DECLARATION

I, **EZEIKE PRECIOUS DEBORAH**, hereby declare to the senate that the project titled **"PHENOTYPIC CHARCTERISTIC OF WEST AFRICAN DWARF (WAD) SHEEP IN THREE LOCAL GOVERNMENT AREAS IN EKITI STATE"** is my own original work carried out by me in the department of Animal Production and Health, Federal University Oye-Ekiti. Ekiti State, under the supervision of Prof. (Mrs) A. A. Aganga, Dr. A. H. Ekeocha and Dr. F. A. Adejoro. All citations and information derived from the literature has been duly acknowledged in the text and the list of references and this work has not been submitted before nor currently in any other institution.

……………………… 13-08-2019

Ezeike D. Precious **Date**

CERTIFICATION

This is to certify that this thesis titled **"Phenotypic Characteristics of West African Dwarf (WAD) Sheep in three (3) Local Government Areas (LGA) in Ekiti State"** was carried out and submitted by **Precious Deborah, EZEIKE** with matriculation number: **ASC/13/0966** and has satisfied the regulations governing the award of the degree of Bachelors in Agriculture (B. Agric) Animal Production and Health in the Department of Animal Production and Health, Federal University, Oye-Ekiti, Ekiti State during the 2017/2018 session and is approved for its contribution to knowledge and literacy presentation by

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DEDICATION

I dedicate this work to the Almighty God for his guidance and protection throughout my stay in school. I also dedicate this report to my indispensable parents, Chief and Lolo (Mrs.) Arthur-Richard Ezeike and my siblings, Richard N. Ezeike, Frank E. Ezeike, Mark-Kennedy M. Ezeike, Godswill C. Ezeike, for their love, support and encouragement. May God bless you all and keep you.

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ABSTRACT

The WAD Sheep represent one of the predominant small ruminant breeds raised by resource-limited households in Southern Nigeria as well as in the humid west and central Africa. This breed of Sheep is renowned for its adaptation to hot and humid environments, high fertility and prolificacy under backyard systems where they are raised almost with zero investment. On account of its contributions to household income and food security in southern Nigeria, there is the need for a detailed phenotypic and genetic characterization as well as the design of breeding strategies for its conservation through sustainable utilization. A critical challenge, however, is that there are no national breeding policies in most of the countries where WAD Sheep are raised.

This study was carried out in three (3) Local Government Areas in Ekiti State, Nigeria; Ikole (07°47′53.76″N 05°30′52.17″E), Oye (07°47′52.55″N 05°19′42.78″E) and Ado (07°37′15.9996″N 05°13′17.0004″E) Local Government Areas. The study aimed at evaluating the phenotypic characteristics of West African Dwarf (WAD) Sheep in study location. A total of one hundred and eighty (180) adult WAD Sheep, comprising of ninety (90) males and ninety (90) females, were randomly selected for the study. Animals were randomly selected across locations within the Local Government Areas. Sick and pregnant animals were not included in the study. Animals were selected based on the phenotypic appraisal only.

Phenotypic characterization is important in breed identification and classification in ways that both research scientists and farming communities can relate with. The aim was to explain the pattern of relationship of the body dimensions and body functions of adult Sheep in the West African Dwarf (WAD) Sheep. Body weight, sex, colour and other seven body traits (ear length, heart girth, rump height, wither height, body length, head length, tail length) were collected from the 180 Sheep comprising of 90 males and 90 females WAD Sheep. Data collected were subjected to Analysis of Variance (ANOVA) and means were separated using Tukey`s test. Results obtained showed that sex had a significant effect ($p < 0.05$) on some of the body parameters considered. This trend confirms sexual dimorphism in WAD Sheep in the study location.

White and black (37.2%) and White (26.1%) are the dominant color types while 36.7% comprises of Brown (21.7%), White and brown (10.0%) and Black (5.0%) colour types with long thin tail in both ewe and ram sheep. The majority of the sheep had a straight tail form at the tip, straight head profiles and also horizontal ear forms. Location and sex had a significant effect ($P<0.05$) on body weight and some of the linear body measurements. The results collected showed significant differences ($P<0.05$) between the following traits for Ikole, Oye and Ado respectively; EL (11.33 ± 0.14^{b}; 11.8 ± 0.17^{a}; 11.6 ± 0.15^{ab})cm, HG (75.3 ± 0.95^{c}; 80.38 ± 0.69^{a}; 77.67 ± 0.89^{b})cm, MBW (38.14 ± 1.2^{c}; 44.61 ± 1.0^{a}; 41.36 ± 1.16^{b})kg, RH (68.47 ± 0.81^{a}; 68.07 ± 0.81^{ab}; 66.1 ± 0.65^{b})cm, WH (68.47 ± 0.81^{a}; 68.07 ± 0.81^{ab}; 66.1 ± 0.65^{b})cm, BL (87.43 ± 0.98^{a}; 83.37 ± 0.97^{b}; 87.3 ± 0.94^{a})cm while HL (20.8 ± 0.28; 21.38 ± 0.24; 21.48 ± 0.27)cm, and TL (32.15 ± 0.44; 34.78 ± 0.7; 32.98 ± 0.5)cm did not show significant differences between the locations. The highest correlation was obtained between BW/HG and RH/WH for all the location.

Keywords: WAD sheep, body dimensions, phenotypic characters, body weight.

