UNIVERSITY OF EDUCATION, WINNEBA

MORPHOLOGICAL CHARACTERIZATION OF INDIGENOUS LAYING CHICKENS IN THREE REGIONS OF GHANA

BY

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DECLARATION

STUDENT'S DECLARATION

I, Joycelyn Afful**,** hereby declare that this submission is my own work towards the Master of Education (Animal Science) degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, or elsewhere except where due acknowledgment has been made in the text.

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Supervisors' declaration

We hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University of Education, Winneba

NAME: DR. DUODU ADDISON

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DEDICATION

This work is dedicated to the Lord for His divine protection and travelling mercies throughout the study.

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ABSTRACT

This experiment was conducted to identify, characterize and assess the variation in morphological traits of indigenous laying chicken populations in Wassa Amenfi Central District, Wassa Amenfi East and West Municipals in the Western Region, Ga East, West and North Municipals in the Greater Accra Region and Nsawam Adoigyiri Municipal, Upper West Akim District and Akuapim South District in the Eastern Region of Ghana. Purposive sampling was used to select twenty-seven laying chickens from twenty-seven farmers in each region. A total of twenty morphological traits were identified and measured successfully. Data collected was subjected to the Analysis of Variance (ANOVA) model using GenStat 12.1 (2009) software. The results of this study showed significant difference ($P<0.05$) in Ornithological measurement, skull with, beak length, neck width, back length, leg length, and tarsus length in birds between the three regions. The performance of birds in the Western and Eastern Regions were higher than the performance of birds in the Greater Accra Region. The result also revealed a non-significant difference ($P>0.05$) in body weight, one wing, wing span, rectal temperature, skull length, wattle length, neck length, tail length, thigh length, thigh width, tarsus width, central toe length and claw length. It could be concluded that variation exists among certain morphological traits in indigenous laying chicken.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Local poultry rearing forms part of a balanced farming system and plays an important role in the supply of high quality protein to farm families, provides small disposable cash income, and serves socio-religious functions (Belay and Oljira, 2019). Local poultry production is also a source of employment for the less privileged in rural communities (Mengesha *et al.,* 2008). Brown *et al.* (2017) indicated that investments and policies of poultry production in developing countries center mainly on exotic breeds and ignoring local poultry breeds due to their lower performance, raising concerns of loss of poultry genetic resources in many countries. They added that due to the rapid population growth in Ghana, there is the need for highly selected poultry birds to meet the growing demand for meet and egg.

The local chicken population in most African countries have various names and have been characterized on different grounds by different researchers (Dana *et al.,* 2010). Some of these breeds have been characterized based on the colour of feathers whiles others have been classified based on ecological zone and also pose that each local chicken population are actually a composition of chickens with a wide range of morphological or genetic diversity. The phenotypic characterization of the domestic animals forms part of the Food and Agricultural Organization (FAO) Global Strategy for the management of Farm Animal Genetic Resources and phenotypic characterization based on their observable attributes contributes to breed definition especially populations which are not well defined and it provides an indication of their genetic diversity (Assefa and Melesse, 2018). They are repository of highly conserved genetic resources with high level of heterozygosity which may provide the biological material for the development of genetic stocks with improved adaptability, disease resistance and productivity (Daikwo *et al*., 2015) as well as traits of economic importance. Phenotypic characteristics are important in breed identification and classification. Characterization information is essential to the design of livestock conservation, development and breeding programmes and the management of Animal Genetic Resources (AnGR) at local, regional, national and global levels (FAO, 2012). Many conscious efforts have been made to characterize animals in developing countries to provide a foundation for developing sustainable genetic improvement approaches. Chief among these efforts is the program by the Food and Agricultural Organization (FAO) of the United Nations to develop a Global Strategy for the Management of Farm Animal Genetic Resources (FAnGR) (Gibson *et al.,* 2006).

Local chickens have varied morphological variations in feather colour and pattern such as white, black red, brown or mixture of such colours, comb shape, ear lobe colour, shank colour, onformation etc. Other characteristics such as naked neck, frizzled feathers, single, pea, rose and cushion combs are common within the flock of local chicken (Negassa *et al*., 2014a) which need further investigations and documentations. Assefa and Melesse (2018) also added that the local chickens that are commonly classified world-wide as non-descriptive types due to lack of information, vary widely in body size, body conformation, plumage color and many other phenotypic characteristics, are of high importance to livelihood and serves as household food security in rural farm families. It is believed by Assefa and Melesse (2018) that though information with detailed phenotypic characters is lacking in remote areas' native chicken population, genetic originality may still be found.

1.2. Problem statement

The local chickens, according to (FAO, 2012) are commonly classified worldwide as non-descriptive types because of lack of information. They vary significantly in body size, shape (body conformation), plumage colour (single or a mixture of colours), performance as well as other phenotypic characteristics (Cabarles *et al*., 2012). Indiscriminate mating of local poultry with breeds of foreign or unknown extraction, breed replacement and changes in traditional production systems are a major threats to local chicken population (Cabarles *et al*., 2012). The authors also noted that a loss, extinction or erosion of genetic materials of the local chicken breeds is an irreversible phenomenon.

To identify and characterize chicken genetic resources, there is the need to gather information on their population, adaptation to a specific environment, traits that the current species possess or future value and the socio-cultural importance or benefit of the species under consideration, which are key inputs to decisions making on conservation of local chicken genetic resources (Soller *et al.,* 2006). However, this needed information may be lost due to the unregulated movement of live birds across ecological zones, introduction of exotic breeds which are raised under extensive system of management and lack direct policy on mapping and tracing local chicken population within the country. Not much is known about the morphological description of local chicken in the Greater Accra, Eastern and Western regions of Ghana hence this study was undertaken with the purpose of describing external morphological variabilities of local chicken in the Greater Accra, Eastern and Western regions of Ghana.

1.3 Objective of the study

The main objective of this study was to identify, characterize and assess the morphological variations of indigenous laying chickens in three regions of Ghana.

1.4 Specific objectives

The specific objectives of this study were to:

1. measure morphological traits in indigenous laying chickens in the study areas.
2. Assess the morphological variations among indigenous laying chickens in the three regions under study.

1.5 Significance of the study

The result from this study will create awareness on the phenotypic potentials of the local chicken breeds and inform farmers of the benefits of improving local chicken breeds. This study will contribute to the characterization information needed to design livestock conservation, development and breeding programmes in Ghana. It will also add to the existing information on the local chicken genetic resources within the country.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Characterization of Local Ghanaian Chicken

The local Ghanaian chicken (*gallus domesticus*) is the most populous chicken genetic resource among all the poultry species that can be found in the country (Birteeb *et al.,* 2016). Aboe *et al.* (2006), pose it that local chickens form about 60-80% of the total poultry population in Ghana constitutes about 60-80% of the total poultry population. Their productivity and performance are low due to poor environment, poor management system and low genetic potential. These local chicken breeds are kept mainly by smallholder farm families under traditional free range management practices, and have developed adaptive features to a wide range of agroecological zones within the country. They are characterized by nondescript and hyper-variable phenotypic landscape (Dana *et al.,* 2010). Chicken rearing plays an important role in the socio-economic life of people role for people living in low-income countries (Tadele *et al.,* 2018).

Local chickens of Africa have various names and are characterized on different grounds, as in many other parts of the world (Dana, 2010; Waaij *et al.,* 2010). Based on the colour of feathers, Teketel (1986) characterized Ethiopian local chickens as Kei (red) or Tikur (black). Other researchers like Halima *et al.* (2007) classified local based on geographical location as ecotypes and Manyelo *et al.* (2020) classified them phenotypically as the naked neck, frizzle and normal feathers. Dana *et al.* (2010) noted that each local chicken ecotype population which was studied actually comprised chickens with a wide range of morphologic or genetic diversity. Local chickens vary widely in body size, body conformation, plumage colour and many other phenotypic characteristics Cabarles *et al.* (2012) which makes them good candidates for study just like other domestic animal species.

