that FCR among the three genotypes of local chicken were 2.96, 2.98, and 2.95 for the Naked Neck (Na), Frizzle (Ff), and the Normal feathered (na) respectively showing no keyeffects. Kuietche*et al.* (2014) found that as the dietary energy of the feeds increased, the feed conversion ratio of Cameronian native barred chickens increased, whereas Hosseini & Afshar (2017) found a similar trend in local broiler chickens. Melesse*et al.* (2013) found that adopting iso-caloric diets, Koekoech chicken breeds improved their FCR by 16 percent, 18 percent, and 20 percent, with no additional increase above 20 percent Crude Protein (CP). Other factors, such as changes in climatic or environmental temperatures, could be blamed for the inconsistencies in the overall FCR trend.Khairunnesa *et al.* (2016) reported a significant variations ($p<0.05$) in the weekly feed conversion efficiency ratio of four (4) indigenous genotypes of chicken. Chilly chicken (2.85) had the best feed conversion ratio, while Native Chicken considered Non-descriptive had the worst (5.99) FCR at the end of the experiment, with the naked neck chicken recording 4.06.

Mondal *et al*. (2015) reported the approximately 4.0 FCR value with respect tothe normal feathered indigenous chicken under controlled farm condition during 12 weeks of age which was found to be similar to the FCR of the Naked Necked birds. Conversely, a non-significant ($p<0.01$) differences in FCR was record by Faruque *et al.* (2017) between three (3)indigenous chicken genotypes (Hilly, non-descriptive native, and Naked Neck). FCR of 2.80 was also discovered whenFaruque*et al.* (2013) carried out their studies on Hilly Chicken kept under controled management system. The result was in agreement with Akhter *et al.* (2018)where local chickenraised in a semi-intensive system and with a supplementation of balanced deit showed good performance with respect to their efficiency in feed conversion than the fully scavenging suplemented with crushed soybean mixed with broken rice.

Duodu (2013) reported a FCR of 2.98, 2.95, and 2.96 for the frizzle, normal feathered, and the naked necked respectively being non-significant. However, Feed Conversion Ratio (FCR) was reported by Nakkazi *et al*. (2015) tovary significantly across breeds. The highest FCR value was observed in frizzle feathered chickens (4.53) while the least was seen in naked neck chickens (3.84). This finding supports Oleforuh-Okoleh *et al.* (2017), where the naked neck chickenswere found to have a higher feed conversion ratio than conventional feather hens. The authors documented a feed conversion ratios of 0.25

and 2.59 for naked and normal feather Nigerian local chicken fed on a low crude protein diet.

2.6.3 Body Weight of Local Chicken

Body weight (BWT) is a function of the animal's structure or size, as well as its condition. Individual disparities in body weight may be related to differences in the genetic make-up and environmental factors that affect the animal (Assan, 2013a). The size of the animalcoupled with its condition, is considered during the determination of the body weight of an animal (Oke *et al.,* 2012). An animal’s BWT is significantly important and fully considered as an economical trait in that is given significance our meat industries when farmers/breeders want to spick the best performing animals as parent stock for the future generation and improvement (Dekhili & Aggoun, 2013). However, it is worth noting that a particular trait’s selection depends on the method of selection adopted by the greeder. A better understanding of the BWT and its oscillations is crucial in examining growth performance, feed efficiency, animal responses to various environmental circumstances and production methods, predicting feed requirements, and making economic decisions(Assan, 2013b; Lukuyu *et al.,* 2016; Deribe*et al.,* 2018). Several reports have been documented on the body weight of the local chicken.

Ebegbulem *et al.* (2018) recorded 1240g and 1190g in Normal feathers *(NF*) and frizzle feathers (*FF*) male chickens respectively.The non-significant difference in body weight between the NF and the FF could be attributable to their ancestors' genetic relatedness. Female birds, on the other hand, had a BW of 1130g, which was superior to the *NF*

(1035g) at mature ages. On the other hand, (Adeyinka, *et al.,* 2006) reported BWT as high as 2428.1g at 56days of age in naked neckbroiler chickens. Environmental variables, breed variances, and differences in management systems could all account for the disparity in their findings.

Graham (2006) reported that Bantam Cocks weigh approximately 0.7- 0.78kg and hens weighing 0.6-0.7kg, respectively, while standard frizzling roosters weigh 3.0-3.6kg and hens 2.3-2.7kg. Standard Silkies, on the other hand, are little chickens, measuring only 1.8 kilograms (4 pounds) for males and 1.4 kilograms for females.

According to Adomako (2009), the average body weights of homozygote, heterozygous heterozygous frizzle and homozygous frizzle were 1413.10g, 1384.20g, 1155.90g, and 1177.70g, respectively showing substential differences. Similarly, at week 20, the birds were discovered to record another significant difference in their average body weight of 2159.50g, 2102.30g, 1795.80g, and 1734.90g for *NaNa*, *Nana*, *FF,* and Ff respectively. Chimenem-Amadi*et al*. (2021), revealed significant variancesbetween the BWT of the naked neck, frizzle, and normal feathered chickens at 16wks of age. A maximum BWT was found in naked neck chicken breeds (994.25g), while the lowest was found in regular feathered chicken types (841.00g).

Adomako *et al.* (2014) investigated the performance in growth of cross-bred laying Naked Neck chickens reared in a tropical community and found substantial variationin the Live weight at week 6, to be 409.7g and 449.0g for the *F1 na/na* (normal feathered and *Na/na* (*Naked Neck*) birds respectively. The live weight at week 20 was also documented by the same authors to be 1895.8g and 1565.4g for the first (*F1*) Na/na and na/na birds respectively showing varried differences. Similarly, Chimenem-Amadi*et al.* (2021) reported the highest body weight in Naked neck chickens (1996.00±38.26g) while the least body weight was observed in frizzle feathered chickens (1467.00±44.18g).

Chikumba&Chimonyo (2014) reported significant deviations between the body weight of the naked neck and Ovambo genotypes reared sixteen weeks (16wks) of age. The Ovambo chickens recorded an average live weight of 1,54±26.20g/bird were heavier ($p<0.05$) than Naked Neckchickens with 1,323±26.2 g/bird. On the other hand, at 16 weeks of age, Magothe *et al.* (2010) documented 1007.90g, 932.80g, and 937.00g for normal, frizzle, and Naked Neck indigenous Kenyan chickens respectively. The Naked Neckchicken's superior body weight and growth features over the regular fathered chicken contradicts what was disclosed by De Almeida & Zuber (2010) and Magothe *et al.*, (2010) who found that Naked Neckchickens have less body weight than their normal feathered counterparts. Magala *et al.* (2012) and Najib & Al-Aqil (2015) stated that the differences observed in their studies may be due to some factors such as breed, management system, age, sex, and different environment which might have influenced the breed involved. In a Randomized Complete Block Design, Oke *et al.* (2012) evaluated the growth characteristics of 210 indigenous chickens acquired from the main and reverse mating of indigenous chickens with the bare-neck *(Na*), frizzle (*F*), and normal feathered genes (*na*) which possess some major genes on the growth characteristics of the pullets. The results indicated that the F/F genotypesrecorded significantly ($p<0.05$) higher body weight mean during their first day of hatch

(30.90±2.73g), with the highest average body weight at sixteen weeks (442.50±6.60g) and twenty four (24) weeks (114.00±33.98g) of age.

2.6.4 Body Weight Gain(BWG(ofIdigenous Chicken

At different ages, Nakkazi *et al.* (2015) reported the average weight gain per day of local chickens at 0-8, 0-12, 0-16 weeks and zero (0) to maturity to be 7.8±0.02, 9.4±0.02, 9.8±0.02, and 8.2±0.03g, respectively. Significantly highest daily gains were observed in the third generation compared to other generations in all stages. The average growth rate differed between sexes and measurement periods. The average growth rate in the 16th week was greateras compared to what was observed in previous reports (Wilson *et al.*, 2017). Faruque *et al.* (2007) report indicated that at 8 weeks of growth, the Non-descript Deshi (*ND*), Hilly (*H*), and Naked Neck (*NN*) genotypes had daily body weight gains of 5.88, 6.17, and 6.27g per bird, respectively under intensive management, and those results were within the range of 5-8g discovered by Halima (2007).

Adomako *et al*. (2014) observed the Growth potentials of F1 naked neck (*Na/na*) and normal feathered (na/na) birds concerning their daily weight gain at week 6 g/week to be 103.5 and 96.7 respectively showingsignificantdistinctions.

In determining the potentials and improvement in local birds, Adomako (2009) reported an Average body weight gain between Week 14 & 15 for the *NaNa*, *Nana*, *FF*, *Ff*, genotypes to be 123.44g, 127.67g, 125.67g, and 118.67g respectively showing some notable differences between the *NaNa, Nana, FF, Ff* with the *NaNa* and *Nana* being similar. Average body weight gain between Week 18 & 19 was also reported to be

192.56g, 185.89g, 155.89g, and 150.67g for *NaNa, Nana, FF, Ff* respectively. Similarly, differences were recorded for the same genotypes between weeks 19 & 20. Generally, his report indicated that from week 7 through to week 20, the body weights gain of F2 birds with the bare neck phenotypes (*NaNa & Nana*) were substantially greater ($p<0.05$) than the frizzles (*FF & Ff*). From week 8 to week 20, *NaNa* and *Nana F2* birds acquired significantly more weight than *FF* and Ff birds ($p<0.05$).

2.6.5 Water Intake in Local Chicken

Water plays significant role in animal nutrition and is involved in many aspects of poultry metabolism, including nutrient delivery, thermal homeostasis, meal digestion and absorption, and waste product removal. In birds, it accounts for 70 to 80 percent of lean body mass (Orakpoghenor,*et al*., 2021). In Southern and West Africa, about 80% of indigenous chicken farmers work in a marginal and unstable environment with little access to portable water for humans and livestock use (Swatson, 2001). The situation is exacerbated during the dry seasons of the year when water becomes scarce. According to the study by Chikumba & Chimonyo (2014), barely 60% of traditional chicken farmers in rural areas do not provide water to newly weaned free-range chickens because they believe in their ability to scavenge for water in an unpalatable, detergent tainted waste-water from bathrooms, gutters, and kitchens.