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LIST OF ABBREVIATIONS

EL – Ear Length

HG – Hearth Girth

BW – Body Weight

MBW – Mean Body Weight

RH – Rump Height

WH – Wither Height

BL – Body Length

HL – Head Length

TL – Tail Length

ANOVA – Analysis of Variance

WAD – West African Dwarf

LGA – Local Government Area

WB – White and Black

WBR – White and Brown

F – Female

M – Male

Sig – Significant

GPS – Global Positioning System

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CHAPTER 1

1.0. INTRODUCTION

Small ruminants contribute largely to the livelihoods of the livestock--keeping households of low and medium income farmers in the developing world. The keeping of small ruminants is mainly concentrated in the developing areas of the world. Small ruminants make up a large proportion of the domestic ruminants in terms of numbers and in contribution to meat production. Small ruminants have been part of the history of the world since the colonization with arrival of goats from Spain and hair sheep from West Africa. Over the course of the past five centuries, people in the various countries have reared small ruminants, have acquired the taste of their meat and have developed traditional dishes and cooking methods. In most countries, the traditional way to rear small ruminants has been under extensive grazing, with animals free to roam around most of the day, and at night, in the best cases, confined in a corral equipped often with a simple shed. During the day, the animals browse and graze a variety of forages resources in the areas where the natural vegetation and the climate are suitable, using their nutritional wisdom to balance their diet in order to fulfill their nutrient requirements. In parts of the larger islands, and in the whole area of many small islands, goats and sheep are seen going around everywhere, even within the city boundaries. The appropriate conditions and the absence of major predators have allowed the small ruminant populations to remain, despite the frequent attacks by dogs. These extensive systems, particularly with limited or no managements at all, are productive to a certain extent, depending on the management and the richness of the natural vegetation. But considering that they require minimum investment, they are therefore, very profitable. The most important limitation for successful small ruminant production has clearly been inadequate nutrition. And the main explanation for this has been the failure to recognize that small ruminants have higher nutrient requirements than large ruminants, and that they should not be fed the typical forages used for cattle, which have largely been grasses. Sheep and goats are simply unable to consume, to ruminate and to digest grasses in general, at the rate they require for acceptable levels of production. When the animals are free to move around, they choose the most nutritive plants or parts of them, in order to fulfill their nutrient needs. In these circumstances they might consume some grasses, but always in low proportion compared to other forages with much better quality. The situation gets much worse when small ruminants are under confinement, either in paddocks or in corrals, and they are forced to eat the low quality grass forage. If they have no choice, they will consume it, but adequate performance can only be obtained if the grass diet is supplemented with other feeds, either agro-industrial by-products, crop residues or commercial feeds. Unless these supplements are of very low price, which is often not the case, this supplementation practice seldom pays back. When both limiting factors are combined, grass pastures with heavy internal parasite load, the results are disastrous: very slow growth rate of young animals and high mortality. These are the main reasons why the attractive market of small ruminant products has not been satisfied by local production.

Sheep farming is one of the important agri-based activities, which has been practiced by a large section of farmers in developing countries and plays an important role in income generation and improving the household nutrition. Sheep were domesticated approximately 10,000 years ago in Central Asia. Sheep and goat contribute about 47.3 million to national economy through various products and byproducts (*Rekib and Vihan, 1997*). Sheep and goats are a potential source of meat, milk, fibre, hide, manure for landless rural small and marginal farmers and provides dependable source of income to 40 per cent of rural population. Thus, the small ruminants have a very significant contribution in revenue generation through livestock products. Sheep is one of the livestock animals belonging to the family Bovidae and genus ovis (*Gillespie, 1997*). It also belongs to the specie aries within which many different breeds exist. Sheep give rise to three major products; meat, wool and skin with meat production given more attention in the tropical region. The sheep in the tropical region is best described as hairy although there is varying development of a woolly under coat (*Blakely and Bade, 1994*). The sheep in Nigeria is entirely of the hairy thin tailed West Africa long legged type kept primary for its meat and skin. Olaitan and Omonia (2006) outlined the breed of sheep kept in Nigeria to include Ouda, Y'ankasa, Bornu breed and West Africa dwarf sheep. West African dwarf sheep is the most commonly used because of its adaptation to humid environment and its resistance to the disease trypanosomiasis and its prolificacy (*Gillespie, 1997*). Sheep is very easy to manage, requiring little investments in housing, feeding, non-labor intensive and efficient in utilization of roughages and agricultural by products. Sheep plays important role in the socio-economic and cultural life of a Nigeria small holder farmer. In Nigeria particularly Ekiti State, sheep is kept for meat production and when disposed in the market serves as a source of income to farmers. It can be given as gift to important persons or offered to the gods during ceremonies. In all parts of Nigeria, the ram is mostly used for their Moslem festivities. Sheep rearing in Ekiti State generally tend to be associated with small holder agriculturists who have fewer resources for large scale production. Numerous factors are responsible for economic losses to Sheep industry, among them the health is of utmost importance. The small ruminant populations are frequently exposed to ravages of infectious diseases. The direct losses of the disease result from its high mortality, reduced milk production and meat yield, cost of treatment, control, disease diagnosis and surveillance. In addition to these, there are indirect losses due to the imposition of trade restrictions.

The characterization of local genetic resources depends on the knowledge of the variation in their morphological traits, which have played a very fundamental role in the classification of livestock based on size and shape (*Yakubu et al, 2010*). A study in Zaria (*Gefu, 2002*) revealed that 80% of respondents kept poultry, goats and sheep primarily to meet immediate household needs and also to supplement family income. Association of visible traits with important economic traits is perhaps the most important use to which this type of information can be put. The objective of this study is to determine and document phenotypic profiles of WAD indigenous sheep in Ekiti State by generating the phenotypic frequencies of visible traits. All visible traits that define a particular breed are considered in building the phenotypic profile of the characters. They present variable coat colors, ranging from black, brown, gray, red and white, and sometimes combinations of these in a variety of patterns (*Mourad et al., 2000*). The black and brown pigments in few Sheep were found as patches in minute parts of the breed. Apart from the relationship between white colorations and environmental stress, it is also of morphostructural importance as it affects the shoulder width of sheep (*Ozoje and Kadri, 2001*).

The body dimensions in different livestock species have been studied by many scientists. The assessment of the powers of body measurements in the estimation of weights and the accuracies of body weights in the estimation of size among livestock species has been widely reported. Body weight is the commonly reported measure of size (*Fitzhugh and Bradford, 1983*). The reliability of single measurements such as wither height, body length, hearth girth, rump height and width etc. in the estimation of weight at both traditional and institutional levels have been widely documented. Others have even used cephalic dimension as indicators of breed origin and relationships within species (*Jewel, 1993*). The relative genetic diversity can be determined using phenotypic characteristics and or molecular markers. Phenotypic characteristics, including adaptive characteristics such as trypanotolerance are important in identifying breed attributes in ways that are relevant to the immediate farming community's need and utility. Morphological descriptions have been used to rank animal proportions according to their levels of phylo-genetic destination (*Gatesy and Arctander, 2000*). Body measurements have also been used to assess type and function in beef and dairy cattle, sheep and goats and the animal's value as a potential breeding stock (*Fernandez et al, 1997; Luo et al, 1997; Alderson, 1999; Salako, 2006*). Apart from taking live weight of meat animals, researchers also use other parameters such as body length, width of pelvis, wither height, and chest girths in order to adequately evaluate live animals (*Attah et al, 2004*). Rump height has been preferred to wither height especially for describing cattle in beef cattle exhibitions and visual appraisal (*Alderson, 1999*).