2.2 Breeds of Local Chickens

According to Chigoma & Tanganyika (2017), there are different phenotypic breeds of indigenous chickens, among which include normal feathered chickens, naked neck, frizzled, dwarfs and others. They added that names of indigenous chickens are based on the description of feather plumage, legs, tail feathers, head, and other features like colour.

2.2.1 Naked Neck Chickens

Naked Neck chickens are birds which have their necks totally free of feathers. The absence of feathers at the neck region is caused by a single incomplete dominant autosomal gene responsible for feather loss in the chicken (Abd El-fattah *et al.,* 2012). Naked neck chickens have good heat dissipation mechanism and are highly resistant to diseases and superior to indigenous full-feathered in terms of egg production (Islam and Nishibori, 2009). They dissipate heat better than the normal feathered chicken breeds (Yunis and Cahaner, 1999; Hagan *et al.,* 2011). Asumah (2015) on his study on the influence of the naked neck (na) and frizzle (f) genes on performance and blood parameters of F2 and F3 generations of crosses of local and commercial chickens noted that naked neck birds recorded a significantly ($p<0.05$) lower mortality rate. According to Yakubu *et al.* (2008) and Dunga (2013), naked neck hens have superior body weight, average eggs per clutch and mortality when compared with their normal feathered counterparts.

2.2.2 Frizzle Feathered Chicken

These breeds of chickens have genetic modification that causes the feathers on the whole body of Frizzle Chicken curved towards the superior (Sholeh *et al.,* 2020). It is a mutant gene in the chicken which makes the plumages grow curve outward, instead of the usual lying smoothly along the body of the bird (Dunga, 2013). The shafts of the contour feathers of the frizzle feathered chickens are curved instead of being straight (Fathil *et al.,* 2013). The frizzle gene reduce the insulating properties of the feather cover as well as reduce feather weight thereby making it easier for the bird to radiate heat from the body more efficiently (Hagan *et al.,* 2011; Musa *et al.,* 2015). The frizzle gene has been reported to reduce insulating properties of the feather cover, reduce feather weight and make it easier for the bird to radiate heat from its body more efficiently (Hagan *et al*., 2011). Fathi *et al.* (2013) and Dunga (2013) reported that frizzle feathered chickens have higher percentage of fertile eggs (84.84%) and a hatchability of 87.46%.

2.2.3 Normal feathers

Chickens with Normal Feathers make up majority of the total local chicken population in various African countries (Chigoma and Tanganyika, 2017; Nigussie *et al.,* 2010) including Ghana. Normal feathered chickens according to Moreki *et al.* (2014) and Yakubu and Ogah (2008) has higher hatchability as compared to the naked neck chickens.

2.3 Socio-Economic Importance of Village Chicken Rearing

Local chickens are mostly reared in the developing countries for diverse use and purposes to the farmers and household. According to Padhi (2016), the use of local chicken from one region vary to another region, where chicken are reared in the small regions for its socioreligious purposes, some are reared for meat and egg. They are able to produce despite the low input in the rearing of indigenous chicken, with inadequate supply of food and water. He also indicated that the local poultry add up to the balanced farming system and plays vital role in the rural households by serving as a source of emergency cash income with demonstration of qualities like possession of natural immunity, good egg sitters and ideal mothers.

Indigenous chicken plays a significant role in family nutrition beside its social and cultural benefits and are good scavengers and foragers and adapt well to harsh tropical environmental conditions (Tadele *et al.,* 2018). Local chickens are hardier, that is they are able to tolerate the harsh environmental conditions and poor husbandry practices (climate, handling, watering, and feeding) without much loss in production (Dessie *et al.,* 2011). Local chickens enhance the organic matter content of soils by providing manure with high content of nitrogen. This contributes to the development of integrated farming systems in developing rural areas (Al-Nasser and Al-Bahouh, 2013). Aside the merits of local chicken like broodiness behavior with high fertility and hatchability, disease resistance thermos tolerant, good egg and meat flavour, hard eggshells and high dressing percentage, Belay & Oljira (2019) added that poultry aids in strengthening marriages in the northern part of Ethiopia and women in remote areas who are able to provide men with chicken food contribute to sustaining marriages. Nutritious chicken parts like gizzard, breastbone and drum stick served to mostly men with the belief of improving the older men's strength and increasing their libido.

2.4 Constraints to Local Chicken production

Despite the numerous contributions of the poultry in general and local chicken in particular to the lives of rural farmers, there are challenges which continue to face smallholder farmers. A major threat to the local indigenous chickens are indiscriminate mating or cross- breeding and breed replacement with imported chickens (Egahi *et al.,* 2010). The continuous and accelerating use of highly productive foreign breeds are likely to leads to a loss of genetic diversity in most African chicken species (Tadele *et al.,* 2018). These challenges are potential cause of genetic loss in the local species.

Feed quality and diseases are another major constraints for improving productivity (Islam and Jabbar, 2003; Maass *et al.,* 2012) of local chickens (N'dri *et al.,* 2018; Khobondo, 2018). According to Belay and Oljira (2019) mortality of local chickens due to disease outbreak is higher during short rainy season, mainly in April (66.8%) and May (31.4%). They also noted that the productive performance in terms of number of eggs laid by local chickens was relatively low (50-60 eggs/hen/year). This may be because, birds are not put on the same production level in terms of feeding and management as compared with the exotic breeds, making the former to perform better over the later. Indigenous birds are characterized by low productivity, particularly when compared with introduced strains (Alemu *et al.,* 2021). For example, Adomako (2009) indicated that the local chickens achieved a live body weight of 1.3 kg in 6 to 8 months whereas the introduced strains can attain this weight in 12 weeks.

2.5 Characterization of Local Chicken in Africa

Characterization of local chicken resources just like any other animal species is the initial step for long-term genetic improvement as it provides the basis for any other livestock development interventions and provides information for designing appropriate breeding programs Fitsum (2016) in Africa. Generally, identification and characterization of chicken genetic resources requires information on their adaptation to a specific environment, possession of unique traits of current or future economic value and their socio-cultural importance, which are vital inputs to making decisions on conservation and utilization (Melesse and Negesse, 2011).

According to the Food and Agriculture Organization FAO (2012) breed characterization includes all activities related with description of the origin, development, structure, population, quantitative and qualitative characteristics of the breeds in a defined management and climatic conditions. Breeds can be characterized by morphological (phenotypic) and molecular tools. Phenotypic characterization is a comparatively easy and cheap tool for breed characterization (FAO, 2012). In Ghana, Osei-Amponsah *et al.* (2015) worked on Phenotypic characterization of local Ghanaian chickens and egg-laying performance under improved management conditions. Brown *et al.* (2017) also studied the phenotypic diversity, major genes and production potential of local chickens and guinea fowl in Tamale whiles Birteeb *et al.* (2016) studied the variations in morphometric traits of local chicken in Gomoa West District. Other studies done in Africa include Assefa and Melesse (2018a), Alemayhu (2003), and Tadele *et al.* (2018). These authors worked on local chicken resources in Ethiopia whiles Adekoya *et al.* (2013) and Faith *et al.* (2018) characterized local Nigerian chicken ecotypes. These studies are indication of the initial steps that has been taken in Africa towards identification of its local chicken resources that will make way for genetic improvement programmes in the future.

2.6 Qualitative and quantitative traits

2.6.1. Qualitative trait

Qualitative traits or Mendelian traits are those traits that are determined by a single gene which follow discontinuous distribution in a given population and may be subjected to standard genetic analysis. Plumage colour, shape of comb, wattle, plumage pattern, feather flick, shank color, comb types, comb color, earlobe color, and eye color are classical examples of qualitative traits (Saxena and Kolluri, 2018).