In rural areas, around 60% of local chicken farmers do not supply water to freshly weaned free-range chickens because they trust their capacity to scavenge for water; and these bird result in drinking an unpleasant, detergent-tainted water from toilets, bathroom, gutters, and kitchens. During an intestinal disturbance, it is common for birds to drink more water; any unexpected changes in water intake should be investigated. As a result, any major variations in water consumption should be investigated because they may indicate the onset of digestive problems. When birds become overheated, they drink more water to cool off; hence, increased water consumption over time could be a sign of heat stress, which has been linked to gut damage. Excessive water intake can also suggest high mineral levels (particularly salt) in the water the birds drink (Ryan, 2019).

Several studies evaluated the level of water intake in indigenous chickens. Producers may be unaware of a crucial fact: feed and water usage are inextricably linked. According to Muckelbauer *et al.* (2013), the correlation between feed and water use is 0.98. This implies that a 98% shift in water consumption is almost always directly proportional to feed intake; as a result, if we properly record daily water intake, we may get a good idea of daily feed intake. Chikumba & Chimonyo (2014) found that Naked Neckchickens have a lower water consumption on ad libitum water intake than their peers (Ovambo). Thethe results indicated that genetopye had a significant variationon water intake with respect to the Ovambo chickens recordeding an Average Daily Water Intake (ADWI) of 113.6mL/d and the naked neck chickens with 91.1mL/d. However, No significant response was recorded between genotype and the level of water restriction on this parameter. This they attributed to the fact that the Naked Neck is either genetically designed to take less water, and possibly depends greatly onon metabolic water to regulate their hydrational homeostasis, or a higher ability of using body water more efficiently than the ovambo chickens. Similarly, Ahmed & Alamer (2011), also recorded similarresults with respect to in the efficiency of water intake among chicken genotypes using the Saudi indigenous chickens fast-growing Hisex commercial layers where the later consumed more water than its counterpart.

The bodyweight of birds around 16 weeks of age was likewise impacted by water restriction. As the degree of the water restriction increased, the BW of the birds at 16 weeks of age decreased proportionately. Birds on 70% and 40% and 30% of ad libitum water consumption had body weights of 1,710, 1,431 and 1,158g/bird, respectively (Chikumba & Chimonyo, (2014). Peng *et al.* (2015) reported that local broiler chicken fed on a corn-based diet without viscosity increasing citrus pectin can take between 139-152ml/day while those fed with viscosity increasing citrus pectin can take between 182-204ml/day of water. Water intake in local chickens increases with physiological stress (Jean-Loup *et al.*, 2016), which could be a factor in ad libitum water intake variations. Puvadolpirod and Thaxton (2000) demonstrated that mediated stress in chickens doubled water intake during a 7-day period.

2.7 Heat Tolerance in Local Chicken

In the tropical and subtropical regions, an animal's ability to maintain homeostasis while under heat or thermal stress is an important feature because heat stress can result into significant economic losses in poultry production. Prolonged panting is the primary sign that an animal is undergoing heat stress (Saeed *et al.,* 2019). The growth, maintainance, and egg production, generates heat within the body as a result of metabolic activities. Factors that significantly affect heat generation in poultry among others are, ambient temperature, level of enzymatic activities, physical activities, breed, body weight, vitamins, and circadian beats (Scanes, 2015; Alagawany*et al.*, 2018; Madkour *et al.*, 2021). Domestic poultry have a body temperature ranging from 41.2–42.2°C, which is significantly above that of mammals (36–39°C). The most difficult problem for farmed birds exposed to variations of temperature is maintaining a state of body that permits the chemical process to function regularly. Food is wasted below the thermal neutrality zone, and birds suffer from heat stress above this zone (Smith, 2001).

Thermoregulation in birds can be compared with that of other animals, although aves also use salt glands, plumage and fat insulation (Scanes, 2015). Birds, as endotherms, can also adjust their body temperature by utilising the heat generated from their bodies. Because birds lack sweat glands, they tranfer generated heat to the surface of the body in order to allow sensible heat losses from surfaces such as thecomb, shank, wattles, and unfeathered parts such as beneath wings to the surrounding environment (Azoulay *et al*,. 2011; Scanes, 2015). According to Azoulay *et al.*, 2011) When the body temperature rises above normal (25°C), the heat loss mechanism used is panting. To maintain ambient temperature in chicken, the birds must increase their evaporative losses. As a result, they begin to breathe more rapidly, and pantingvigrousily (hyperventilation) which develops at around 30°C.

Poultry welfare and productivity are affected by heat stress. For example in a research conducted by Guerreiro *et al.* (2004), heat stress was found to be responsible for the illness and mortality of over one million broilers chickens every month in the poultry business. It has been proven that heat stress has a negative impact on water intake of chicken (Bruno *et al.*, 2011), electrolytes (Borges *et al.*, 2004), their growth rate (Abu-Dieyeh, 2006), feed consumption (Cooper & Washburn, 1998), blood variables (Aengwanich, 2007), and the immune response (Tirawattanawanich *et al.* 2011), as well as increasing number of death rate (Al-Fataftah *et al.*, 2007).

There are genes that are linked to heat or thermal tolerance which was reported in chickens, including the Naked-Neck (Patra *et al.*, 2002),Frizzle (Sharifi *et al.*, 2010), the normalfeathering (Fotsa *et al.*, 2001) and dwarfism (Sharifi *et al.*, 2010) genes. The chicken's growth performance and appearance characteristics can be modified by the genes in all cases. Isidahomen *et al.* (2012) discovered significant variations in physiological variables related to heat tolerance among the Nigerian chicken genetic group.On rectal temperature, their results ranged from 40.09 ± 0.21^{0}C to 41.68 ± 0.03^{o}C with the highest mean value recorded by the naked neck genotype while the normal feather genotype had the least value. Rectal temperature was very high in the third month of their study for naked neck genotype as a result of genetic differences. However, the rectal temperature was quite stable throughout the experiment from week 1 to week 24. Under normal and abnormal (heat stress) settings, a comparison of commercial broilers with local Thai chickens reveals differences in the growth performance of the two genetic genotypes kept at various temperatures. Commercial broilers' average daily gain (ADG) and feed consumption were considerably ($p<0.05$) reduced under heat stress circumstances, whereas native chickens' ADG was unaffected, demonstrating the native breed's heat resistance. disparities in growth performance between the two genetic genotypes maintained at different temperatures. The average daily gain (ADG) and feed consumption of broilers were considerably ($p<0.05$) reduced by thermal stress, whereas the ADG of native chickens was unaffected by the extreme heat, demonstrating the heat tolerance of this native breed (Duangjinda *et al.,* 2017). The observed result with respiratory rate was significantly affected by genotype. It follows the same pattern observed with rectal temperature. The naked neck had the highest range (64.80±2.60 breaths/min) while frizzled feathered genotype had the least value of 22.00±1.49 beats/min.

Domestic poultry's internal body temperature is typically 41.2-42.2oC, which is significantly higher than that of mammals (36-39oC). The key challenge for farmed chickens exposed to extremes of temperature is to keep their bodies in a state that allows the chemical process to function normally. Food is wasted below the thermal neutrality zone, and the bird suffers from heat stress above it (Speakman & Keijer 2013). As a result, it is necessary to assess, re-evaluate and consider the management of birds and the equipment used in high thermal conditions on a regular basis in order to avoid heat stress and the related welfare issues.

In a researchcarried out by Isidahomen *et al.* (2012), genetic variation and genetic makeup of the chickens accounted for observed differences in rectal temperature. This implies that body temperature, respiratory rate, pulse rate values can be used to classify birds into their genetically distinct sub-groups. The use of Naked neck chicken that confer some extent of tolerance to harsh tropical environment should be encouraged especially in crossbreeding programmes in order to produce individuals that are adaptive and more productive. Fadare and Famuyide (2021) recorded the least rectal temperature (40.42±0.03^{o}C) in the first two weeks (0-2weeks) of the life of broilers. It was observed that as cloacal temperature is directly proportional to the age of the birds and the highest rectal temperature was noticed or observed at 6 to 8 weeks.

2.8 Mortality Rate of Local Chicken Genotype

According to Blackie (2014) in a survey conducted in the Greater Accra Region of Ghana, free range chicken production system was characterized by high mortality. Disease, predation, and other factors such as inadequate diet and theft were the leading causes of village chicken deaths. Using a pre-coded questionnaire, respondents were required to identify the three most important reasons accounting for the death of their birds and the results of the ranking indicated that diseases and predation were ranked first and second, respectively, as the most important restrictions to local chicken production by respondents. The importance of poor nutrition was ranked third. During the dry season, the majority of rural chicken deaths due to illnesses and predation have been documented. As previously stated, Newcastle disease is regarded as one of the most significant restrictions to village chicken production in Africa and Asia. Formal disease control for indigenous chicken flocks in Ghana is basically non-existent (Blackie, 2014).

Fadare&Famuyide (2021) recorded mortality percentage to be significantly affected by age. The first two weeks had the highest mortality rate, while the last six to eight weeks had the lowest. Shepelo and Maingi (2014) discovered that chicken death is highest in the first two weeks (0-14 days) and reduces as the birds get older. The first week of a chick's existence is a delicate time when most of the chicks' systems and organs are still undeveloped. Stress factors have a significant impact on chick physiology and wellbeing during this time, leading to their deaths (Yerpes *et al.,* 2020).

In study conducted by Selam & Kelay (2013) to revealed the main causes of chicken mortality raised under free range system and the intervention measures farmers adopt to combat suchkey variables that contribute to chicken deaths in some villages in Ada District of Ethiopia, the significant number of the respondents, unveil predation and sickness representing 91.9% and 86.0% respectively as the two most common causes of death in chickens which are older than one week. More than half of the chicken at this age are lost owing to predation and mismanagement representing 67.8% and 29.4% respectively withother causesdisclosed by less than ten percent (10%) of the respondents. An approximate large percentage (48.3%) of the respondents do not provide modern medication and those who do use it mostly use broad-spectrum medications without consulting veterinarians. Different symptoms and certain disorders that lead to death were also noted by respondents. The majority of the respondents were unfamiliar with disease nomenclature, however Newcastle disease (NCD), also known as "Fengel" in the study area, was well-known. Diarrhea (65.6%), stress and death within a few days (48.6%), and lowering of the head were the most prevalent symptoms of illness reported by respondents (28.9%). Coughing and sneezing, blindness of the eyes, blackening of the comb, staggering movement, swelling and loss of appetite were some of the other symptoms listed.