1.1. PRODUCTION CONSTRAINTS / PROBLEM STATEMENT

Since the introduction of the small ruminants, the free ranging systems, with minimum or no management, have provided the meat that local populations demanded. Nevertheless, in most places it is no longer the case, production levels are insufficient and unable to supply the constantly increasing demands from local and regional markets. The most important losses in production come from offspring mortality due to starvation, malnutrition, myiasis from screwworm (*Cochliomyia hominivorax*) and parasitism, and unfortunately, also from predator attacks (mainly dogs) and theft. Most, if not all, these production constraints can be reduced or minimized with adequate installations and proper flock management.

Livestock production efficiency is to a large extent dependent on reproductive performance (*Nwaodu, 2008*). Lack of demand constrains production of sheep. The low production rate of sheep because of poor producer management is a serious restriction to the rate at which the supply responds to increases in prices and costs and translates into low return to investment. Sheep are not inherently poor producers. In fact, their biological potential is higher than cattle. Because of the high relative cost of inputs, few producers in developing countries are willing or able to make the necessary investment inputs to increase the production of their flocks. The result is that sheep production tends to be a low investment-low output activity. Although the lack of good management practices constrains the increase in the size of flocks, another factor is the physical incapability of the small producer to herd large numbers of animals, as is the case under extensive grazing.

The WAD Sheep production is also constrained by the following factors: low genetic potential, seasonality of availability of feed and scarce water resources, high ambient temperature, and mortality. However, Okoli *et al, (2000)* and Odeyinka and Okunade (2005) stated that other constraints to indigenous small ruminant production in the tropics include: diseases, accidents, seasonality of feed supply, theft, lack of capital and land. The problems of sheep production can neither be efficiently nor successfully solved until research concentrates on studying all of the related and interrelated components involved.

1.2. JUSTIFICATION

Body measurements and live weights taken on live animals have been used extensively for a variety of reasons both in experimental work and in selection practices (*Lawrence and Fowler, 2002*). In addition, they have been used as a means of selecting replacement animals (*Sowande and Sobola, 2008*). Body size and shape measured objectively could improve selection for growth by enabling the breeder to recognize early maturing and late maturing animals of different sizes. Measurement of various body conformations are of value in judging quantitative characteristics of meat animals and are also helpful in developing suitable selection criteria.

Body measurements have been used to evaluate breed performance and to characterize animals. The knowledge of morphological body measurements of sheep could be exploited to aid adequate management and production of sheep. The accuracy of functions used to predict live weight or growth characteristics from live animal measurements is of immense financial contribution to livestock production enterprise (*Afolayan et al, 2006*). Knowing the morphological measurements of WAD sheep will be very useful for good animal management, including understanding medication doses, adjusting feed supply, monitoring growth and choosing replacement males and females (*Slippers et al, 2000*). Knowledge on method of weight estimation will also be very useful in sheep production since most farmers do not have weighing scales for measuring live weight.

1.3. OBJECTIVES

1. To evaluate the different phenotypic variability of the body traits of WAD sheep.
2. To estimate the live body weight using the hearth girth.
3. To determine how body weight and other body measurements vary within and between the different locations.
4. To determine how sex affects the various body traits within and between the different locations.
5. To determine the economic profitability of carrying out the experiment and make useful recommendation from the results.

1.4. HYPOTHESIS

H_O: There are no significant differences between the location and various body traits in the three (3) LGA.

H_A: There are significant differences between the location and various body traits in the three (3) LGA.

H_O: There are no significant differences within the location and the various body traits in the three (3) LGA.

H_A: There are significant differences within the location and the various body traits in the three (3) LGA.

H_O: There are no significant differences between the sex and the various body traits in the three (3) LGA.

H_A: There are significant differences between the sex and various body traits in the three (3) LGA.

H_O: There are no significant differences between the various coat colours and sex of the Sheep in the three (3) LGA.

H_A: There are significant differences between the various coat colours and sex of the Sheep in the three (3) LGA.

H_O: There are no significant differences between the coat colours and the various body traits of the Sheep in the three (3) LGA.

H_A: There are significant differences between the coat colours and the various body traits of the Sheep in the three (3) LGA.

H_O: There is no significant difference between sex of Sheep and the three (3) LGA.

H_A: There is significant difference between sex of Sheep and the three (3) LGA.

H_O: There are no significant differences between the LGAs and various coat colours.

H_A: There are significant differences between the LGAs and various coat colours.

H_O: There is no significant difference in the phenotypic characteristics of West African Dwarf Sheep (WAD) in the three (3) LGA.

H_A: There is a significant difference in the phenotypic characteristics of West African Dwarf Sheep (WAD) in the three (3) LGA.

CHAPTER 2

2.0. LITERATURE REVIEW

2.1. SHEEP

Domestic sheep (*Ovis aries*) are quadrupedal, ruminant mammal typically kept as livestock. Like most ruminants, sheep are members of the order Artiodactyla, the even-toed ungulates. Although the name sheep applies to many species in the genus *Ovis*, in everyday usage it almost always refers to *Ovis aries*. Their original centre of domestication seems to be the Arlo Caspian steppes, including the area occupied by present day Iran and Iraq (*McLeroy, 1961*). Numbering a little over one billion, domestic sheep are also the most numerous species of sheep. An adult female sheep is referred to as a ewe, an intact male as a ram or occasionally a tup, a castrated male as a wether, and a younger sheep as a lamb. Sheep are most likely descended from the wild mouflon of Europe and Asia. One of the earliest animals to be domesticated for agricultural purposes, sheep is raised for fleece, meat (lamb, hogget or mutton) and milk. A sheep's wool is the most widely used animal fiber, and is usually harvested by shearing. Ovine meat is called lamb when from younger animals and mutton when from older ones. Sheep continue to be important for wool and meat today, and are also occasionally raised for pelts, as dairy animals, or as model organisms for science.

Sheep husbandry is practiced throughout the majority of the inhabited world, and has been fundamental to many civilizations. In the modern era, Australia, New Zealand, the southern and central South American nations, and the British Isles are most closely associated with sheep production. Sheep-raising has a large lexicon of unique terms which vary considerably by region and dialect. A group of sheep is called a flock, herd or mob. Many other specific terms for the various life stages of sheep exist, generally related to lambing, shearing, and age. Being a key animal in the history of farming, sheep have a deeply entrenched place in human culture, and find representation in much modern language and symbology. As livestock, sheep are most often associated with pastoral, Arcadian imagery. Sheep figure in many mythologies—such as the Golden Fleece—and major religions, especially the Abrahamic traditions. In both ancient and modern religious ritual, sheep are used as sacrificial animals.