Qualitative traits are assesses using visual aid or assessment scores whiles quantitative traits are measured using instruments such as scale, rule, caliper etc. Visual observations of the general features of chickens such as feather patterns, body morphology and specific traits such as naked- neck, frizzled feather and crested head are determined as qualitative (categorical) traits (FAO, 2012). Morphological traits such as plumage color and comb type have been found to have significant economic values and their preference in some communities based on socio-cultural believes. In some communities, birds with black plumage colour are believe to bring bad fortunes (Fitsum, 2016) whiles white plumage colour is said to have good luck.

2.6.2. Quantitative trait

Quantitative trait on the other hand, exhibits gradual variation following a continuous pattern in a specified population, e.g., body size, milk yield, wool yield, egg size, body weight, beak length, wattle length, breast width, breast circumference, wing length, breast length, femur length, tibia length, shank length, shank diameter, and third finger length etc. (Saxena and Kolluri, 2018; Maharani *et al.,* 2021).

Quantitative traits related to growth and egg production Nigussie *et al.* (2014) have significant effect as they determine the farmers income. The economically important quantitative traits require considerable recording efforts and are more important when integrated in genetically based performance evaluation schemes (Alemayhu, 2003). For instance, Okeno *et al.* (2011) stated that majority of rural farmers in Africa and elsewhere considered egg yield as the most important trait followed by mothering ability and body size. Plumage color of birds and comb type were identified as the traits farmers would like the least to be improved in both sexes of birds (Nigussie *et al.* 2010). It is important to note that efforts to characterize and improve local chickens require the understanding of the roles of genes influencing the specific characteristics of the breed, their relative frequencies and their possible utilization (Odah *et al.,* 2018). Some researchers have used qualitative traits such as colour of plumage Teketel (1986) as a means of identification and classification of local chickens. Plumage colour of indigenous chickens is second in value to live weight of birds in determining market preferences in most communities (Aklilu, 2007; Dana *et al.,* 2010). Plumage colour may serve adaptive purposes for local chickens to adapt to their environment. Colour is known to play a role in the absorption and reflection of ultraviolet radiation and therefore, birds with black phenotypic (plumage) characteristics may be more susceptible to heat stress under intense solar radiation whiles birds with white phenotypic characteristics on the other hand may be more tolerant under same conditions (Egahi *et al.,* 2010).

Local chickens have different morphological markers, carrying genes which have adaptive values to their environment, performance characteristics (disease resistance, broodiness etc.), and their unique identities (Aklilu *et al.,* 2013). Local chickens exhibits numerous observable attributes such as plumage, shank and earlobe colour, comb type, head shape and other qualitative traits (Machete *et al*., 2021). Variations in major qualitative traits such as outline and feather contours, shank and ear-lobe colours, and comb types are common among local chicken populations Negassa *et al.* (2014a) in various communities. Most of the morphological characteristics vary between the males and females Dana *et al.* (2010) are used as distinguishing features between them. Mbuza *et al. (2*016) indicated that local indigenous chickens have large morphological variation.

2.7 Variation in quantitative traits of local chickens

Quantitative traits of chicken have high economic importance. These traits can be expressed by measuring production traits that can be affected by many genes and environment. Productivity figures of chicken in some parameters were reviewed by many authors in different part of the region (Fitsum, 2016).

Fitsum (2016) recorded significance differences ($P<0.05$) between neck length, wing span, wattle width and wattle length for birds in different ecologies. With the exception of wing span that showed a non- significant difference ($P>0.05$) between sexes, all the above-mentioned traits were significant with sex effect also. There was a non- significant difference ($P>0.05$) in body length and wing length with respect to different ecological zones. Birds exhibited significant difference ($P<0.05$) in all six traits measured in his study with sex effect. Female values recorded in his study for traits length neck, body length, wing length, wing span and wattle length, were 10.93cm, 26.14cm, 11.93cm, 32.17cm, and 1.44cm respectively.

Assefa and Melesse (2018) in their study recorded the overall mean live body weights of village chicken as 1.68 kg for cocks and 1.42 kg for hens with overall mean value of 1.55kg showing a significant difference between and within sexes of indigenous birds in three different districts in Ethiopia. They noted that location has a significant ($P<0.05$) difference in body weight. Their finding saw significant difference among female birds in the three districts of study for each parameter, wingspan, body length, shank length, shank circumference, neck length, comb length, comb height, wattle length and wattle width were 44.9cm, 35.4cm, 7.6cm, 3.8cm, 15.6cm, 2.1cm, 0.9cm, 1.2cm, and 1cm, respectively. In a study by Nigussie D. *et al.* (2010), showed no significant variation among males and females within same districts, but recorded a high significant difference among same sex birds in five different regions. Mean values of live body weight (g) of females from their five regions under study were 1630, 1652, 1700, 1411 and 1697 with their corresponding males mean values of 1054, 1426, 1372, 1011 and 1517 respectively. They attributed their findings to either the variation in age of birds or negative effect of confined management.

Tadele *et al.* (2018) also recorded significant differences in head shape between male and female ($P<0.01$) chickens and among the studied districts. They observed that the districts and sex had significant effect on all quantitative traits, body length, chest width, shank length, shank circumference, back length and wing length with female birds mean values, 38.6cm, 26.1cm, 7.49cm, 3.59cm, 18.4cm, 38.8cm respectively. Body weight on the other hand in their study exhibited no significant difference ($P>0.05$) in all three districts. Sex however, had significant effect on all quantitative traits with female birds recording 37.4cm, 25.3cm, 7.02cm, 3.4cm, 17.4cm and 37.5cm. The overall average body weight of males and females were 1.49 kg and 1.21 kg, respectively (Tadele *et al.,* 2018).

Other studies on normal feathers and naked neck chickens at week 16 and 12 showed no significant difference in body weight with recorded mean values of 1.64kg and 1.59kg respectively, but both breeds showed significant difference at week 4 and 8, (Oleforuh-Okoleh *et al*., 2017). They opined a significant difference in leg length at 4^{th} and 8^{th}

weeks, but non-significant at 12th and 16th weeks. Shank length and shank circumference saw a significant difference between birds at 8th and 4th weeks respectively, but showed non- significant difference in their remaining respective weeks.

Francesch *et al.* (2011) also recorded a non-significant difference (>0.05) in quantitative traits such as, ornithological measurement, wing span, skull length, comb length, comb width, wattle length and width, neck length, back length, tail length, thigh length, tarsus length and width and central toe length. Some values recorded for the above traits for breed in their study include, 581.3mm, 764.05mm, 50.14mm, 62.05mm, 35.41mm, 27.16mm, 21.44mm, 139.06mm, 221.33mm, 159.99mm, 122.47mm, 80.24mm, 12.68mm and 53.52mm respectively.

Skull width, beak length and beak width, showed a significant (P<0.05) difference between operator and breed in their study with their breed corresponding values of 24.99mm, 20.16mm, and 12.12mm respectively. Udeh & Ogbu (2011) also recorded significant difference (P<0.05) between three strains of chickens with average means of body weight, 1.88kg, 1.65kg, 1.81kg. Thigh length, body length and wing length, also exhibited differences between the three strains of chicken. The values for their traits include recorded for Arbor Acre strain are 17.16cm, 32.78cm, and 18.98cm, respectively at 8weeks old. They however recorded a non-significant difference in shank length (7.8cm) in their study. Daikwo *et al.* (2015) opined a significant difference among traits such as head circumference, shank length, neck length and wing length among normal feathers and frizzle feather chicken. He recorded values of such traits as 11.4cm, 9.3cm, 10.86cm and 17.24 for normal feathers. Tadondjou *et al.* (2014) rekoned a significant difference (P<0.05) among traits like foot length, tarsus length, tarsus diameter and head length with values, 23.66cm, 7.27cm, 1.03cm and 5.84cm respectively among local birds with energy level effect. They however opined a non- significant effect on beak length, comb length and wattle heigth with values at 2700kcal/kg energy level as 3.29cm, 2.52cm and 1,23 respectively among birds in their study.