Other causes of chicks mortality can be attributed to the following causes:

- **High Brooding Temperature:** Your flock is at risk if the brooding temperature is too high. Chicks become dehydrated as a result of too much heat, and they drink more water than they eat. Their growth is stunted due to their lower feed ingestion, and they eventually die. Furthermore, it produces plastered vent (i.e., feces tracked around the vent area obstruct the vent, causing chicks to die as a result of their inability to pass waste from the body).
- **Low Brooding Temperature:** Low brooding temperature promotes chilling, and extreme exposure to coldevevironment can have a direct influence on the flock's immune system, making birds more susceptible to disease. Furthermore, when exposed to extreme weather, flocks tend to snuggle together to keep warm. Huddling causes the flock to suffocate, resulting in chick mortality.
- **Poisoning:** Poisoning causes a significant percentage of death in young chicks. However, the kind, dose, and duration of exposure all play a role. Poisoning death can be swift and terrifying. Poisoning can be caused by everything from food to too much salt, herbicides to insecticides, disinfectants, and so on.
- **Litter Contamination**: Contaminated bedding materials are another major cause of chick mortality. Some farmers use sawdust to brood their chicks, which could be quite damaging to them. Chicks can confuse sawdust for feed and devour large amounts of it, causing gastric impaction and, eventually, death.
- **Inadequate Feeders and Drinkers:** Chick mortality can also be caused by improper feeding and drinking equipment. The performance of flocks is influenced by insufficient feeders and drinkers. It also leads to waste of feed and

water spills, resulting in damp litter, which is conducive to disease breakout. Less feeders and drinkers, on the other hand, result in famine and mortality.

- **High Relative Humidity:** High relative humidity dampens litter material in the brooding house, allowing microorganisms to thrive and create a favourable environment for disease breakout.

2.9 Production and Breeding of Indigenous/Local Chickens in the Local Settings

In Indigenous Chicken, mating takes place between the household farm's hens or pullets particularl among the household cock or cockscoming from outside the household. Farmers employed mating control as a criteriato culling underproductive chickens, birds with undesirable features, and preserving those cocks and hens with desired characteristics as well as avoidingcrossing with undesirable cock. This limitation mating is a strategy used for a particular number of eggs (thus 3 and above) selected for incubation when the farmer intends to manipulate and control the crossing using the cockspreserved for desired qualities. The pullets are able to mate with other male counterparts they meet while scavenging after mating (Hailu *et al.,* 2013).

Due to the characteristics of this systemas well as farmers' levels of awareness and understanding, coupled with their benefits and drawbacks, the control mechanism for breeding techniques has proven to be challenging. As previously stated, the Indigenous Chicken system has been more traditional-based, with less inputs and insufficient infrastructure, as well as small flock sizes (Hailu *et al.,* 2013). Inbreeding is encouraged by tiny flock size which may result in fitness loss (Falconer and Mackay, 1996). Other issues like feed shortages, illnesses, and predators which combined form several limiting factors of flock expansion in rural areas, increase inbreeding depression in Ghana and other African countries (Hailu *et al.*, 2013; Khobondo *et al.*, 2015 & Mahoro *et al.*, 2017).

Another factor limiting the development of the the value chain of indigenous chicken is the lack of government's and other stakeholders' involvement or active participation in genetic and improvement at the local household level, making it sometimes an ineffective practiceamong vulnerable local farmers. Farmers, on the other hand, have their own breeding and reproductive procedures to sustain their flocks at the household level. According to Addisu (2013), the number of eggs produced per hen (37.91%) and feather colour (37.58%) were the most valued traits among farmers in high altitudes. In high altitude, a higher percentage of farmers (46%) choose egg as their major trait, whereas in low altitude, plumage colour is the preferred trait (44.34%). The report of Dana (2011) however, indicated that farmers in various parts of Ethiopia, on the other hand, appear to favour adaptive qualities like meat and egg testing. Other farmers consider the following as the most important traits: growth rate, egg yield, disease tolerance, body size, and fertility which are factored in the main criteria in selection and breeding. In a study conducted by Addisu *et al.* (2013), only 17.3% of the respondents had knowledge or experience in breeding to improve their chicken productivity either by line breeding (79.1.0%) or cross breeding (19.9.0%). On the contrary, Meseret (2010) indicated that the local chicken rearing system is distinquishedby a lack of organized breeding technique. In a similar research carried out by the same author in a different section of Ethiopia, it was revealed that tradional or local chicken breeding is fully uncontrolled, with replacement stock created through natural incubation of hens (Nigussie, 2011).

2.10 Improving Local Chicken Performance through Breeding and Genetics

Breeding and genetics are being used to enhance the production and productivity of local chickens. Local chicken breeding and genetic improvement are difficult operations, yet they are necessary for sustaining our agricultural system. They are dependent on the breeds to be employed and require a thorough study of each breed's distinctive features or phenotype (Pym, 2013). These strategies have been used by animal breeders to create more hardy and efficient agricultural animals. Semen collection and preservation, artificial insemination, and other innovations have been used in the anima and food industries. When it comes to genetic improvement in local hens, however, numerous aspects must be taken into account. For example, a single gene that change or reduce feathering, like the naked-neck and frizzle genescan enhance endurance to high temperatures, which is a fundamental requirement (Pym, 2013). Crossbreeding, backcrossing, and within-line selection are examples of breeding procedures that can possible be used to improve the performance of local chicken genotypes (Mahrous, 2008). For example cross-breeding, in particular, can be used to increase the bodyweight and growth performance of local birds kept under an intensive and semi-intensive management system (Mothibedi *et al.*, 2016).

Current genetic enhancement projects have been spurred by the realization of indigenous chicken potential. Developing a procedure that ensures increasing performance of the birds with respect to their performance in meat and egg (Okeno *et al.,* 2013), persistent adaptability to slightly varied scavenging environment, and preservation and/or conservation of local chicken ecotypes is a potential alternative. In Kenya and Malawi, for example, a unique program called the Smallholder-Indigenous-Chicken-Improvement Project (INCIP) is in operation since 2006.

To generate the breeding stock, eggs of locla chicken and live fowl were acquired from distinct Agro-ecological locations. These ecotypes are presently on station at Egerton University National Poultry Research and Development Station in Kenya and the Lilongwe University in Malawi respectively for multiplication, performance recording, and selection (Okeno *et al.,* 2013; Ngeno *et al.,* 2014).

Several important genes have been uncovered after scientists completed a series of studies using the indigenous chicken of different nations. These genes are divided into three categories: feather-reducing genes, body-size-reducing genes, and plumage-color-controlling genes (FAO 2010). The genes were linked to different ecological zones. In cold climates, feathered chickens/genotypes predominate; their bodies are fully*covered* with plumage to aid in thermoregulation and protection against losing their body heat. The frizzle and Naked necks feathers expression, caused by imperfect dominant genes F and Na, respectively, dominate the hot and warm environment, a trait that allows for better heat dissipation. The less feathers of thethe breast, ventral and neck, region of the body characterizes the naked-neck genotype (Khobondo *et al.,* 2014). Modern research and developments in molecular genetics, breeding and genomics have provided more information about these native chickens. LEI 0258 and MCW0371, MHC-linked markers,identified 10 alleles (198-207 bp) and 46 alleles (194-550 bp) for Kenyan and Malawi local chickens, respectively (Ngeno *et al.*,2014). This is lower than 52 alleles reported by Chazara (2013) on Eighty (80) varied populations or lines from Europe, Asia and Africa but higher than 42 alleles recorded by Hako-Touko *et al.* (2015) for Cameroonian chickens.

However, in Ghanaand other Africa countries, there is limited scientific research on cross-breeding native chickens to increase growth performance qualities (Tyasi *et al.*, 2019). Furthermore, foreign breeds have been the focus of chicken genetic development in poorer and developing countries (Dana, 2011). For example, the lack of productivity among Ghanaian chickens can be attributed to a lack of genetic development of attributes regarded commercially valuable (Assan, 2015).

2.11 Breeding Value (BV)/Estimated Breeding Value (EBV)

The term breeding value of an animal is commonly used to describe the value of an animal in terms of the contribution that can be made by passing on its genes. It describes the importance of particular genes when they are passed down to the following generation. EBVs (Estimated Breeding Values) are a measure of aanimal's ability to transfer its traits to its progeny. The lesser the heritability of a characteristic under selection, the less the herd advances. When a characteristic is 40% heritable, it implies that genetics (the EBVs) account for 40% of the variation between animals, whereas the other 60% is due to management and environmental variances or influences (Annor, 2019).

In animal breeding systems, we wouldd like to rank and select animals based on their genuine breeding values (TBV or "A": additive genetic value). However, we do not have perfect or complete information because we can not see genes or breeding values, so we have to calculte projected breeding values based on observable phenotypes (EBVs). Breeding values are the average effects of genes passed down from one parent to their offspring. EBV-based selection produces less genetic variation than selections based on true breeding value. The EBV precision, which ranges from 0 to 1, is proportional to the relative reaction.

The most evident piece of phenotypic data we can use to evaluate an animal's breeding value is its own phenotype. Information from relatives such the parent, siblings, and offspring can also be utilised. Commercial genetic evaluation methods create EBVs for each animal based on all relevant parameters. This type of assessment is based on a statistical calculations that result in the Best Linear Unbiased Prediction (BLUP) estimated breeding values. BLUPthis method is accepted and used worldwide to calculate determine the Estimated breeding values (EBV) for important commercial traits. To estimate the animal's EBV, BLUP uses all available data on the animal and corrects for fixed effects. Inclusion of information from relatives is handled automatically by the BLUP approach, assuming that such information is present in the database due to pedigree knowledge (Rajkumar *et al.*, 2021).