2.2. Scientific classification and description of sheep

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Artiodactyla

Family: Bovidae

Subfamily: Caprinae

Genus: Ovis

Species: O. aries

Binomial name: Ovis aries

Linnaeus, 1758

2.3. Description/Attributes

Sheep is a ruminant animal characterized by enlarged four stomach compartment namely rumen, reticulum, omasum and abomasum. These stomach structures endowed them with the ability to utilize forage and non-protein substances to produce meat wool and skin. Sheep are very agile and graze easily in the most rugged of mountain terrain, where cattle choose not to feed. Furthermore, some sheep breeds are well suited to survive on sparse desert range that would not be used otherwise. Thus, sheep have the ability to convert the natural forage of these extreme habitats into protein for human uses. We use the proteins produced by sheep in the form of wool and lamb. Sheep can use practically all types of forage, including crop residue and even ditch banks. An abundance of forage is one key to profitable sheep production.

2.4. Some Advantages of Producing Sheep

1. Sheep are easy to handle and generally require little input.
2. Sheep production does not require elaborate facilities and equipment.
3. Sheep consume roughage as their primary feed.
4. Sheep help control weeds.
5. Sheep provide two sources of cash income: lamb and wool.
6. Sheep require a minimum amount of supplemental feeding.
7. Sheep can provide a quick return on investment.

2.5. Disadvantages of Producing Sheep

1. A sheep enterprise must be well managed.
2. Sheep are subject to predation by coyotes, eagles, Bobcats, lions, bears, domestic dogs, etc.
3. Sheep require better fencing than do cattle.
4. Internal parasites can create health problems when
5. Sheep are intensively grazed on irrigated pastures.

2.6. WEST AFRICAN DWARF (WAD) SHEEP

The West African Dwarf (also Djallonke) is a domesticated breed of sheep and is the dominant breed from southwest to central Africa. This breed is primarily raised for meat. The WAD Sheep is most predominantly found in the Southwest (*Adu and Ngere, 1979*). It is known by some other names such as West African Maned, Southern, Savannah-type, Pagan, Nigerian Dwarf, Lakka, Kirdimi, Kirdi, Guinean, Futa Jallon, Fouta Djallon, Forest-type, Djallonke and Cameroons Dwarf.

2.6.1. Characteristics of West African Dwarf (WAD) Sheep

The West African Dwarf is generally white, brown, black or piebald, the front half being black and the back half white. However, skewbald (tan on white) and the black belly pattern are found, and the Kirdi types are specially selected to be entirely black. Rams weigh approximately 37 kg (82 lb), have a well-developed throat ruff and are usually horned. The horns are wide at the base; curve backwards, outwards and then forwards again, with a maximum of one and a half coils. Ewes weigh about 25 kg (55 lb) and are usually polled (hornless), but may have slender short horns. The ears are short and pendulous, the neck is long and slender, the chest is deep, the legs are short, the back is long and dished, higher at the withers than at the tail-head, and the tail reaches the hocks.

On average, ewes produce 1.15 to 1.50 lambs per lambing. This breed grows slowly as evaluated in Nigeria in the last 1970s. This breed is also highly tolerant of trypanosome. Resistant to most diseases affecting most farm animals (*Aina, 2012*). This breed is thought to go into estrus throughout the year.

2.6.2. Distribution OF West African Dwarf (WAD) Sheep

The West African Dwarf sheep is found in West Africa, its range extending from Senegal to Chad, Gabon, Cameroon and the Republic of the Congo. It is adapted for life in humid forested area, sub-humid areas and savannahs. The Kirdi or Poulfouli is a wholly black variant found in Northern Cameroon and Southwestern Chad.

2.7. PHENOTYPIC CHARACTERS

Phenotypic characterization is important in breed identification and classification in ways that both research scientists and farming communities can relate with. Phenotypic characters have been used for classification and identification of animal populations. The relative genetic diversity can be determined using phenotypic characteristics and or molecular markers. Phenotypic characteristics, including adaptive characteristics such as trypanotolerance are important in identifying breed attributes in ways that are relevant to the immediate farming community's need and utility. Morphological descriptions have been used to rank animal proportions according to their levels of phylo-genetic destination (*Gatesy and Arctander, 2000*). Since characterization of a breed is the first approach to a sustainable use of its animal genetic resource; studies on diversity and variability between indigenous goats as well as sheep breeds on the basis of quantitative (morphostructural) and qualitative (morphological) variables have been extensively carried out on-station and on-farm in Southern Nigeria (*Orheruata et al., 1997; Ozoje and Kadri, 2001; Ozoje and Mgbere, 2002*).

Traditionally, animals are usually assessed visually, which is a subjective method of judgment *(Abanikannda, et al, 2002)*. Body measurements have been used to evaluate breed performance and to characterize breed of animals. In addition, it has been used as a means of selecting replacement animals (*Sowande and Sobola 2008*). Body measurements have also been used to assess type and function in beef and dairy cattle, sheep and goats and the animal's value as a potential breeding stock (*Brotherstone and Hill, 1991; Fernandez et al, 1997; Luo et al, 1997; Alderson, 1999; Salako, 2006*). Apart from taking live weight of meat animals, researchers also use other parameters such as body length, width of pelvis, wither height, and chest girths in order to adequately evaluate live animals (*Attah et al, 2004*). Rump height has been preferred to wither height especially for describing cattle in beef cattle exhibitions and visual appraisal (*Alderson, 1999*). Body size and body shape of sheep can be described using measurements and visual assessments. How those measurements of size and shape relate to the functioning of the individual animal is of paramount importance in livestock production since they affect management decision making (*Fourie et al, 2002*). Although small ruminant species are widely distributed, sheep remain neglected resources (*Devendra and McLeroy, 1982*) and the important role of this species in tropical agriculture is inadequately understood (*Wilson, 1983*). Many improved breeds are monotypic for most visible traits and have therefore made quantitative assessment easy to monitor over time.