Other reserachers like Birteeb *et al.* (2016) also opined a significant difference on traits such as neck length, head length, comb length, wattle length and beak length among local birds in Gomoa West District in the Central Region of Ghana with sex, age and cob type effects. All traits in his study except head length showed a non significant difference among birds with skin colour effect. Female birds values recorded for the above mentioned traits in his study are, 8.37cm, 5.9cm, 2.52cm, 0.84cm and 3.0cm respectively. Patterns *et al.* (2020) were also among researchers who reported a significant difference among traits like beak length, head length, head circumference, neck length, neck circumference, wing lenth, back length, shank length, shank circumference, tibia length, tibia circle and third finger (central toe) length among 3 months old birds of three breeds. Values recorded for KUB chicken in their study for the mentioned traits are 3.476cm, 4.027cm, 3.23cm, 12.58cm, 8.33cm, 19.01cm, 20.82cm, 7.93cm, 4.21cm, 11.86cm, 9.57cm, and 6.29cm respectively.

Another reseacher in an attempt to characterize indegenous chicken in Rwanda, measured the body dimensions of some local birds on traits such as; tail length, thigh length, tarsus length, tarsus diameter, central toe length, and others. Recorded mean values for the traits mentioned are 14.66cm, 13.49cm, 8.01cm, 1.51cm and 5.02cm respectively (Claire *et al*., 2019).

Gwaza *et al.* (2013) also opined a significant difference in shank length, thigh length, tail length, and tail width among four groups of indigenous chickens of different ecotypes with mean values for traits in birds from kpumtyo (group 1) are 8.41cm, 12.08cm, 14.29cm and 5.37cm respectively. Claw length showed significant difference among birds at 18th and 44th weeks at different cage position and density effect, Fidan & Yildirim (2013) with mean value of claw length as 4cm at 18th week for all positions of cage. Another researcher also had no significant difference in claw length in 21 days' old bird with stocking density effect (Son, n.d.). At age 35days of birds in his study saw a significant difference in claw length.

Ukwu & Nosike (2017) indicated a significant difference in body weight, shank length, wing length and toe length between female local chicken with effect of location. Thigh length however showed no significant effect among female birds from different location. Recoded values of female birds from south east location were 1.01kg, 6.42cm, 12.77cm, 4.43cm and 12.23cm respectively.

According to Article (2020), drumstick circumference saw a non-significant difference in female naked neck birds reared under intensive and free range systems with values, 7.43cm and 8.15cm respectively.

2.8 Effect of morphometric traits on production performance

The use of morphometric traits in the prediction of production performance such as body weight in animals has been well proven over the period since they determine the market values of the animals (Robinson *et al.,* 1993). Linear body measurements have been used by researchers to describe body conformation and carcass composition, evaluate breed performance, predict live weight gain, reproductive performance, and examine relationships among morphometric characteristics in several animals (Egena *et al.,* 2014). The body weight of an animal is usually used as a measure of growth performance; however numerous research works have shown that morphometric measurements such as body length, shank length and body girth can serve as good predictors of growth traits (Sola-Ojo *et al.,* 2020). Tadele *et al.* (2018) indicated that the ratio values of body weight to shank length in male chickens were. They also indicated that, female chickens had significantly higher ($P < 0.01$) ratio values. All linear body measurements according to Tadele *et al.* (2018) of chickens were highly correlated with body weight. Body weight and linear body measurements according to their study showed strong ($P<0.01$) associations.

Assefa and Melesse (2018) also observed higher correlation (0.64) value between body weight and body circumference followed by a correlation of 0.63 between body weight and wing span. Similarly correlation of 0.57 between body weight and shank circumference and correlation of 0.56 between body weight and keel length were also estimated which were significantly moderate whiles Tabassum *et al.* (2014) reported the highest correlation (0.70) between body weight and body circumference followed by correlation of 0.36 between body weight and back length and correlation of 0.27 between body weight and pelvis width. They also reported that there was no significant correlation between back length and body circumference, back length and pelvis width and body circumference and pelvis.

In Ghana, Osei-amponsah *et al.* (2013) reported that genetic and phenotypic correlations between body weight and shank length were generally high and positive. According to Nematbakhsh *et al.* (2021) wingspan and chest circumference values can be used in predicting fast growing and slowing growing traits in local chicken breeds. They further stated that there was significant difference ($P < 0.05$) between the fast and slow growing chicken. Males always have larger values for body circumference, wing length and breast width than females in all the chicken types, though the differences were not statistically significant.

There is a high correlation of 0.84, between body weight and ornithological measurement (Udeh & Ogbu, 2011). They recorded an average mean of 51.14cm. Other researchers also showed higher significant difference ($P < 0.0001$) within and between treatment among birds (Aklilu *et al*., 2013). According to Fajemilehin (2017), there was a significant difference ($p<0.05$) in wing span and leg length between indigenous adult hen and cock with such trait values for hens as, 11.3cm and 11.12cm respectively, which is similar to Belay & Oljira (2019) whose work also revealed significant ($P<0.05$) difference in wing span and leg length.

Another research work also indicated significant difference between and within sexes of chickens in body weight, back length, body length, shank length, and wing span with recorded values for females in Horro as 1.29kg, 18.26cm, 35.16cm, 9.22cm and 69.96cm respectively. Comb height and wattle length of Horro female values, 0.77cm and 0.81cm, showed no significant difference between female bird though not between sexes (Aklilu *et al*., 2013).

Rectal temperature has been opined by Simsek (2019) to be a suitable indicator of thermal balance and could be used to assess the negative effect of heat stress on egg production of laying hens. He further indicated an increase in rectal temperature when the temperature and humidity index increases. He concluded that though heat stress did not affect the quality of the eggs produced, it decreased the production of the egg in the study. Another researcher also saw a non-significant difference ($P>0.05$) between the overall mean values of cloacal temperature obtained from daily records of experimental and control pullets with betamint supplement effect (Ayo *et al*., 2014). Mean values of cloacal temperature for experimental and control pullets are 41.63ºC and 41.64ºC respectively.

Article (2020) reckoned a non -significant difference in cloaca / rectal temperature among males naked neck chicken on different productive system and nutritional regimes. They however opined a significant difference in cloaca/ rectal temperature among female naked necked chicken with same production system and nutritional regimes effects. Highest and lowest recorded rectal temperature values were 41.63ºC and 41.37ºC respectively.

2.9 The Use of Body Measurements to Forecast Body Weight in Chickens

Practically, to determine the body weight of an animal, it must be weighed (Attah *et al.,* 2004). This may not always be possible due to the lack of equipment and/or time. There are however, indirect methods of assessing body weight of farm animals without the use of a weighing scale. Negassa *et al.* (2014b) determined the associations of body width, body length as well as breast angle with body weight whiles Oleforuh-Okoleh *et al.* (2017) also determined body weight of chicken using body measurements. Both researchers reported significant association ($P<0.05$) association between body weight and body characteristics. Similar predictions of bodyweight using body measurements in sheep (Traiq *et al.*, 2012; Agamy *et al*., 2015) and goat Fadlelmoula *et al.* (*2*014) have been recorded. The use of linear body measurements to predict live body weight of animals is perceived more reliable compared to the use of weighing scales which could introduce biases as a result of feed in the gut (Mbelayim, 2015). In localities where weighing scales are not readily available, the use of morphometric measurements to determine body weight may be ideal.