The objective of genetic improvement is to improve performance by increasing the average values of genotype of the population. From the genetic point of view, the ranking of animals is based on their ability to contribute genes to their offsprings or the next generation. The rate of improvement in the primary trait of selection is determined by the estimated breeding value (EBV). Any attempt to improve livestock and poultry genetics must begin from or with the population variability. Genetic advancement is determined by the response to selection in the main as well as other related attributes of economic worth.EBVs can be estimated using one's own performance as well as the performance of family members. The breeding value of phenotypic differences is used to compute EBV and is calculated as a regression of phenotypic differences' breeding value. The higher the heritability, the more the variations are attributed to EBV. The EBV's accuracy or precision is one of its most essential characteristics; it is a measure of the selection efficiency. The reliability can range from 35 to 99 percent, with greater values for characteristics with a higher heritability and when additional data is used, such as information from more relatives, information about the breed's progeny is required to attain precision of greater than 70%. The prediction error, the selection difference, and the variation among EBV are all predicted using the accuracy. In a animal breeding program, accurate evaluation of a selection candidate's breeding value is critical since it is an indicator of the selection candidate's ability to generate superior progeny (Aruna & Chakravarty, 2020). Although Genetic Selection (GS) has been utilized to deliver Genetic Estimated Breeding Value (GEBV) in animal breeding programs for some time, it is still a new technique in crop breeding.

EBVs have been found to improve breeding choices that maximize farm productivity. Several significant economic qualities in animals can only be identified through the calculation of BVs, rather than through visual identification/inspection. EBVs have been proven to be an effective tool for predicting the extent to which an animal will pass on important features including growth rate, wool quality, carcass quality, reproductive ability, and parasite resistance to its offspring. Better selction decisions can be made to improving your herd and profits faster if you have reliabledataon the animal's genetics (Rajkumar *et al.*, 2021).

It is necessary to have an understanding of one's own performance, pedigree data, and progeny information in order to determine breeding values. The phenotypic differences between animals are used to estimate breeding values. The phenotype is the sole information that can be used to compute breeding value without knowledge/data of genuine genotypes. To do so, we employ phenotypic differences, or more accurately, phenotypic variations. The breeding value is now calculated as a percentage of this variance, i.e. the percentage of total variation owing to breeding value fluctuation (Annor, 2019; Rajkumar *et al.*, 2021). Because the breeding value is equal to heritability when the information employed is an animal's own phenotypic variation, it is estimated as:

$EBV = h^2 \times P$

Where h^2 is the symbol for heritability and

P represents the phenotypic deviation,

The heritability (h^2) is a genetic population parameter (thus its value is fixed). It can only differ between the same trait in various climate or populations (breeds). $h^2$is used instead of h for statistical reasons. The correlation between breeding value and phenotype is equal to h. Heritability (h^2) is the percentage of variation explained by breeding value. This notation is the same as in statistical modeling, where r^2 represents the fraction of variance explained by the model and r represents the correlation between observed and predicted values.

2.12 Coefficient of Variation

The coefficient of variation (CV) can be defined as an estimation of the ratio of the standard deviation to the average or mean. The CV determines the level of dispersion around the mean of the parameter measured. In most cases, percentage is used to expresss it. Because it does not use units, it can be used to compare distributions of values with different measurement scales. In statistics and the theory of probability, the coefficient of variation (CV) is a normalized measure of variation of a frequency or probability distribution.

The CV is frequently stated as a percentage, which corresponds to the formula:

$$\text{Coefficient of Variation} = \frac{\sigma}{\mu} \times 100\%$$

σ= The standard deviation

μ – The mean

Yakubu &Aya (2012) estimated the coefficient or indices of correlation of body weight and other body parameters of three genotypes of chickens and proven that the link between body weight and zoometrical features of the birds was determined to be extremely significant ($P<0.01$).The coefficients values ranged from 21.61, 21.43 and

24.60% for normal feathered, naked neck and frizzled chickens respectively. The highest coefficient of variation was noticed in local white (3.16%) medium in local black (1.93%) and the least was found in the black brown neck (1.0 %).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area and Period of Study

The study was undertaken at a section of Zaaley Commercial Poultry Farm in Sagnarigu, the capital town of the Sanarigu Municipality. The study was conducted from 18th July, 2021 to 11th January, 2022.The municipality of Sagnarigu is one of sixteen (16) MMDAs in the Northern Region of Ghana. Sagnarigu Municipal was initially part of the Tamale Metropolis until it was splited off to become Sagnarigu District on June 24, 2012.The Municipal is found between longitudes 0^{o} 36' and 0^{o} 57' West andlatitudes9^{o}16' and 9^{o}34' North.

The Municipality shares boundaries with its Mother District (the Tamale Metropolis) to South-East, West to Tolon District, North to Savelugu Municipality and Kumbungu District to the North-West. According to the results of the 2021 Population and Housing Census,the municipality has a land area of approximately 200.40km^2 and a total population of 341,711 inhabitants, with 170199 males and 171512 females (Ghana Statistical Service, 2021).

Agriculture and trading are the primary economic activities in the area. Millet, maize, cassava, yam, groundnuts, cowpea, and soya beans are among the principal crops grown by farmers in the Municipality. Livestock farming is also practiced in the Municipality and animals such as guinea fowl, chicken, goats, sheep and cattle are some of the main animals reared in the municipality. According to Köppen's climatological classification, the municipality has a tropical wet and dry climate. The raining season in the area is from April to September or October, with a peak in July and August. The average annual rainfall is 1100 mm, with tropical showers accounting for 95 days of the total with an average relative humidity of approximately 49.9%. The Municipality also has daily temperatures ranging from 27.5^{o}C to 39.8^{o}(Ghana Meteorological Agency, 2021).

3.2 Experimental Birds and Design

For this research, a total of 112 native chickens made up of 47 males and 65 females were used. There were 28 birds of each genotype of the naked neck, frizzled, silky, and normal/typical feathered chickens. The chicks were purchased one week after hatching from three (3) commercial local poultry farmers in Kpalsi, Gurugu and Nyohini all which are suburb of the Municipality. The chicks after their acquisition were further brooded for three (3) weeks with a brooding temperature of 34^{o}C. The chicks were exposed to 24 hours of heat supply during brooding. The temperature was gradually reduced weekly as brooding continued. The genetic group were reared for 23 weeks. In order to combat stress and infections, medication and immunizations were administered as and when neccesary. For simple identification, all chicks were wing-tagged with unique numbers and subjected to the same management procedures throughout the experiment.

Based on genotype, the birds were replicated four (4) times, with each replicate having a total number of 7 birds in a Completely Randomized Design (CRD). The design was chosen in order to have the units in a block as uniform as possible in that observed differences would be largely attributed to treatment effects.

3.3 Management of Experimental Birds

3.3.1 Housing

The experimental birds were randomly distributed and reared on a slated net floor pen partitioned into 16 compartments, each measuring 3m x 4m x 1m. The slatted floor was built with wire mesh with sturdy wood reapers under to support human movement. Each compartment was installed with plastic drinkers with a capacity of 3.5 liters and dimensions of 50 x 15 x 24cm (L x D x H) with an approximte maximum pressure of 0.5 N/m^2. Wire mesh was used to cover the side of each cage from top to down leaving an entrance into the cage. To provide adequate illumination to the facility, energy-efficient bulbs were put at focal locations in the cages.

3.3.2 Health Care and Medication

The watering troughs were washed daily and clean water provided daily to prevent infection. The chicks were given glucose and antibiotics on arrival, dewormed on the 38^{th}, 55^{th} and 98^{th} days and other appropriate medication such as Newcastle vaccination, coccnidiostat, gumboro and fowl pox were given to the birds as and when necessary throughout the experimental period.

Birds were observed for signs of illness and the appropriate actions taken to bring them back to good health. A veterinary officer from Animal Health and Production Department, Sanarigu was assigned to help take care of any ailment and post mortem examinations on the dead birds. Deaths were documented as they occurred.

3.3.3 Feeding and Watering

From the 2nd week to the 4th week of age, the birds were fed with a diet that contains 2995Kcal/kg Metabolizable Energy (*ME*) with a crude protein content of 20.2%, and from 5 to 23 weeks of age, growers marsh comprising approximately 2716Kcal/kg Metabolizable Energy with 15.9% crude protein (Table 3.2). Throughout the trial, clean water was provided *adlibitum* on a continual basis. Every morning, feed was measured and distributed to the birds. Before distributing fresh feed, the leftovers were weighed the next morning to ascertain the amount consumed. The feed intake of the chickens was calculated by taking the difference between the amount of feed delivered and what was left over. The drinking and feeding troughs are shown in plates 3.1 and 3.2.

Chemical composition of feed supplied to the birds at different stages or level of their growth is shown in Table 3.1.

Table 3.1: Composition of the Diet Supplied to Birds

Ingredient	Starter mash (kg)	Grower mash (kg)
Maize	46.50	55.45
Groundnut cake	24.65	15
Soy bean meal	18.00	20
Fish meal	2.50	2.0
Bone meal	2.50	1.5
Limestone	5.00	5.00
Vitamin & Mineral Premix	0.250	0.25
Salt	0.30	0.30
Lysine	0.250	0.25
Methionine	0.250	0.25
Total	**100**	**100**
Calculated CP	20.17%	15.85%
ME, Kcal/Kg	2,995	2,715

3.4 Parameters Measured and Estimated

The data was taken daily, weekly or fortnightly depending on the parameter in question. Data for body weight and heat tolerance traits were collected on weekly basis for a period of 23 weeks. The following parameters were measured: weekly body weight, daily body weight gain, weekly feed intake , feed conversion ratio, body temperature, pulse rate, respiratory rate, mortality rate

3.4.1 Production Traits

Weekly Body weight (WBWT): Individual body weight (g), were recorded from chickens of the four genotypes weekly which were tagged individually. The body weights were measured using the Camry top loading sensitive scale manufactured from China by Jadever Company Limited with sensitivity or readability of 0.1g. Body weight gain (g/bird) was calculated by subtracting the initial weight from the final weight.

Weekly Feed intake (WFI): Leftovers feed were weighed the next morning to ascertain the amount consumed Camry top loading sensitive scale manufactured from China by Jadever Company Limited. The difference between the amount of feed delivered and what was left over represented the birds' feed intake.