Variation in traits such as coat color, ear size, heart girth, rump height, wither height, body weight, body length, tail length and nominal attributes such as presence and absence of horn could be of tremendous assistance in generating racial interspecific variations among animal populations within the species. Ewes typically weigh between 45 and 100kg while Rams weigh between 45 and 160kg. According to *Oseni et al. (2006)*, varied expression of qualitative traits may represent some adaptive mechanisms related to adaptation and survival in different ecological zones in the country. This is substantiated by the report of *Odubote (1994)* on the influence of certain qualitative traits on the genetic potential or adaptability of Nigerian goats and sheep. Hence, the need for the conservation of these unique genes for present and future use. This becomes expedient in view of the fact that high-level production crossbreds do not perform under the low-input management typical of the smallholder production system (*Rege and Gibson, 2003*). The weight of sheep fluctuates because of management system, pregnancy, gut fill, lactation, etc. Measurements of various body conformations are of value in judging quantitative characteristics of meat and developing suitable selection criteria. Moreover, because of the relative ease in measuring linear dimensions they can be used as an indirect way to estimate weight (*Getachew, 2008; ESGPIP, 2009*).

Due to the recent changes in climate, the extensive system of management of livestock exposes animals to the direct effects of various environmental fluctuations which may affect the phenotypic characteristics of such animals. Climate change has an influence on the nutrition and resistivity of animals to pest and disease infestations. Besides; uncontrolled breeding practised by farmers under the extensive management system has led to gene introgressions, thereby resulting in the eventual dilution of the gene pool of the WAD sheep. Indigenous sheep genetic resources have developed specific adaptations to survive and produce under adverse condition of climatic stresses, poor quality feed, seasonal feed and water shortage, endemic disease and parasite challenge that make them suitable for their use in the traditional, low-external-input production system (*IBC, 2004.*). Therefore, selection and breeding based on zoometric/morphometrical measurement, fast growth rate, good body size and conformation (*Zewdu et al, 2009*) could result in improvement in live weight of indigenous sheep and goat for meat production (*Sowande and Sobola, 2008; Sowande et al, 2010*). The productivity of sheep as in the case of most of the ruminants is markedly low due to several genetic and environmental factors (*Markos, 2006*).

The information on body measurement is the basis for the establishment of further advanced characterization, conservation, breeding and selection strategies for indigenous sheep breed (*Oke and Ogbonnaya, 2011; Ibrahim and Isa, 2011*) and used to assess the type and function and the value of the animal as potential breeding stocks (*Aamir et al, 2010*). Body measurements are well thought-out as qualitative development indicator which reflects the conformational fluctuations occurring during the life span of animals (*Sisay, 2009*). Correlation is one of the most common and useful statistics that describes the degree of relationship between two variables. Amongst body measurements, high correlation coefficient values have been found between chest girth and body weight (*Bello, and Adama, 2012*). In addition, the highest relationship among body measurements may be used as the selection criterion (*Khan et al., 2006*). The reports of Slippers *et al.* (2000); Badi *et al.* (2002); Grum (2010); Dereje (2011); Halima *et al.* (2012) and Yaekob *et al.* (2015) showed that chest girth was best parameter for estimating body weight due to high correlation estimates.

Analysis of morphometric variables that are easy to measure make it possible to explore areas such as the structure of breeds, the degree of variability between various populations, the harmony of morphological models and the definition of morphological models for a given breed. Hence, it is important to accurately analyse the morphological variables that enable us to distinguish between breeds, as well as explore the use of various discrimination methods to assess the potential of each of the variables under study (*Rodero et al. 2011*). Measurement of linear body parameters has been used to estimate necessary size in sheep. The use of quantitative information in livestock breeding programmes has become more sophisticated over time. This allows breeders to make faster progress in a chosen set of traits. Phenotypic information was initially used in mass selection, whereby individuals with better trait values were chosen to be parents of the next generation (*Carneiro et al. 2010*). This model has worked remarkably well and has allowed much progress in genetic merits.

Indigenous livestock breeds of Africa are well adapted to the local environment even though their productivity is generally lower when compared to other parts of the world. Attempts by breeders and farmers to improve the performance of the indigenous African breeds involves the introduction of exotic animals and crossbreeding practices, which is gradually leading to the erosion and complete masking of important survival traits, such as disease resistance associated with indigenous livestock as well as the extinction of certain breeds (*Gizaw et al. 2011*). The characterisation of African small ruminant populations will play a major role in the maintenance of these autochthonous genetic resources as the basis for future improvement at both the production and the genetic levels. This can be partly achieved through the analysis of morphological traits to assess variation within and between populations using classical multivariate analysis such as principal components and discriminant analysis, which have been shown to be suitable in assessing variation within and can discriminate different population types when all measured morphological variables are considered simultaneously (*Yakubu et al. 2010a; Legaz et al. 2011*). The principal component technique can reduce the information contained in the original complex of variables by eliminating redundant information due to correlation among them (*Cerqueira et al. 2011; Yakubu et al. 2011a*).

CHAPTER 3

3.0.MATERIALS AND METHODS

3.1.Study area and climate

The research was conducted in three different Local Government Areas (LGA) in Ekiti State; Ikole, Oye and Ado LGA. The coordinates for the three (3) locations were documented using a Global Positioning System (GPS).

Ekiti State is mainly an upland zone, rising over 250 meters above sea level. It lies on an area underlain by metamorphic rock. It is generally undulating country with a characteristic landscape that consists of old plains broken by step-sided out-crops that may occur singularly or in groups or ridges. Ekiti State enjoys tropical climate with two distinct seasons. The climate is of the Lowland Tropical Rain Forest type. These are the rainy season (April–October) and the dry season (November–March). Temperature ranges between 21° and 28 °C with high humidity. The south westerly wind and the northeast trade winds blow in the rainy and dry (Harmattan) seasons respectively. Tropical forest exists in the south, while savannah occupies the northern peripheries. (*Samuel, 1921*).