2.10 Effect of environmental conditions on indigenous chickens

Simsek (2019) indicated that environmental conditions such as temperature and humidity, are important stressors on poultry production. He further indicated his studies that insufficient supply of indoor temperature and humidity demands for laying chicken can cause heat stress which leads to low feed intake and eventually reducing performance of birds and reduced egg production. Another researcher added that although rural poultry is generally known to be hardy and well adapted to harsh and stressful environments, prolonged high temperatures can put local chicken in critical heat stress (Nyoni *et al*., 2019). Talukder *et al.* (2010) concluded in their research that excess environmental temperature in poultry houses can negatively affect egg production, growth and egg size.

A number of researchers have researched into the effect of different ecological on chicken performance including Yihun *et al.* (2020), opined a significant difference ($P<0.05$) in body weight, comb width, wing span, shank length, shank circumference, neck length, wing length and comb length and non- significant difference ($P>0.05$) in body length, comb width, wattle width, beak length, wattle length and ear length among indigenous chicken with highland, midland and lowland agro – ecological effects. Tadele *et al.* (2018), another researcher also opined a significant difference in body weight, body length, shank length, shank circumference, back length and wing span among indigenous chicken in three different ecological districts in Kenya. There was another variation in all morphological traits, such as body weight, body length, back length, beak length, shank length and shank circumference among local and exotic chicken reared in two districts of Metekel Zone in Benishangul characterized by an average annual temperature and rainfall (Kebede, 2019). Ukwu & Nosike (2017) also opined a significant difference in body weight, shank length, thigh length, wing length and toe length among local females from different location. (Nigussie, 2015)

2.11 Effect of sex and age on local chicken performance

Dana *et al.* (2010) indicated that most of the morphological characteristics varied between male and female chicken. Their findings revealed significant difference in shank length between males and female local birds of five different population, while males and female birds showed no significant difference in shank length between the birds. Tadele *et al.* (2018) opined significant difference in all morphological traits measured including body weight, body length, shank length and circumference, etc among males and female local chicken in their research. Another researcher also saw significant difference in all traits measured among males and female local chicken in Nigeria (Ukwu & Nosike, 2017). A review of work of some researchers Birteeb *et al.* (2016) revealed variation of chicken at all ages in all traits measured such as body weight, body length, thigh length and circumference and shank length. Oleforuh-Okoleh *et al.* (2017) also indicated variation in some morphological traits in local birds at four and eight weeks old, but showed no variation in same traits among same traits measured at sixteenth week.

Variations in traits by researchers like Kebede (2019), were attributed to a number of factors such as, differences in genotype, feed availability, location, traditional husbandry practices and other environmental factor.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1. Location and duration of study

The study was conducted in six municipals and three districts of three Regions of the Republic of Ghana. The six municipals and the three districts were randomly selected from three Regions which were also randomly selected. The three (3) regions from which the study was undertaken were Western Region, Greater Accra region and the Eastern Region. The Western Region is situated in the south-western part of Ghana and shares common borders with La Cote d'Ivoire on the west, the Central Region in the East, parts of Ashanti and Brong Ahafo Regions in the North and the Gulf of Guinea (Atlantic Ocean) in the South. It covers an area of 23,921 square kilometers representing about 10 percent of the total land surface of Ghana and has a total of 192 kilometers coastline. The Southernmost part of Ghana, Cape Three Points near Busua in the Ahanta West District, is also located in this region, (Ghana Statistical Service, 2013). The region falls under two main climatic types: the south-western equatorial and the wet semi-equatorial (Dickson & Benneh, 2001). The south-western equatorial climate is the wettest in the country with high rainfall patterns. The highest temperatures which occur in March/April are around 30 degrees centigrade while the lowest temperatures of 26 degrees occur in August. Relative humidity is between 70-80% all year round. The wet semi-equatorial climate has average yearly rainfall between 1250 and 2000 millimetres with sharp dry seasons. The Wassa Amenfi Central District, Wassa Amenfi East and Wassa Amenfi West Municipals were the District and Municipals considered.

The Greater Accra Region is located in the south-central part of the country and shares borders with the Central Region to the west, Volta Region to the east, Eastern Region to the north, and the Gulf of Guinea to the south and occupies an area of 3,245 square kilometres or 1.4 percent of the total land area of Ghana. The region falls within the dry, coastal, equatorial climatic zone with temperatures ranging between 20° and 30° Celsius, and annual rainfall ranging between 635 millimetres along the coast to 1,140 millimetres in the northern parts with an average humidity of 80% , (GSS Region, 2013). Three municipals in the region that were under study are Ga West, Ga East and Ga North Municipals.

The Eastern Region lies between latitudes 6 and 7 degrees North and longitude 1.30 West 0.30 degrees East. It is the sixth largest region with a land area of 19,323 kilometers square, which is 8.1% of the land area of Ghana (Ghana Statistical Survey, 2005). It shares boundaries with five other regions: Greater Accra, Volta, Brong East, Ashanti and Central regions. The region lies within the wet semi- equatorial zone which is characterized by double maxima rainfall in June and October (GSS, 2012). The first rainy season is from May to June, with the heaviest rainfall occurring in June while the second season is from September to October, with the little variations between the districts. Temperatures in the region are high and range between 26ºC in August and 30ºC in March. The relative humidity which is high throughout the year varies between 70 percent to 80 percent (GSS, 2012). The Nsawam Adoigyiri Municipal, Upper West Akim District and the Akuapim South District are municipal and the districts the study was undertaken in the Eastern Region. The study begun on February, 2021 and ended in July, 2021.

3.2. Sampling Technique and Sample Size

Purposive sampling (a process in which the researcher chooses specific people within the population to use for a particular study or research project) was used to select nine farmers (both males and females) per district. One female laying bird was randomly sampled from each farmer's farm for the study. A sample size of nine (9) laying hens were selected in each district/municipal through simple random sampling technique. This same method of selection was repeated in two additional district/municipal in each region across the three regions under study. A total sample size of eighty-one (81) laying female chickens were selected for morphological traits measurements following FAO standard descriptors (FAO, 2007).

3.3. Data collection

3.3.1. Morphometric Measurement

Twenty (20) quantitative traits were measured from nine (9) laying birds in each of the six municipals and three districts identified. The morphometric descriptors included:

3.3.1.1. General measurement

3.3.1.1.1. Body weight

Body weight was measured with the Mid-Size Automatic Weighing Scale (500g - 20kg), manufactured by YAMATO-SCALE Co., Ltd. Measurement was done by putting birds in a transparent polythene bag with an insignificant weight. The birds in polythene were hanged on the weighing scale for reading and recording.

3.3.1.1.2. Ornithological measurement / body length

Ornithological measurement, according to Scott (1982) is measured from the tip of the beak to the end of the tail when the bird was laid down on its back. Ornithological measurement is same as body length (Fajemilehin, 2017). Measurement was done by the researcher with the assistance of two persons holding and stretching the tape measure gently on a table, while two persons held firmly a bird laid down to its back for reading to be taken from tip of the beak to the end of the tail (Scott, 1982).

3.3.1.1.3. One wing

One wing/ wing length according to Birteeb *et al.* (2016) was measured at the distance from the shoulder joint to the extremity of the terminal phalanx, by stretching gently either of the wing.

3.3.1.1.4. Wing span

Wing span according to Hassan *et al* (2020) is the length between the tips of the right and left wings after both are stretched completely. Two persons held firmly a bird with one hand and the other stretching each wing while the experimenter took the measurement.

3.3.1.1.5. Rectal temperature

Rectal temperature are recorded when chickens close their eyes and with preferably no respiration using a digital thermometer inserted nearly 3 cm into the cloaca (Chen *et al.*, 2013).