Feed Conversion Ratio (FCR):This measures the amount of feed consumed per unit increase in weight. In this research, FCR was estimated from the ratio of the body weight gain to the feed intake. As a result,

FCR = feed intake/weight gain

3.4.2 Heat Tolerant Traits

Body Temperature: This was determined using clinical thermometer; a product from China manufactured by Asia Connection Corperation Limited. The Temperature was determined by inserting a clinical thermometer into the cloaca for 1 minute and taking measurements.

Pulse Rate*:* The pulse was measured using a veterinary standard pulse oximeter by placing the instrument on the wing and recording the readings within 1 minute. The Oximeter was acquired from Pong Tamale Animal Breeding Station. Oximeter was manufactured by CONTEC Medical Systems Co. Ltd., China.

Respiratory Rate: This was measured for each bird by using a veterinary standard pulse oximeter which records the amplitude varying over respiratory cycle within 1 minute. The Oximeter was acquired from Pong Tamale Animal Breeding Station. Oximeter was a a product of CONTEC Medical Systems Co. Ltd., China

Heat Stress index (H)*:* The heat stress index was calculated using the relationship between pulse rate and respiration rate, as well as the normal average values for both. The formula used was adapted from Isidahomen *et al.* (2012) as follows:

$$H = (NP/NR) \times (AR/AP)$$

H=Heat Tolerant/Stress Index

AR= Value for the Average Respiratory Rate

AP=Average Pulse Rate Value

NP= The Normal Pulse Rate Value

NR=Normal Respiratory Rate Value

Mortality Rate: This was measured by counting the number of mortality observed in each treatment during the study period and expressed in percentages.

3.4.3 Other Estimated Values

Estimated Breeding Value (EBV): This is a determination of the genetic merit of an animal for a certain trait. Breeding values determine whether the progenies of an animal are superior or inferior. The EBV in this study was calculated as:

$EBV = P \times h^2$

Where;

h^2 = Heritability

P = phenotypic deviation (Deviation of the individual performance from the population mean).

3.4 Data analysis

The data collected wasanalysed using the Genstat with General Linear Model (GLM) procedure. Differences between means were separated by probability difference (PDIFF) procedure of Genstat ANOVA output on the following fixed model:

$Y_{ijk} = \mu + G_i + e_{ijk}$

Where:

Y_{ijk}= performance/productivity of the i^{th} bird at a particular age

μ= General mean common to all observations

G_i =Effect of thei^{th}genotype (i = 1, 2, 3, 4)

e_{ijk} = error term that cannot be explained.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Production Traits of Local Chicken Genotypes

4.1.1 Body Weight

Results of the body weight (BWT) of the four genotype of the Ghanaian local chicken are presented in Table 4.1. The four (4) weeks body weight of the birds was found to be significantly ($P<0.05$) different. The naked neck genotype exhibited the highest ($P<0.05$) numerical body weight at week two (140.4g).

The body weight of the silky genotype in the 4th week was found to be superior ($P<0.05$) over the other three genotypes. However, the four-week weight of the Silky (262.5g) and the Frizzle (251.2g) did not differ significantly ($P>0.05$). Major differences ($P<0.05$) were also not observed in the body weight of the frizzle and the naked neck (Table 4.1). This implies that at week four, the frizzle's body weight fell between that of the silky and the naked neck.

At the 6th through to the 24th week, the trend of the body weight performance of the local chicken showed significant variations ($P<0.05$); this is becauses the numerical values of the naked neck was higher which was followed by the silky. However, the normal feathered and the frizzle generally exhibited similar ($P>0.05$) body weight performance within this same period (Table 4.1).

Table 4.1: The Effects of Naked Neck, Frizzle, Silky and Normal Feathered on Body Weight (g)

BODY WT(g)/Per Bird	GENOTYPE				
	Silky	**Naked Neck**	**Frizzle**	**Normal**	**SEM**	**P-value**
Initial weight	125.9	140.4	122.9	98.8	4.61	001
4- Wks	262.5^{a}	238.3^{b}	251.2^{ab}	213.3^{c}	11.70	001
6- Wks	376.2^{b}	394.0^{a}	419.0^{a}	376.3^{b}	14.97	015
8- Wks	541.9^{bc}	568.8^{ab}	582.7^{a}	524.9^{c}	18.35	008
10- Wks	747.4^{b}	807.0^{a}	730.5^{b}	701.1^{b}	19.21	001
12- Wks	919.8^{b}	1055.7^{a}	916.5^{b}	883.4^{b}	25.68	001
14- Wks	1103.0^{b}	1215.0^{a}	1059b^{c}	1035^{c}	29.40	001
16- Wks	1337.0^{a}	1400.0^{a}	1200.0^{b}	1174^{b}	33.10	001
18- Wks	1477.0^{b}	1624.0^{a}	1348.0^{b}	1340.0^{b}	35.10	001
20- Wks	1627.0^{b}	1736.0^{a}	1480.0^{c}	1536.0^{c}	33.30	001
22- Wks	1763.0^{b}	1909.0^{a}	1642.0^{c}	1686.0^{c}	36.60	001
24- Wks	1934.0^{b}	2060.0^{a}	1829.0^{c}	1859.0^{c}	35.30	001

^{abc}*Means in the same row with different superscripts are significantly different (p<0.05).*
2-Wks (2weeks weight), 4-Wks (4 weeks weight), 6-Wks (6 weeks weight), 8- Wks (8 weeks weight), 10-Wks (10 weeks weight), 12-Wks (12 weeks weight), 14-Wks (14 weeks weight), 16-Wks (16 weeks weight), 18-Wks (18 weeks weight), 20-Wks(20 weeks weight), 22-Wks (22 weeks weight), 24-Wks (24 weeks weight).

4.1.2 Daily Weight Gain

Apart from week eight, the observed Daily Weight Gain for the four genotypes differed significantly (P<0.05) as shown in Table 4.2. For week six (6) and twenty four (24), the frizzle and the normal feathered maintained higher body weight gain(12.0g and 11.8g) respectively. The results also indicated that at week ten through to the week 15, the naked neck grew daily at a faster rate (P<0.05) with the highest daily weight gain (17.8g/d) recorded in week twelve (Table 4.2). Generally, the silky genotype placed second within the same period and also recorded the highest values in weeks 4, 14 and 16 among the genotypes. However, a comparison of the growth rate (Daily Weight Gain) for the normal feathered and the frizzle was intermittent throughout the study period.

Table 4.2: The Effects of Naked Neck, Frizzle, Silky and Normal Feathered on Body Weight Gain(g)

DailyWeight Gain(g)/per bird	**GENOTYPE**					
	Silky	**Naked Neck**	**Frizzle**	**Normal**	**SEM**	**P-value**
4- Daily-**G**	9.8^{a}	7.0^{c}	9.2^{a}	8.2^{b}	0.61	.023
6- Daily-G	8.1^{b}	11.1^{b}	12.0^{a}	11.6^{a}	0.89	.015
8- Daily-G	11.8	12.5	11.7	10.6	0.87	.187
10- Daily-G	14.7^{b}	17.0^{a}	10.6^{d}	12.5^{c}	1.38	.001
12- Daily-G	12.3^{b}	17.8^{a}	13.4^{b}	13.0^{b}	1.02	.001
14- Daily-G	13.1^{a}	11.4^{a}	10.2^{bc}	10.8^{c}	1.05	.046
16- Daily-G	16.1^{a}	13.2^{b}	10.1^{c}	10.0^{c}	1.45	.001
18- Daily-G	10.0^{c}	16.0^{a}	10.6^{c}	11.8^{b}	0.70	.001
20- Daily-G	10.7^{b}	8.0^{d}	9.4^{c}	14.0^{a}	1.28	.001
22- Daily-G	9.7^{b}	12.3^{a}	11.6^{b}	10.8^{a}	0.56	.001
24- Daily-G	$12.2^{b.}$	10.7^{c}	13.3^{a}	12.4^{b}	0.54	.001

[abc]Means in the same row with different superscripts are significantly different (p<0.05).
4- Daily -G (4 weeks daily weight-gain), 6- Daily -G (6 weeks daily weight-gain), 8- Daily -G (8 weeks daily weight-gain), 10- Daily -G (10 weeks daily weigh-gaint), 12- Daily -G (12 weeks daily weight-gain), 14- Daily -G (14 weeks daily weight-gain), 16- Daily -G (16 weeks daily weight-gain), 18-WdWT-G (18 weeks daily weight-gain), 20- Daily -G (20 weeks daily weight-gain), 22- Daily -G (22 weeks daily weight-gain), 24- Daily -G (24 weeks daily weight-gain).

4.1.3 Feed Intake (FI) and Feed Convention Ratio (FCR)

Significant differences(P<0.05) were recorded in the average daily feed consumption and daily feed convention ratio between the chicken genotype. The frizzle chicken breeds had the largest average daily feed intake (55.64g/d) while the silky consumed an average of 44.77g/d for the study period. Despite the fact that there were significant/key differences(P<0.05) in feed intake, the frizzle and normal feathered recorded similar(P>0.05) feed intake and the naked neck and the silky also consumed similar(P>0.05) feed per day.

In addition, the feed conversion ratio (FCR) differed significantly(P<0.05) between breeds. Frizzle feathered chickens had the greatest FCR value (5.19), whereas naked neck birds had the lowest (3.48) indicating that the naked neck has the tendency to efficiently convert feed consumed into body weight.

Table 4.3: Effects of Naked Neck, Frizzle, Silky and Normal Feathered on Feed intake and Feed Conversion Ratio

PARAMETER	GENOTYPE					
	Silky	**Naked Neck**	**Frizzle**	**Normal**	**SEM**	**P-value**
FI (22 weeks g/day)	44.77^{b}	45.87^{b}	55.64^{a}	53.50^{a}	1.62	001
FCR	3.46^{c}	3.35^{c}	4.56^{a}	4.26^{b}	0.11	001

^{abc}*Means in the same row with different superscripts are significantly different (p<0.05).*
p = probability of main effects.*
FCR = Feed Convection Ratio; FI = Feed Intake

Source: Field Data, 2022

4.1.1 Mortality Rate of Indigenous Chicken

Results of brooding and post-brooding mortality of the indigenous birds are shown in Figure 4.1. Genotype was found to have no significant (p>0.05) influence in the brooding and post-brooding survival of the chicken. Though there was no notable differences(p>0.05), the frizzle at brooding recorded no mortality (0%) while the normal and the naked neck each had 3.6% mortality with the silky recording the highest percentage value (7.1%). Similarly, at post-brooding, the normal and the frizzle each had 3.6% mortality with the naked neck and the silky having no mortality (Figure 4.1).