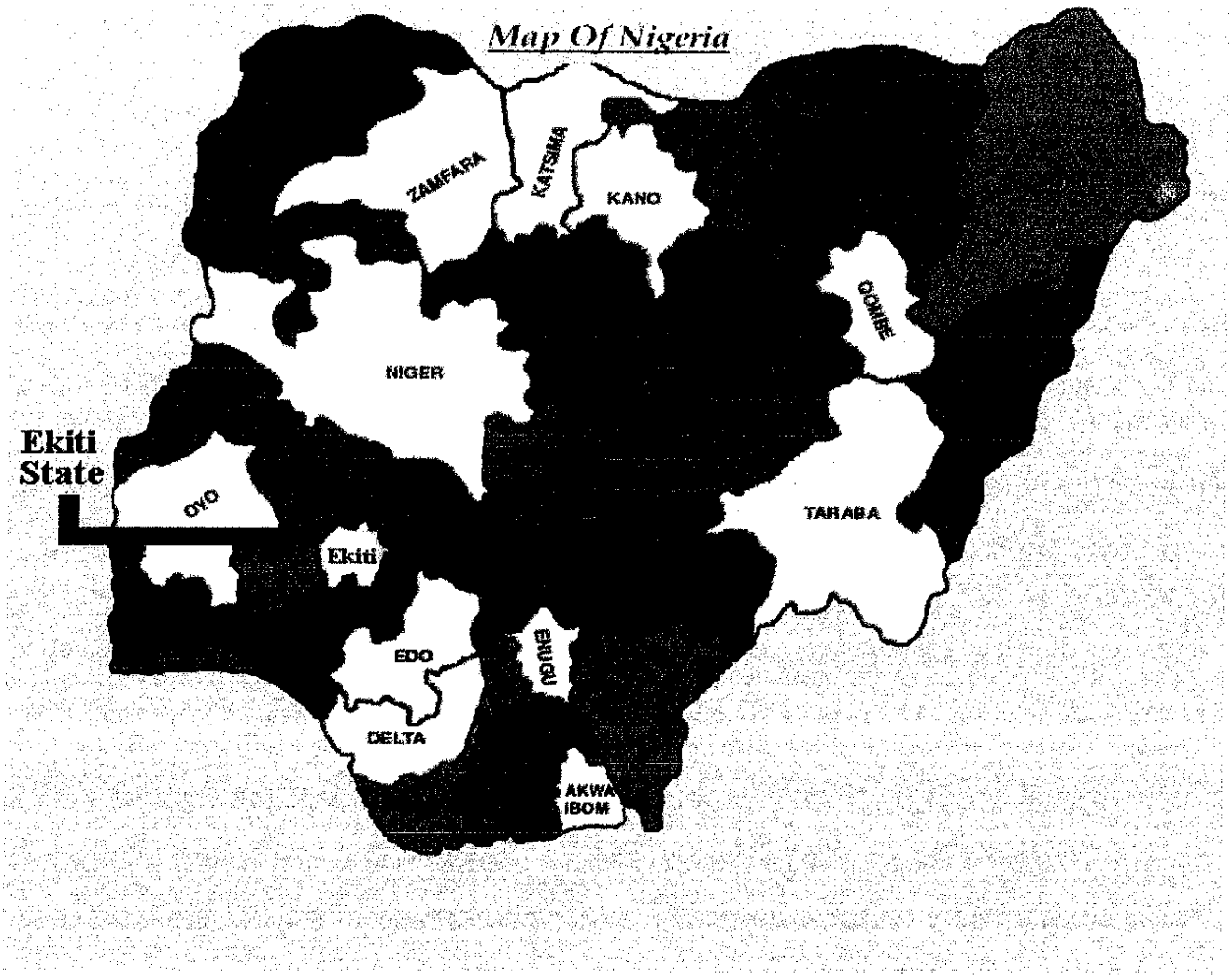
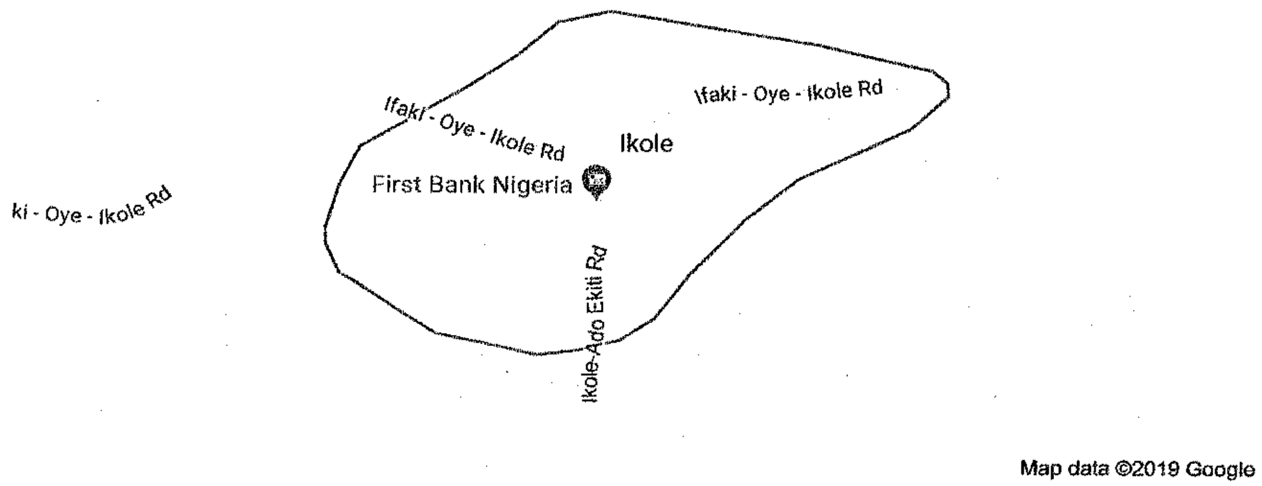


Fig. 3.1: Map of Nigeria showing Ekiti State

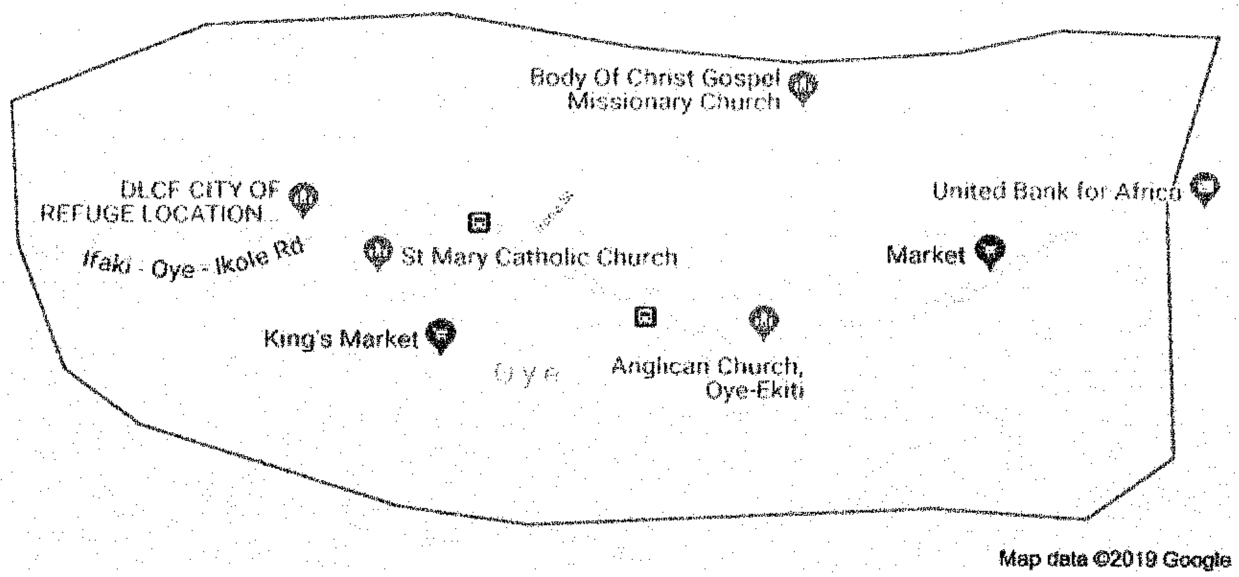
Ekiti State is located on **Latitude/longitude:** 07°40'00"N 05°15'00"E and **Altitude of** 373 m.