3.3.1.2. Head measurement

3.3.1.2.1. Skull length/ head length

Skull length or head length as indicated by Birteeb *et al.* (2016), was measured as the distance between the occipital bone to the insertion of the beak into the skull (where the plumage starts) according to Francesch *et al.* (2011). The tape measure was used to take the measurement with the help of one person holding firmly its beak.

3.3.1.2.2 Skull width / diameter

Skull width was measured at end of one earlobe to the end of another earlobe using callipers.

3.3.1.2.3. Beak length

Beak length was measured from the tip of the beak until insertion of the beak into the skull (Francesch *et al*., 2011).

3.3.1.2.4. Wattle length

Wattle length was taken from the vertical distance from the beginning to the end of the wattle (Birteeb *et al*., 2016). Measurement was taken with one person holding the hen firmly and another holding the end of its wattle.

3.3.1.3 Neck measurement

3.3.1.3.1. Neck length

The neck length according to Birteeb *et al.* (2016) is the distance between the occipital condyle and the cephalic borders of the coracoids. It was measured with the aid of one person holding and gently stretching the head to measure from end of skull to end of neck cape.

3.3.1.3.2. Neck width/ diameter

Neck width (diameter of neck) was measured from one end to another end of the middle part of neck when neck is stretched (Patterns *et al*., 2020).

3.3.1.4. Body measurement

3.3.1.4.1. Back length

Back length was measured from insertion of the neck into the body to the saddle as indicated by Francesch *et al.* (2011). Bird was firmly held upright for measurement to be taken.

3.3.1.4.2. Tail length

Tail length is the distance measured from the tip of a central rectrix to the point where it emerges from the skin (Francesch *et al*., 2011).

3.3.1.5. Leg measurement

3.3.1.5.1. Leg length

Leg length was measured from the distance between the hock joint to the pelvic joint as propined by Adeleke *et al.* (2011).

3.3.1.5.2 Thigh length

Thigh length was measured from the length between the hock joint to the pelvic joint (Ukwu & Nosike, 2017).

3.3.1.4.3. Thigh width

It was measured from the distance one end to another end of the widest point of the thigh (Udeh & Ogbu, 2011).

3.3.1.4.4. Tarsus/Shank length

Tarsus length according to Hassan *et al* (2020) is the length from the joint of the fingers to the articulation of the thigh.

3.3.1.4.5. Tarsus/Shank diameter

Tarsus diameter was measured as the diameter from back to the front, on the middle of the metatarsus bone (Francesch *et al.*, 2011).

3.3.1.4.6. Central toe length

It was measured by extending the toes on the table and reading from the length of the central toe – metatarsus joint until the insertion of the nail (Francesch *et al*., 2011).

3.3.1.4.7. Claw length

Claw length was measured from the beginning of the claw insertion to the end of the claw on the central toe, (Son, n.d.). Measurement was done using the tape measure.

3.3.2 Morphometric Instrument and Units

3.3.2.1 Weighing Scale

A twenty kilogram (20kg) weighing scale was used to take a direct measurement of the live body weight. Measurement was recorded into kilogram.

3.3.2.2. Flexible tape measure

A flexible tape measure was used to measure the following in centimeters (cm):

Ornithological measurement (Or), one wing (OW,), wing span (WS), skull length (SL), neck length (NL), back length (BL), tail length (TaL), thigh length (ThL), tarsus length (TL), beak length (BkL), wattle length (WL), central toe length (CTL), leg length (LL), claw length (CL).

3.3.2.3. The calipers

The caliper was used to measure the tarsus diameter (TD), skull width (SW), neck width (NW), and thigh diameter (ThD). Measurement was recorded in centimeter.

3.3.2.4 Digital thermometer

The digital thermometer was used to measure the rectal temperature. Measurement was recorded into degree Celsius (°C).

All measurements and weighing were taken by the same researcher to avoid measurement variations with three persons aiding in the handling of the birds for measurement to be taken.

3.4. Data Analysis

Data collected on the twenty morphological traits, were subjected to one way analysis of variance (ANOVA) with the aid of GenStat version 12.1 (2009) software. The treatment means were separated by the least significant difference (LSD) to determine which of the treatments has significant difference or not at 5% probability level.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSINS

4.1. Results

4.1.1 General measurements

The means of the general measurements that is body weight, ornithological measurement, one wing, wingspan and rectal temperature are presented in Table 4.1.

Table 4.1: Average means of general measurements of birds in Wester, Greater Accra and Eastern Regions

Parameter	T 1	T 2	T 3	OM	SEM	P Value
Body weight (kg)	1.65	1.47	1.8	1.64	0.11	0.189
Ornithological Measurement (cm)	48.89^{a}	44.26^{b}	48.40^{a}	47.18	0.89	0.019
One wing (cm)	29.23	28.33	29.85	29.14	0.96	0.350
Wing span (cm)	63.56	60.88	62.83	62.43	1.58	0.29
Rectal Temperature (°C)	40.88	40.96	41.29	41.04	0.35	0.496

TI, T2, T3 represent birds in Western, Greater Accra and Eastern Regions respectively. OM represents Overall Mean SEM indicates standard errors of differences of means.. Means on the same row with different superscripts a and b, are significantly different (P < 0.05)

With the exception of ornithological measurement that showed significant difference (P < 0.05), there were no significant difference (P > 0.05) in the body weight, one wing, wing span and rectal temperature among birds in the three research locations. The performance of Ornithological measurement of birds in Eastern and Western Regions was significantly (P < 0.05) higher than birds in the Greater Accra Region.

4.1.2. Head measurement

Table 4.2 shows the means of measurement of skull length, skull width, beak length and wattle length.

Table 4.2: Average means of head measurements of birds in Wester, Greater Accra and Eastern Regions

Parameter	T 1	T 2	T 3	OM	SEM	P Value
Skull length (cm)	7.04	6.94	7.34	7.11	0.22	0.441
Skull width (cm)	4.34^{a}	3.62^{b}	4.22^{a}	4.06	0.13	0.018
Beak length (cm)	1.81^{b}	2.16^{b}	2.77^{a}	2.25	0.33	0.006
Wattle length (cm)	1.06	0.84	0.95	0.95	0.09	0.328

TI, T2, T3 represent birds in Western, Greater Accra and Eastern Regions respectively. SEM indicates standard errors of differences of means. OM represents Overall Mean. Means on the same row with different superscripts a and b, are significantly different (P < 0.05)

Birds in Western and Eastern Regions had higher ($P < 0.05$) skull width than birds in Greater Accra region. Though the birds did not show significant difference ($P > 0.05$) in the Western and Easter regions, the two regions however, showed a higher superiority ($P < 0.05$) in the skull width between the birds in the Greater Accra Region.

Beak length of the birds in the Eastern region was significantly higher ($P < 0.05$) than beak length of the birds in the Western and Greater Accra Regions. There was no significant difference ($P > 0.05$) in skull length and wattle length of birds in all the three regions.

4.1.3. Neck measurement

Measurement of neck length and neck width are presented on Table 4.3.

Table 4.3: Average means of neck length and neck width of birds in Wester, Greater Accra and Eastern Regions

Parameter	T 1	T 2	T 3	O.M	SEM	P Value
Neck length (cm)	8.68	8.68	9.16	8.84	0.33	0.541
Neck width (cm)	4.05^{a}	3.29^{b}	4.02^{a}	3.79	0.16	0.028

TI, T2, T3 represent birds in Western, Greater Accra and Eastern Regions respectively. SEM indicates standard errors of differences of means. OM represents Overall Mean. Means on the same row with different superscripts a and b, are significantly different ($P < 0.05$)

Table 4.3 indicates that the birds in all the three regions showed no significant levels ($P > 0.05$) in the neck length. However, there was significant difference ($P < 0.05$) in the neck width among the birds. The neck width of the birds in the Eastern and Western regions were significantly ($P < 0.05$) higher than the neck width of birds in the Greater Accra Region.