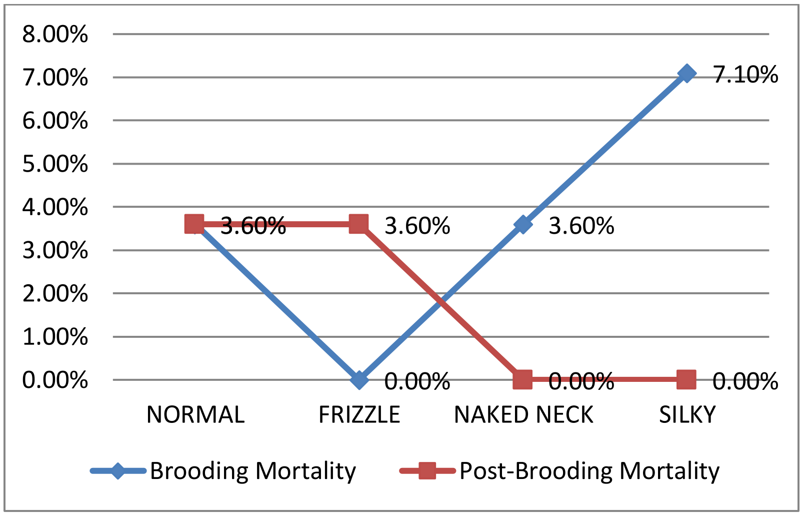

Figure 4.1: Brooding and Post Brooding Mortality of Naked Neck, Frizzle, Silky and Normal Feathered

4.2 Heat Tolerant Traits of Local Chicken

4.2.1 Pulse Rate of Local Chicken

The average pulse rate for the 1st, 2nd, 4th, 5th, and 6th month of the normal feathered were significantly higher than those of the frizzle, the silky and the naked neck birds. However, there were non-significant differences (P>0.05)observed in the pulse rate of the silky, naked neck and the frizzle within the period of 2nd, 4th and the 6th months while at the 1st month the pulse rate of the frizzle was found to fall between that of the silky and the naked neck (Table 4.4). A similar trend was observed in the 5th month where the observed pulse rate of the naked neck fell between that of the silky and the frizzle.

Table 4.4: Pulse Rate of Naked Neck, Frizzle, Silky and Normal Feathered

PULSE RATE (bpm)	GENOTYPE					
	Silky	Naked Neck	Frizzle	Normal	SEM	P-value
1-Month	209^{c}	305.2^{ab}	303.6^{b}	316.6^{a}	6.50	.037
2-Month	305.6^{b}	304.0^{b}	301.0^{b}	331.1^{a}	12.60	.001
3-Month	310.2	308.0	307.7	322.2	6.55	.090
4-Month	313.8^{b}	303.6^{b}	306.0^{b}	326.5^{a}	6.57	.003
5-Month	293.9^{c}	299.6^{bc}	309.4^{b}	333.6^{a}	7.45	.001
6-Month	297.8^{b}	302.3^{b}	302.3^{b}	326.3^{a}	5.70	.001

^{abc}*Means in the same row with different superscripts are significantly different (p<0.05).*

4.2.2 Influence of Genotype on the Respiratory Rate of Local Chicken

Genotype had significant ($P<0.05$) influence on the respiratory rate. The respiratory rate of the birds ranged from 33.1bpm to 60.2bpm. At 2-6 months, the respiratory rate of the birds were found to differ significantly ($P<0.05$). Meanwhile, the normal feathered genotype recorded a higher numerical total pulse rate than the other three genotypes (Table 4.5).

Table 4.5: Respiratory Rate of Naked Neck, Frizzle, Silky and Normal Feathered

Resp. Rate (Breath/Min)	GENOTYPE					
	Silky	Naked Neck	Frizzle	Normal	SEM	P-value
1-Month	38.8^{b}	41.1^{a}	36.8^{c}	41.3^{a}		.037
2-Month	39.5^{b}	37.3^{b}	36.9^{b}	53.9^{a}	1.69	.001
3-Month	40.4^{b}	37.2^{c}	38.6^{c}	45.7^{a}	1.20	.001
4-Month	40.1^{b}	33.1^{c}	33.2^{c}	60.2^{a}	1.24	.001
5-Month	40.2^{b}	33.6^{c}	39.3^{b}	51.4^{a}	1.10	.001
6-Month	33.1^{c}	38.6^{b}	37.0^{b}	57.5^{a}	1.85	.001

^{abc}*Means in the same row with different superscripts are significantly different (p<0.05).*

4.2.3 Effects of Genotype on the Body Temperature of Local Chicken

The observed body temperature for the various genotypes was found to range from 40.8^{o}C to 42.4^{o}C. Genotype had significant influence on the body temperature of the local birds (Table 4.6). Apart from the 2nd month, where the body temperatures of the birds were similar (P>0.05), several variations/differences were observed in the body temperatures in the other months where the normal feathered recorded mostly the highest body temperature.

Table 4.6: Effects of Naked Neck, Frizzle, Silky and Normal Feathered on the Rectal (Body) Temperature

Body Temperature (^{O}C)	**GENOTYPE**					
	Silky	**Naked Neck**	**Frizzle**	**Normal**	**SEM**	**P-value**
1-Month	41.0^{c}	40.8^{d}	41.3^{b}	42.0^{a}	0.16	.001
2-Month	41.2^{b}	41.9^{a}	41.2^{b}	41.0^{b}	0.16	.438
3-Month	42.4^{a}	40.9^{c}	41.3^{b}	41.4^{b}	0.15	.001
4-Month	41.3^{bc}	41.4^{b}	41.1^{c}	41.9^{a}	0.14	.001
5-Month	41.4^{b}	41.3^{b}	40.8^{c}	42.4^{a}	0.15	.001
6-Month	41.1^{c}	41.1^{c}	41.2^{b}	42.3^{a}	0.12	.001

^{abc}Means in the same row with different superscripts are significantly different (p<0.05).

4.2.4 Heat Stress Index for the Four Genotype of Local Chicken

The results of the heat stress index of the local chicken genotype was estimated using the pulse rate and respiratory rate together with their normal average values and presented in figure 4.1. The highest heat stress index was observed for the normal feathered from the

1st month through to the 6th month. With respect to the other three genotypes, the naked neck and the frizzle recorded the highest (1.2) at the 1st and 2nd month respectively. From the 3rd month to the 6th month, the naked neck maintained slightly higher heat stress index than the Silky and the frizzle while the lowest stress index (0.9) was recorded by the Frizzle and the silky at the 5th and 6th month. Generally, the heat stress index decline with increasing age in all the genotype. An indication of the birds getting aclamatized to the environment as they age.

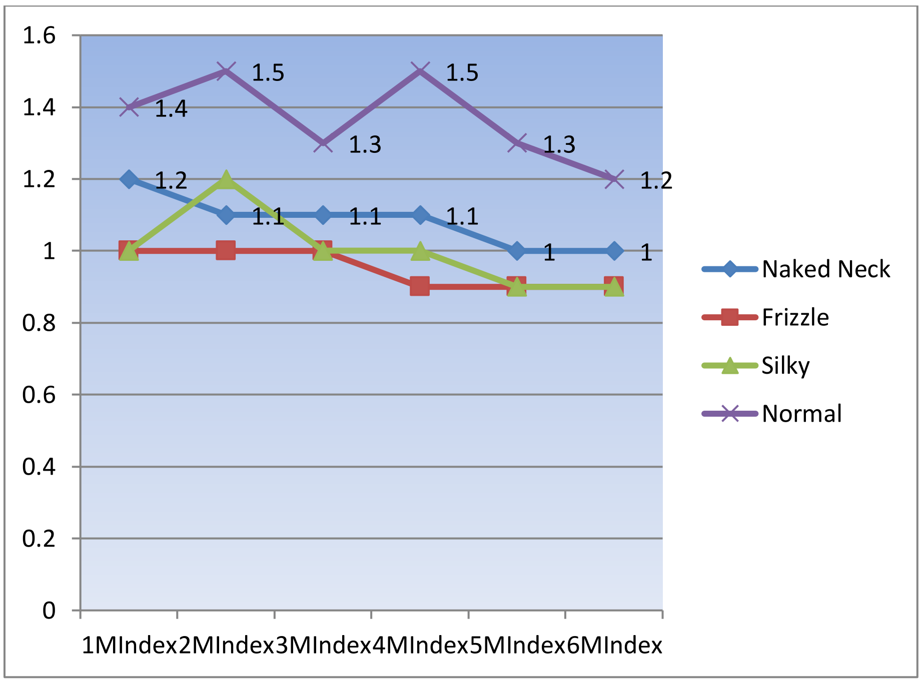

Figure 4.2: Heat Stress Index of Naked Neck, Frizzle, Silky and Normal Feathered

4.3 Effects of Genotype on the Estimated Breeding Value (EBV) of Local Chicken

Genotype had significant ($p>0.05$) effect on 1 to 6 months Estimated Breeding Values (EBV) of the local birds (Table 4.7).

Table 4.7: Estimated Breeding Value of Naked Neck, Frizzle, Silky and Normal Feathered

EBV	GENOTYPE					
	Silky	**Naked Neck**	**Frizzle**	**Normal**	**SEM**	**P-value**
1-Month	0.3^{a}	1.1^{a}	-4.8^{b}	-16.8^{c}	4.13	.001
2-Month	1.5^{a}	-1.1^{c}	-0.5^{b}	-1.4^{d}	0.65	.001
3-Month	0.5^{b}	-0.4^{c}	-2.6d	3.8^{a}	1.33	.044
4-Month	-2.4^{c}	-1.4^{b}	-0.4^{a}	-2.3^{c}	0.47	.001
5-Month	14.8^{a}	0.3^{b}	-1.0^{c}	16.1^{a}	4.58	.001
5-Month	-3.3^{b}	3.2^{a}	-7.2^{c}	3.3^{a}	2.62	.032

EBV: Estimted Breeding Value

4.4 DISCUSSIONS

4.4.1 Growth Performance of Indigenous Chicken

4.4.1.1 Body Weight

The body weight of the naked neck birds compared to the other three genotypes is in line with the findings of Adomako *et al.* (2014) who recorded greater body weight for crossbred naked neck than the normal feathered at week 6, to be 449.0g and 409.7g for the F1 naked neck (*Na/na*) and normal feathered (*na/na*) birds respectively. The body weight at week 20 was also reported by the same authors to be 1565.4g and 1895.8g for the na/na and *F1 Na/na* birds respectively, showing clear differences. Again, Reddy *et al.*

(2015) reported the body weight at the 4th, 5th and 6th weeks of age to be significantly different among the three genotypes (naked neck, normal feathered and the frizzle) with the naked neck genotype recording significantly higher values while normal feathered recorded lowest.