Map data ©2019 Google

Fig. 3.2: Map of Ikole Ekiti

Ikole is located on **Latitude/longitude:** 07°47′53.76″N 05°30′52.17″E and **Altitude of** 557.06m.



Map data ©2019 Google

Fig. 3.3: Map of Oye Ekiti

Oye is located on **Latitude/longitude:** 07°47′52.55″N 05°19′42.78″E and **Altitude of** 546.91m.

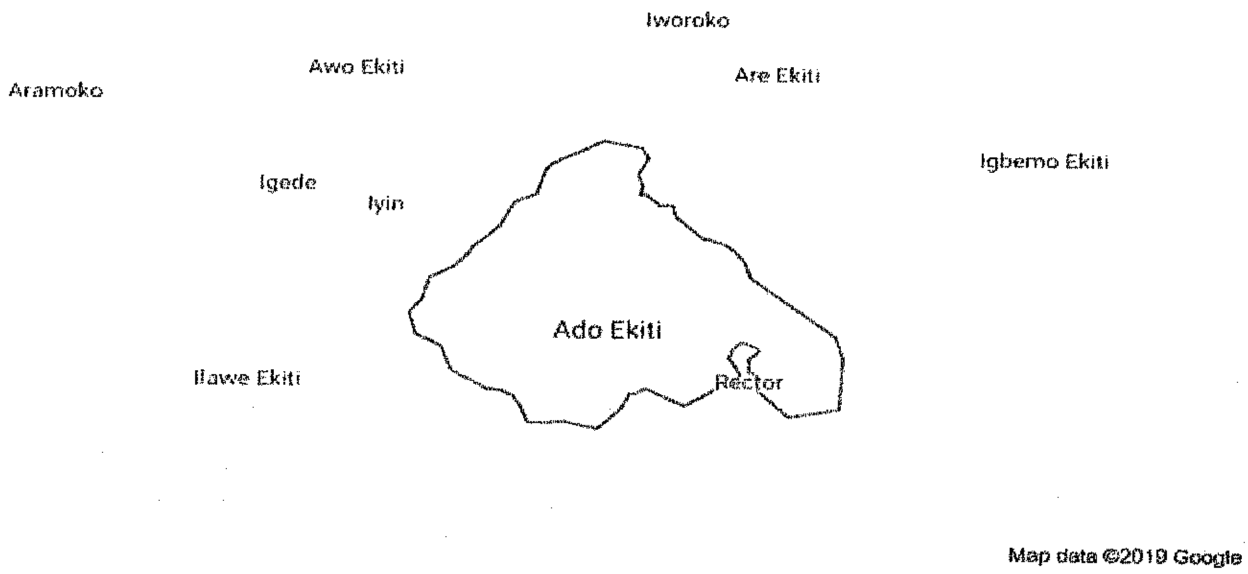


Fig.3.4: Map of Ado Ekiti

Ado is located on **Latitude/longitude:** 07°37′15.9996″N 05°13′17.0004″E and **Altitude of** 431m.

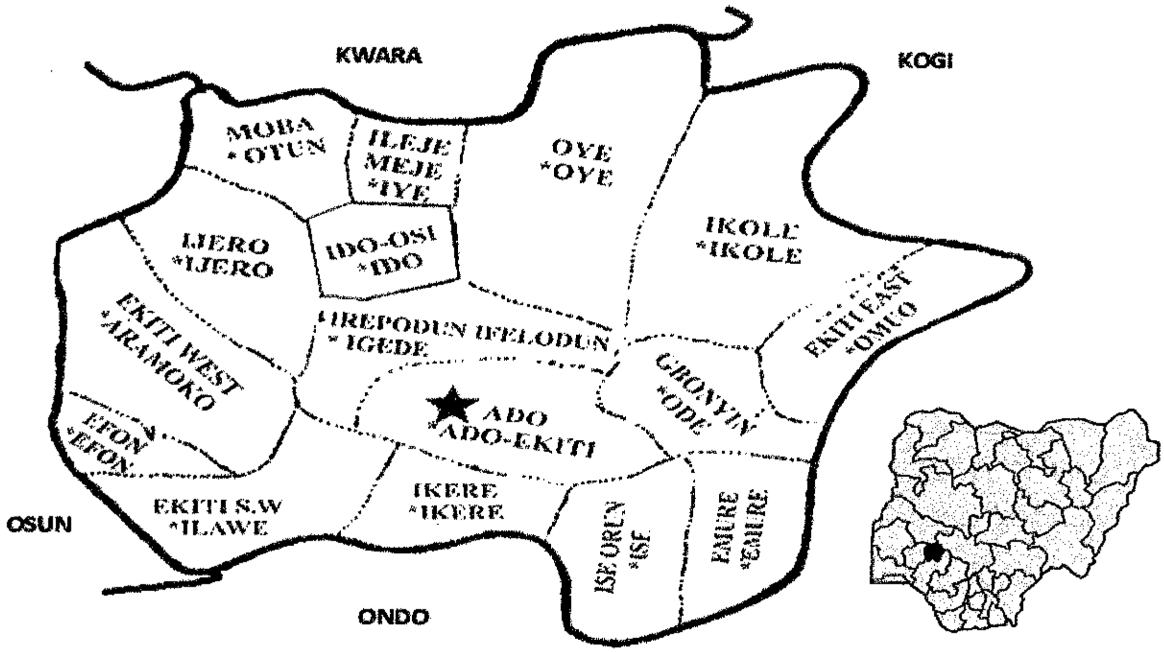


Fig. 3.5: Map of Ekiti State showing the three (3) local government areas where experiment was carried out; Ikole, Oye and Ado LGA

3.2.Collection of data

The data were collected randomly from one hundred and eighty (180) sheep; sixty (60) from each of the three (3) Local Government Areas (LGA) consisting of both males (30) and females (30) from different markets at Ado, Ikole and Oye Local Government Areas (LGA), Ekiti State. Prior to taking the measurements, the animals were identified in each location on the basis of species, breed/strain, coat colour, sex and age; only the adult WAD Sheep were considered for average uniformity. Ages of animals were provided by the farmers and verified using dentition method (*Sastry and Thomas, 1980*).