4.1.4. Body measurement

Means of the back length, tail length and vent/cloaca size of the birds in the three regions are presented on Table 4.4

Table 4.4: Average means of back length and tail length of birds in the three regions

Parameter	T 1	T 2	T 3	OM	SEM	P Value
Back length	22.95^{a}	21.29^{b}	20.34^{b}	21.53	0.35	0.005
Tail length	15.17	12.93	14.07	14.05	0.53	0.066

TI, T2, T3 represent birds in Western, Greater Accra and Eastern Regions respectively. SEM indicates standard errors of differences of means. OM represents Overall Mean. Means on the same row with different superscripts a and b, are significantly different (P < 0.05)

There was a significant difference ($P < 0.05$) in back length among the birds in all the three regions under study. Back length was significantly longer ($P < 0.05$) in the birds from Western region compared to their contemporaries in Greater Accra and Eastern Regions. Tail length among the birds in all the three regions, did not show any significant difference ($P < 0.05$).

4.1.5. Leg measurement

Table 4.5 shows the means of leg length, thigh/drumstick length, thigh width, tarsus/shank diameter, tarsus/shank diameter, central toe length, claw length of the birds in the three research regions.

Table 4.5: **Average means of leg measurements of birds in the Western, Greater Accra and
Western Regions**

Parameters	T 1	T 2	T 3	OM	SEM	P value
Leg length (cm)	26.65[a]	24.04[b]	26.26[a]	25.65	0.5	0.004
Thigh length (cm)	12.1	11.48	12.04	11.88	0.29	0.325
Thigh width (cm)	4.36	3.61	4.37	4.11	0.25	0.118
Tarsus length (cm)	7.02[a]	6.57[b]	7.30[a]	6.96	0.12	0.012
Tarsus width (cm)	1.47	1.29	1.37	1.38	0.06	0.209
Central toe length (cm)	5.93	6.12	6.27	6.11	0.15	0.163
Claw length (cm)	1.17	1.20	1.26	1.21	0.10	0.685

T1, T2, T3 represents bird in Western, Greater Accra and Eastern Regions respectively. SEM indicates standard errors of differences of means. OM represents Overall Mean. Means on the same row with different superscripts a and b, are significantly different ($P < 0.05$)

Birds in the regions under study showed significant difference ($P < 0.05$) in the leg length and tarsus length among them. In terms of leg length and tarsus length, both Western and Eastern regional birds had significantly higher ($P < 0.05$) values than birds from Greater Accra Region. However, leg length and tarsus length did not show any significant difference (P > 0.05) between the birds in Western and Eastern regions. Thigh length, thigh width, tarsus width, central toe length, and claw length, did not show any significant difference (P > 0.05) among the birds in all the three regions.

4.2 DISCUSSIONS

4.2.1. General Measurement

The non-significant difference among the birds in live body weight confirms the finding of Tadele *et al.* (2018), who reported a non-significant difference of live weight of local birds in three districts in Ethiopia. The results also agrees with the findings of Dana *et al.* (2010), who recorded a non-significant difference of birds (both sexes) in terms of live weight within same districts in Ethiopia. The results of body weight of the female birds under this research however are closer to the results of Dana *et al.* (2010) who recorded average body weight means of female birds with values 1.63kg, 1.652kg, 1.7kg, 1.411kg and 1.697kg. Values of this study are similar to that of Udeh & Ogbu (2011) who recorded mean body weight of 1.88kg, 1.65kg and 1.81kg though the results of the finding disagrees with their finding as theirs showed a significant difference between three strains of chickens under their study. The non-significance in body weight of the birds in all three regions though different location, may be attributed to the same or close age mates as attributed by Dana *et al.* (2010).

The significant difference in the ornithological measurement (body length) among the birds in the finding of this study agrees with Tadele *et al.* (2018) who reported that female chickens show high significant linear body measurement, including body length, over males. Other researchers like Kebede (2019) and Assefa & Melesse (2018a) also confirmed higher body length in some breeds, sexes of local and exotic chicken reared in two districts of Ethiopia and female birds in three different research districts in Ethiopia respectively. The overall mean values of ornithological measurement / body length of the birds in this study however, was higher than values recorded for female birds by Kebede (2019) and Assefa & Melesse (2018) who had 41.5cm and 35.9cm respectively but lower than the results of Francesch *et al.* (2011) whose findings recorded 58.13cm in exotic chickens in Spain. The finding of this study disagrees with the findings of Fitsum (2016) which showed no significant in body length. Kebede (2019) suggested that chicken with higher body length or ornithological measurement could be attributed to the effect of larger skeletal dimension of those birds. The chickens in Western and Eastern Regions showing higher performance can be attributed to the adequate environmental temperature in these two regions over the high temperature in the Greater Accra Region (Simsek, 2019).

The non -significant difference of wing span among the birds in this study confirms the findings of Francesch *et al.* (2011) who recorded a non-significant difference in wing span among operator and race of birds in their study. The recorded value in their study for wing span was higher than the value recorded in this study, but lower than value recorded by Fitsum (2016) whose results also confirmed the non-significant difference in wing spam between local chicken with sex effects. The finding however disagrees with the findings of

Fajemilehin (2017), whose results showed a non-significant difference in wing span among normal feathered birds in Nigeria.

The non-significant difference in one wing of the birds in the three regions, agrees with Birteeb *et al.* (2016) whose results indicated a non-significant difference in wing length between three breeds of local chicken in Gomoa West District in Ghana. The results of one wing disagrees with the findings of Fitsum (2016), whose results showed a significant difference in one wing between local chickens in three different ecotypes in Northern Ethiopia.

Rectal temperature showing no significant difference in this study, confirms the study of Ayo *et al.* (2014) whose results opined a non-significant difference between overall mean rectal/cloacal temperature among black pullets. The findings of this work showing non-significant difference in rectal temperature, also confirms the findings of Article (2020) whose results showed a non-significant difference in cloacal temperature among naked necked chicken in Pakistan.

4.2.2. Head measurement

The non-significant difference of skull length between treatments agrees with Francesch *et al.* (2011) whose findings also recorded a non-significant difference in skull length between breeds of exotic chicken, but had a value of 7.64cm that is higher than the overall mean value of the birds in this research. The study however disagrees with the study of Birteeb *et al.* (2016) in the Gomoa West District of Ghana, whose findings recorded a significant difference for head /skull length with sex, breeds, comb type and skin colour effects. The results of the findings of Tadondjou *et al.* (2014) also disapproves the results of this study by showing a non-significant difference in head / skull length in local barred chickens in Cameroon with a lesser value recorded than the value recorded in this study.

The skull width/ diameter of this research showing a significant difference between the birds in the regions under study agrees with Francesch *et al.* (2011) and Patterns *et al.* (2020) whose findings also revealed a significant difference in skull width among breeder and operator interaction in Spain, and among three breeds of local chickens in Indonesia respectively. The value for skull width of this study however is higher than the values recorded in their studies, but lower than the value recorded by Claire *et al.* (2019) whose findings recorded a value of 5.1cm in their study for skull width for indigenous chickens in Rwanda. The variation in skull width among the chicken in this study with chickens from Western and Eastern showing superiority may be attributed to the conducive environmental conditions in the two regions over the high temperature in Greater Accra Region as similarly opined by Kebede (2019).