On the contary, Mensah (2016) observed that the average body weight of frizzle, silky, polydactyl, ptilopody and the normal feathered birds were significantly better than naked neck within the indigenous chicken population observed. Again, Oleforuh-Okoleh *et al.*(2017), observed significantly higher body weight for the normal feathered than the naked neck in the 4th, 8th, 12th and the 16th weeks.Similarly, Ibe (2021) studied the growth performance of frizzle, normal-feathered, and naked neck local chickens of Nigeria during an 18-week growing period and found no significant variations at all ages, even though those with normal feathers showed some general superiority over the other two counterparts. Deeve (2015), also recorded that, the weight of naked neck chicks was similarly lower than that of the frizzle, normal, and dwarf chickens, indicating that the energy required to maintain a constant body temperature due to inadequate body insulation compared to normal feathered chicks with greater body insulation could be the cause. However, as the birds grew older, the naked neck genotype gained the highest weight, followed by normal feathering and dwarf chickens, with the frizzle chicken gaining the least.

The heavier body weight of the naked neck than the other three genotype observed in this current study may be attributed to the fact that the naked neck gene (*Na*) may be linked to some of the genes that affect body weight and weight gain in chickens, such as insulinlike growth factor *II* (*IGF-II*) (Molee *et al.,* 2018). These researchers revealed that *IGF-II* promotes the proliferation, differentiation, and metabolism of myogenic cell lines, which is important for chicken growth and development.

The better body weight performance of the naked neck can also be ascribed to their ability to save protein for body development which otherwise could have been used for feather growth (Adedeji *et al.,* 2016). Because naked neck birds have 20-40% less feather coverage, they have a lower demand for dietary nutrition to offer protein input for feather synthesis. As a result, naked neck birds conserve protein, potentially resulting in faster growth. This suggests that the naked neck birds are genetically designed to utilize the feed that they consume and convert the nutrients into body weight. On the other hand, lower body weight observed among the silky, frizzle and the normal feathered in this study might be due to genetically slower growth rate associated with these birds (Duodu, *et al.,* 2018).

Some genes, such as frizzling and naked, have been shown to have a significant impact on the growth performance of native chickens (Atansuyi *et al.*, 2017). While the findings of Atansuyi *et al*. (2017) support the high body weight of naked neck birds, they however contradict the study's findings of frizzled feather hens having the lowest body weight. This shows that body structure genes, such as the bare neck and frizzling genes, have a significant impact on growth performance, particularly the naked neck genes. There appears to be an over-run in the growth performance of regular feathered chickens over frizzle feathered hens, as indicated in Table 4.1. This was reflected in their final body weights, which were 1829 g for frizzle chickens and 1859 g for normal feather chickens respectively.

4.4.1.2 Daily Body Weight Gain

Similar to the weekly body weight, the growth rate (Daily Weight Gain) for the four birds indicated that the naked neck performed better in its daily weight gain. This indicates that the naked neck genotype's had favourable effect on development under the conditions of this experiment which is in contrast to what Atansuyi *et al*. (2017) reported for the frizzle. The naked neck-gene may only fast growth in chickens under normal environmental conditions in the tropic, beginning at the juvenile stages (after 6wks). Faruque *et al.* (2013) observed the highest and lowest average body weight gain bird/day for normal featheredchicken genotypes, which showed an average daily growth rate of 5.88 ± 0.05 and 6.27 ± 0.09 g per bird per day at their 8^{th} weeks growth phases which is lower than the values observed in this current study. The differences may be attributed to environmental factors such as feeding, temperature, etc., that the birds were subjected to. Again, Reddy *et al.* (2015) discovered the body growth rate or weight gain at the 4^{th}, 5^{th} and 6^{th} weeks of age to be different among the three genotypes (naked neck, normal feathered and the frizzle) with the naked neck recording greater values while normal feathered recorded lowest which contradicts the results of this study current where the frizzle maintained the greatest growth rate or body weight gain at week 4 and 6. Thus differences may be due to environmental effects rather than genetic.

Though in Guinea Fowls, Oke *et al.* (2012); Khairunnes *et al.* (2016) and Duodu *et al.* (2018) observed the body weight and body weight acquisition of indigenous Guinea fowls at two months to increase rapidly among the Pearls as compared to the Lavender, White and the Black. This implies that some local birds have the tendency to perform better after the juvenile stage than others based on their genetic make-ups. This is in disagreement with Onunkwo, *et al.* (2015), who obtained non-significant variations among the genotype group broiler chicken from 0-14 weeks of age. This he indicated that the unobserved numerical differences were generally due to environmental factors than genetic. Oleforuh-Okoleh and Wagoha (2017)employed three genetic local chicken groups for their study: *NF* (Normal Feathered) male X *NN* (Naked Neck) female (GG1), *NN* (*Naked Neck*) male X *NN* (Naked Neck) female (GG2), and *NN* (Naked Neck) male X NF (Normal Feathered) female (GG3) and observed clear variations in the body weight gain among the genotype. The findings of Oleforuh-Okoleh and Wagoha demonstrated that, whereas GG2 chicks were heavier at hatch, GG3 chicks had a higher specific growth rate or body weight gain (4.36 and 5.59 percent higher than *GG1* and *GG2*, respectively), resulting in a bigger body weight (1116.50 g) at 12 weeks of age.

It can be assumed that in 16 weeks of experimentation, chicken do not reach their maximum growth potential. As a result, the only way to increase their performance is to raise them in regulated feeding and housing environments.

4.4.1.3 Feed Intake (FI)

Though the values in this current study vary, this results agrees with Chimenem-Amadi *et al.* (2021), who reported daily feed intake for 16 weeks rearing period of Nigerian local

Chicken as 32.4 g/d, 31.5 g/d and 31.72 g/d for the normal, frizzle and naked neck respectively. The variations in the values may be due to relatively shorter period of their study (16 weeks) as gainst 24 weeks of this current study. This is because The effectiveness of body weight production in poultry is significantly influenced by the age of the birds over time (Murawska, 2016). The disparity observed with respect to the values may also be due to breed, management system, age, sex and different environment (Magala*et al.*, 2012) which may have influenced the quantity of feed consumed.Oleforuh-Okoleh*et al.* (2021), also reported majorvariations in the *FI* of two Nigerian local chicken (normal feathered and naked neck) fed with moderate crude protein. In their report, the Naked neck was found to consume 40.29 g/d and the normal feathered consumed 41.42 g/d.

4.4.1.4 Feed Convention Ratio (FCR)

With respect to FCR, the results implies that the Naked neck can efficiently utilize the feed it consumes into body weight. This results is consistent with Oleforuh-Okoleh *et al.* (2021), who found that The naked neck chickens can efficiently convert feed into body weight than regular feather hens. For Naked naked and regular feather Nigerian local chicken fed with a high crude protein diet, the researchers found feed conversion ratios of 2.51 and 2.62 for the Naked Neck and the normal feathered respectively. Similarly, Chimenem-Amadi *et al*. (2021) reported feed conversion ratio for the normal, frizzle and the naked neck to be 4.40, 4.53 and 3.84 respectively indicating that the naked neck had the tendency of efficiently utilizing the consumed feed to body weight gain.

Oleforuh-Okoleh *et al.* (2021) discovered that although the Normal feather chicks weighed 8.92 percent more than the Naked neck chicks on day one, the naked neck chicks had a higher feed conversion ratio, resulting in an 8.55 percent bigger weight at 12 weeks. They explained thatreduced feather mass lowers the negative effects of hot weather on the consumption of feed, growth, and meat yield of the birds by minimizing an excessive rise in body temperature produced by eating and digesting at high ambient temperatures. The naked neck chicken may release more heat and so consume more feed since they have more exposed skin.

4.4.2 Heat Tolerant Traits of Local Chicken Genotype

4.4.2.1 Pulse Rate

The fluctuation in pulse rate as observed among the genotypes agrees with the results of Isidahomen *et al*. (2012), Fadare & Fanujide (2021) and Ademola *et al.* (2015). The existence in fluctuation in pulse rate month by month might have been as a result of external factors such as temperature (Isadahomen, 2012). Notwithstanding, the numerical values obtained in this study differed with what was observed by Ademola *et al*. (2015); Fadare & Fanujide (2021) but within the threshold of Isidahomen*et al.* (2012). The pulse rate reported by Isidahomen *et al.* (2012) ranged from 234.00±17.21 to 397.001±19.15 beats/min. with the highest pulse rate (pulse above 300bpm) recorded for naked neck genotype in the 4th week.

The current finding indicates that all genotypes experienced some degree of heat stress, but the normal feathered genotype was more susceptible to heat stress than the other genotypes, which supports Omodewu and Tiamiyu's report (2021) that birds with higher pulse experience heat stress. Nascimento *et al.* (2012) contend, in contrast to the findings of the current investigation, that the impact of heat stress brought on by a stronger pulse is more pronounced in genotypes with high growth potent.

4.4.2.2 Respiratory Rate

The result of this study disagrees with the earlier study of Isadahomen *et al.* (2012) that the animal' size also affects the respiratory rate and the larger the animal, the higher the rate of respiration because they have a higher metabolism. In this current findings, the heavier breed, which were the naked neck and the silky rather had the lowest respiratory rate for most part of the experiment followed by the frizzle, which disagrees with the general principle/rule, that the greater the mass of an animal the greater the respiratory and metabolic rates. This is because the higher metabolic rate of small animals needs a greater release of oxygen to tissues across the body, whereas larger animals have a larger surface area, which could result in a faster rate of gas exchange. This variation is most likely due to the phenotypic (hair style) of the birds in this study, which causes them to lose heat, resulting in less respiration.

Heat production according to Defra (2013) isinfluenced by species, body weight, breed, level of production, the quality of feed and to a lesser extent, by the amount of exercise and activitiesthe animal undergoes. This implies that, as body temperature increases, birds begin to pant to lose heat which is accompanied with increase in respiratory rates.

However, for each genotype across the 24 weeks, an increase in respiratory rate as age progresses was observed with some few intermittent variations.

4.4.2.3 Body Temperature

The current findings on chicken body temperature revealed that, the body temperature is genotype-dependent. The findings on body temperature of the local chickens were consistent with that reported by Isidahomen *et al.* (2012). In southern part of Nigeria, the researchers observed values for body temperature within the limits of 40.4 to 41.98^{0}C and also unveil a similar range of values for frizzle, normal, naked neck, and other two Nigerian local chickens. In the 3rd, 4th, and 5th months, the lowest and maximum rectal temperature values reported for frizzle, normal, and naked neck were consistent with their findings. Similarly, the values of the body temperature of the local birds documented in this study also agrees with an observation made by Fadare & Fanujide (2021) and Oke*et al.* (2021). In their investigations, they found similar results for the naked neck, frizzle and the normal feather. The advantage of naked neck over other genotypes in terms of heat tolerance was documented by N'dri *et al.* (2013) and Zerjal *et al.* (2013).

4.4.2.4 Heat Stress Index

The results obtained generally in this present research on the heat stress index were within the range and agrees with the work of Isidahomen *et al. (*2012) who found the frizzle and the naked neck to be less heat stressed than the normal feathered chicken.

In this current study, the highest heat stress index was estimated for the normal feathered from the 1st month through to the 6th month while the silky and the frizzle had the lowest mean value (Figure 4.1). This implies that as compared to their counterparts, the normal feathered chicken used in this study were more heat stressed. The lowest heat-stress-index as observed in the silky and the frizzle genotypes could be an indication that the silky and the frizzle genotypes are tolerant to heat and can better dissipate heat than other genotypes as earlier proven by Isidahomen *et al.* (2012). This can be attributed to the the fact that the frizzle and silky have feathers design to dissipate heat effectively.

The trend of heat characteristic demonstrated by the genotypes of hens was also consistent with the observation of Lara &Rostagno(2013). The authors noted disparities in heat stress across various avian species. However, Sharifi *et al.* (2010) reported no appreciable effect for the heterozygous genotype in their study on the impact of high temperature conditions on reproductive outputs in heterozygous and homozygous frizzle broiler birds. Instead, compared to the normally feathered hens, the frizzle homozygous hens retained greater reproduction performances under heat stress, although they were less effective in temperate climates.

The naked neck is more heat tolerant than its counterparts and probably because theirless feather coverage enhances the rate of irradiation of internally generated heat, leading to enhanced thermoregulation under moderate (22^{o}C) and even high (30^{o}C) external temperatures. This relieves heat stress, which improves the reproductive and productive performance of birds. When chickens reduce feed intake to avoid a deadly increase in body temperature, growth and meat yield are affected.With respect to the Frizzle, their raised feathers give them a primary evaporative cooling technique because air circulation is facilitated closer to their bodies (Nawaz, 2021). Similarly, the Silky and the Frizzle are less heat stressed in this study probably because they are genetically designed to respond to higher temperatures using their Autonomic Nervous System (ANS) to trigger increase respiratory rate, tachycardia (increase heart beat), and enhance the flow of blood towards the body peripheries for maximum heat loss to maintain body temperature (Chen *et al.*, 2012).

As the birds grew older, their heat stress decreased, indicating that they had adapted to their tropical surroundings.

Local chickens in general have been discovered especially those with the normal feather (*na*), naked neck (*Na*), and frizzle feather (*FF*) genes, to be highly thermotolerance than the exotic genotypes (Adeleke *et al.*, 2011; Isidahomen, *et al.*, 2012; Adedeji, 2015;). This is because the native chickens have the advantage of having an innate and genetic ability to tolerate severe temperature and poor management systems (Dessie, *et al.*, 2012). This tolerance prevents native chickens from suffering significant production losses.

Heat stress is caused by variations of a multiple environmental factors such as, air temperature, humidity, thermal irradiation, metabolism rate, breed, the activityactivity of the birds and thermoregulatory mechanisms as well as the housing conditions of birds (Lara & Rostagno, 2013). It is worth noting that heat stress has a negative influence on poultry productivity and wellbeing. This has negative consequences for growth, livability, and immunosuppression, all of which contribute to a decline in output (Attia *et al.*, 2017; Nassar & Elsherif, 2018).

4.4.3 Estimated Breeding Value (EBV) of Local Chicken

From Table 4.7 it indicated that there was significant differences recorded in the breeding values of the four genotypes of the chicken under study. The normal feathred recording the highest breeding value (16.1) which means that at the particular age, and on an average the daughters of that genotype are having genetic capacity to produce 8.05Kg more body wieght compared to the population of daughters of all other genotype together. Interestingly, the same breed also recorded the lowest negative value (-16.8) at the first month. Negative (-) breeding value implies that compared to other genotype tested, the daughters of this genotype on an average, will have lower genetic capacity/ability for body weight production at that particular age.

The results of this study is in agreement with the discoveries of Moazeni (2016) who reported EBV of Body weight at sexual maturity of three (3) selected genotypes to be significantly different. However, both negative and positive values were also recorded by this author. According to report by Rajkumar *et al*. (2020), the average Breeding Value of all the economic traits depicted a positive linear trend, indicating the improvement in the required direction in the population. The trend of genetic progressreflects the effectiveness of selection in the given population. In a study conducted by Rajkumar *et al.* (2016), there was also a positive trend in the EBV values for body weight in 4^{th} and 6^{th} weeks. Rajkumar*et al.* (2020) also reported EBV for body weight at weeks 20 and 40 also showing a significant positive linear trendalong the positive association as both were greatly significant and positively correlated. In their study, the EBV for Age at Sexual Maturity (ASM), was similar with minor improvement over generations, which could be attributable to the previous selection for BW, which had no influence on ASM.

4.4.4 Mortality Rate

4.4.4.1 Brooding and Post-Brooding Survival of Indigenous Chicken

Chicks' survival is essential for a successful chicken production. The most delicate period for chicks is from day-old up to six weeks of age when high chicks mortality rates are recorded. With respective to guinea fowl keets, Agbolosu, *et al.* (2012), opined that on the average, 34 and 32 keets are lost per keeper annually in the Tolon and Builsa North Districts respectively. These figures are significantly high compared to the mean flock size of 46 and 40 in the Tolon and Builsa North Districts respectively (Agbolosu, *et al.,*2012). The brooding mortality of the normal, frizzle and the naked was 3.6% while that of the silky was 7.7%. This means that the mortality rate of the four genotypes (Silky, naked neck, frizzle, and normal feathered) were within the lower threshold (10%) opined by Agbolosu *et al.* (2012) indicating that the genetic make-up did not affect brooding mortality. The results of this study is similar to the results of a study conducted by Delabouglise*et al.* (2019) where 8.2% of birds died during the course of the study instead of being offered as gifts, sold, slaughtered, or fed to other animals/pets, and about 44% of these motalities were associated with diseases. Similarly, Agbolosu *et al*. (2012) and Khairunnesa *et al.* (2016) observed low keet mortality rate (10%) whe they studied the performance characteristics of growing indigenous poultry from Upper East, Upper

West and Northern Regions of Ghana, this was attributed to proper management practices carried out during their research making the birds to withstand parasites and diseases that affect birds.

Again, the result of this current discovery is consistent with Ferdaus *et al*. (2016) who reported high survivability of local chicken (naked neck, frizzle and the silky) as 97.25% (2.75% mortality) and 97.34% (2.66% mortality) and 95.24%. (4.76% mortality) respectively. However, this results disagrees with Duodu *et al*. (2018) who recorded significant ($p<0.05$) higher pre-brooding survival in the Pearl genotype and lower in the Black genotype of indigenous guinea fowls and explained that the higher pre-brooding survival of the Pearl genotype is associated with the insusceptibility nature of the Pearl genotype at the juvenile stage. Unlike other poultry birds, Guinea fowlkeets are more susceptible to most parasites and diseases which affect poultry species. Similarly, Kumar *et al.* (2017) recorded higher mortality 30.62 % (up to 72 weeks) and major cause of mortality during the entire growingperiod were wolf (24.29 percent), mongoose (44.63 percent), and diseases (52.18 percent) respectively. Their value was significantly higher than this current study probably because their birds were studied on free range where they are exposed to diseases and predators leading to more deaths.

Finally, Agbolosu *et al*. (2012) revealed that the adult birds generally experience a low mortality rate which in the study was 1-2%. Factors that might have contributed to the lower mortality of the artificially brooded poultry could be because, the birds at nine or twelve weeks of age might have formed a strong immune system against diseases and the adverse environmental factors that are worrisome to them at the keets stage (0-8 weeks old).

In conclusion, brooding and post-brooding mortality rates for each genotype was less than 10% and indication that all the genotypes adapted favourably to the study environment during brooding and post-brooding.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the study, the following conclusion were drawn:

- The naked neck performed better with respect to body weight, body weight gain, feed intake and feed conversion ratio.
- The frizzle and the silky have good characteristics for heat tolerance
- The four varieties showed some similarities in their survivability at brooding and post-brooding.
- Genotype affected Estimated Breeding Values of the four genotypes of the chicken understudied

5.2 Recommendations

Based on this study the following recommendations were made:

- Breeders, commercial farmers and smallholder farmers can use the naked neck genotype for production in order to achieve higher productivity in body weight, body weight gain and feed conversion ratio .
- The frizzle and the silky could be reared in heat-prone zones since they have good characteristics for heat tolerance
- The results could be used to initiate local chicken selection and breeding programmes in Northern Region as well as Ghana at large.
- Also, the study should be repeated for more than two generations of birds to evaluate the consistency in the performance from one generation to the other.

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