The significant difference in beak length in this study agrees with Kebede (2019) who opined a significant difference among local birds reared in two different districts and with sex effect in Ethiopia. Birteeb *et al.* (2016) are researchers whose results approves the finding of this study by recording a significant difference in beak length among local birds with different comb type in Ghana. The results however disagrees with the finding of Yihun *et al.* (2020) whose results showed a non-significant difference among indigenous chickens from three different ecological effects . The overall mean value for beak length of this study was below the finding of Kebede (2019), 2.46cm and Birteeb *et al.* (2016), 3.0cm, but higher than the value recorded by Assefa & Melesse (2018) who had 1.5cm for beak length. The Easter Region showing superiority in beak length over Western and Greater Accra Regions may be attributed to proper management system (housing) as it was observed during the study birds were properly housed or may be due to genetic superiority (Kebede, 2019).

The non-significant difference in wattle length among the birds in this study supports the findings of Aklilu *et al.* (2013) whose work revealed a non- significant difference between female birds of two districts. It also confirms the results of Birteeb *et al.* (2016) which showed a non- significant difference in wattle length among local poultry with five different skin colour effects in Ghana.. However, the birds showing non- significant difference in wattle length among them in the three regions in this study, contradicts the findings of Yihun *et al.* (2020) whose results indicated a significant difference in wattle length among indigenous poultry from two different ecological location in Ethiopia.

4.2.3. Neck measurement

The neck length showing non-significance among the chickens in three regions in this study agrees with the research of Assefa & Melesse (2018b) who opined a non -significant difference in neck length between indigenous female chickens in three districts in Southwestern Ethiopia. It also agrees with the findings of Birteeb *et al.* (2016) whose results showed a non-significant difference in five different skin colours of indigenous chicken in

Ghana. It disagrees with the results of the findings Daikwo *et al.* (2015), who had a significant difference in neck length between two breeds of indigenous chickens in Nigeria. Apart from Birteeb *et al*. (2016) who recorded a lower value than this research work, all other researchers recorded a higher values.

Though not many research work has been carried out on neck width, the significant difference of neck in this study agrees with Patterns *et al.* (2020) who also recorded a significant difference in neck between three breeds of birds, though their value recorded was higher than overall mean value recorded in this study. The variation in neck width among the birds in the three regions with Western and Eastern Regions showing superiority over Greater Accra Region may be attributed to favourable weather conditions in these two regions, Ghana Statistical Service (2013), over Greater Accra or proper management system (Kebede, 2019).

4.2.4. Body measurement

The significant difference in back length agrees with the results of Patterns *et al.* (2020), Tadele *et al.* (2018) and Claire *et al.* (2019) whose findings also showed significant difference in back length among local birds in Indonesia, Ethiopia and Philippines respectively. The overall mean value recorded for this research work however are above their values recorded. The results back length showing significant difference in back length among the birds in the regions of this finding, again confirms the findings of Kebede (2019) whose results showed a significant difference in back length among local birds in two districts in Ethiopia. The finding of this work on the other hand is contrary to the findings of

Francesch *et al.* (2011) who opined a non-significant difference in back length though their value was higher than the value recorded for this research. The significant difference exhibited in the birds in the regions may be attributed to availability of food and favourable environmental conditions.

Tail length showing non-significant difference among birds agrees with the findings of Francesch *et al.* (2011) who also reckoned a non-significant difference in tail length among birds studied in Spain. The finding however objects to Gwaza *et al.* (2013), who recorded a significant difference in beak length among birds in four ecotypes. The value of this work happened to be lower than the value recorded by both researchers, though the value is closely to Gwaza *et al.* (2013).

4.2.5. Leg measurement

The significance difference in leg length among the birds in this study agrees with the findings of Tadondjou *et al.* (2014) and Fajemilehin (2017) whose results showed significant difference in foot length/ total leg length among local chickens in Cameroon and Nigeria respectively in their research. The findings of this work agrees with the research of Oleforuh-Okoleh *et al.* (2017) whose results indicated a significant difference in leg length among naked neck and normal feather at 4^{th} and 8^{th} weeks old in leg length. The results of this work, however disapproves with their findings where birds showed similarity in leg length at 12^{th} and 16^{th} weeks old. The value recorded for this work however is higher than their values. The variation may be due to the effect of conducive environmental conditions or superiority in genotypes of birds in the Western and Eastern Regions over Greater Accra Regions.

The non-significant difference of thigh length among the birds in the three regions of this findings is in support of the findings of Ukwu & Nosike (2017) whose results showed a non-significant difference in thigh length among female chicken from two different locations in Nigeria. It also agrees with the findings of Francesch *et al.* (2011), whose results revealed a significant difference in thigh length among operators and breeds of exotic birds in Spain. Patterns *et al.* (2020) and Gwaza *et al.* (2013) on the other hand, disagree with the finding of this work, by having a significant difference in thigh length in their researches. Overall mean value of this work was very near to values recorded by these researchers.

Thigh width showing no significant difference in this research confirms the work of Article (2020) whose results showed a non-significant difference in thigh width between female naked chickens reared under intensive and free range systems. The results contradicts the findings of Patterns *et al.* (2020) and Yakubu & Salako (2009) whose results showed a significant difference in thigh diameter/ width. Values of these researchers however are higher than the value recorded in this research.

The differences in tarsus/ shank length among birds in the three regions in this study agrees with the findings of Ukwu & Nosike (2017) whose results indicated a significant different in shank/tarsus length among female local chicken in two location in Nigeria. Differences shown in this work also confirms the work of Assefa & Melesse (2018) and Tadele *et al.*

(2018) whose results showed variation in among female local birds of different breeds and among local chickens from three districts both in Ethiopia. The results disagrees with the results of Francesch *et al.* (2011) who opined a no significant difference in tarsus length among birds. Values of these researches were slightly above overall mean value of this research work.

The non-significant difference in tarsus/ shank circumference among the birds in this research work agrees with the findings of Francesch *et al.* (2011) whose work showed a non-significant difference in tarsus/ shank tarsus circumference among birds of different breeds in Spain. Values of tarsus circumference for both works are similar to each other. The result of this finding disagrees with Assefa & Melesse (2018) and Tadelle *et al.* (2003) whose work showed significant difference among birds. Their values were higher than the value recorded in this research.

Central toe length showing non-significant difference between birds in the three regions confirms the work of Francesch *et al.* (2011) which showed a non-significant level in central toe length. It however disapproves with the finding of Patterns *et al.* (2020) whose work showed a significant level between three breeds of local chickens in their study. The overall mean value of this research is slightly lower than the value of Patterns *et al.* (2020), but higher than value recorded by Francesch *et al.* (2011). Non-significant difference of claw length agrees with the work of Son (2013) who opined significant difference in claw length among broiler chickens on stocking density effect at age 21days in South Korea. The non-significant difference contradicts the finding of Fidan & Yildirim (2013) whose work showed a significant difference in claw length among 18 weeks Denizli chickens with cage density and position effects in Turkey.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1. Conclusion

From the results of this research, it could be concluded that;

- Indigenous laying chickens have numerous quantitative morphological traits that could be measured.
- Variation in physical features of indigenous laying chickens exists among different population.
- Different ecology can influence variation in morphological traits of indigenous laying chicken.
- Laying birds from Western and Eastern Regions had higher ornithological measurement,

  skull width, neck width, leg length and tarsus length than laying birds from the Greater Accra Region.
- Laying birds from all three regions under study had no difference in body weight, one wing, wing span, rectal temperature, skull length, wattle length, neck length, tail length, thigh length, thigh width, tarsus width, central toe length, and claw length among them.

5.2. Recommendation

The following are the recommendations made;

- The study should be repeated in most of the regions in Ghana for wider assessment of physical variation among different chicken populations.

- A further study on the effect of ecological differences on the quality and quantity of indigenous chicken products among chicken population should be done.
- Regular training on sensitization on effective production of indigenous poultry farming of farmers should be organized.

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