The traits considered during the collection were;

i. Sex
ii. Coat Color
iii. Ear length: This was measured from the point where the ear is attached to its tip.
iv. Heart girth: The circumference around the chest just behind the front legs and withers.
v. Body weight: The body weight (kg) was gotten using the heart girth measurement (cm) (done with a tape rule).
vi. Rump height: This is the distance from the surface of a platform to the rump.
vii. Wither height: The distance from the surface of a platform on which an animal stands, to the withers of the animal.
viii. Body length: The distance from the base of the tail to the tip of the head.
ix. Head length: This was measured from the tip of the skull at the mouth region to the point where the cervical vertebrae connect to the skull.
x. Tail length: This was measured as the distance between the beginning of the caudal vertebrae to its tip.

3.3.Body Traits Measurement

Table 3.1: Traits measured and means of measurement

Traits	Measured by
Coat colour	By visual appraisal
Sex	By visual appraisal
Ear length (cm)	Measuring tape
Heart girth (cm)	Measuring tape
Rump height (cm)	Measuring tape
Wither height (cm)	Measuring tape
Body length (cm)	Measuring tape
Head length (cm)	Measuring tape
Tail length (cm)	Measuring tape
Body weight (kg)	Using the heart girth measurement

The body weight (kg) was gotten using the heart girth measurement (cm) (done with a tape rule) according to the book of Ethnoveterinary medicine in Asia - An information kit on traditional animal health care practices (*IIRR, 1994*).

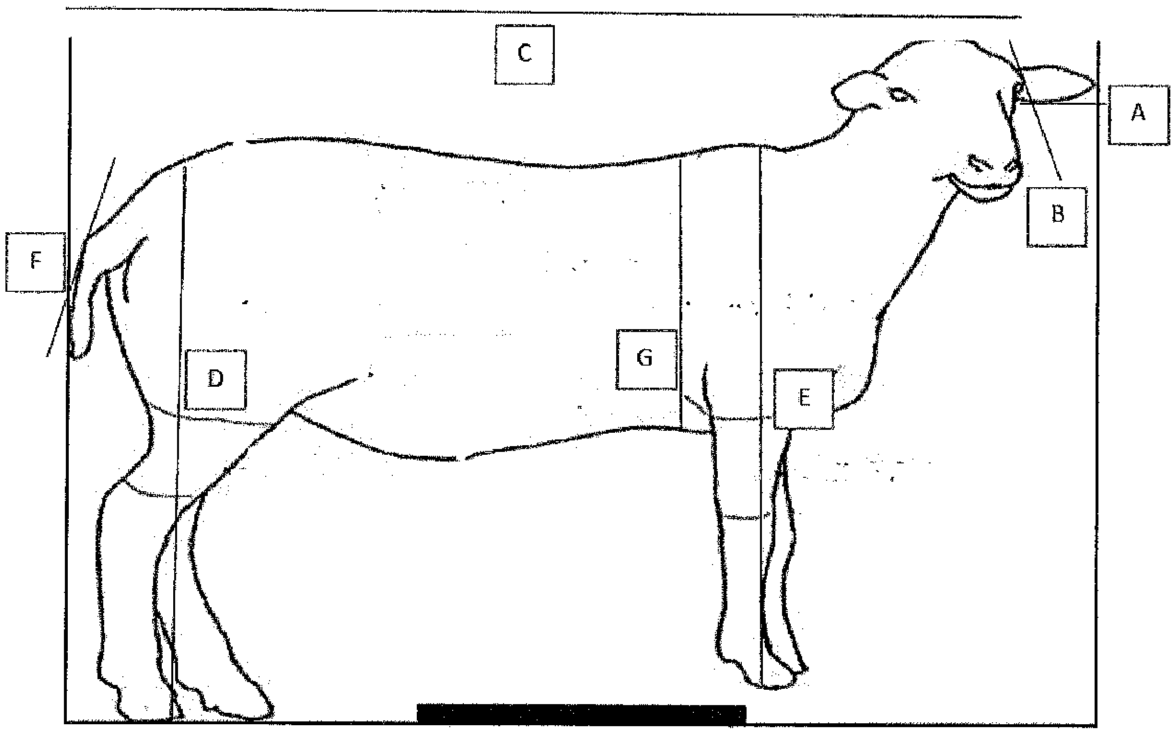


Fig 3.6: Typical diagram of a Sheep showing the various body linear measurements taken

Where;

A- Ear length

B- Head length

C- Body length

D- Rump height

E- Wither height

F- Tail length

G- Heart girth

3.4.Small ruminants

Measure the heart girth of small ruminants (Goats or Sheep) using a tape measure or string. Pull the tape tight. Use the table below to estimate the weight.

Table 3.2: Table showing various heart girth measurements for small ruminants (Sheep/Goat) used in determining the body weight

Heart girth		Body weight		Heart girth		Body weight	
(in)	**(cm)**	**(lb)**	**(kg)**	**(in)**	**(cm)**	**(lb)**	**(kg)**
10 ¾	27.3	5	2.3	18 ¾	47.6	25	11.3
11 ¼	28.6	5½	2.5	19¼	48.9	27	12.2
11 ¾	29.9	6	2.7	19 ¾	50.2	29	13.2
12 ¼	31.1	6½	3	20 ¼	51.4	31	14.1
12 3/	32.4	7	3.2	20 ¾	52.7	33	15
13 ¼	33.7	8	3.6	21 ¼	53.9	35	15.9
13 ¾	34.9	9	4.1	21 ¾	55.3	37	16.8
14 ¼	36.2	10	4.5	22 ¼	56.5	39	17.7
14 ¾	37.5	11	5	22 ¾	57.8	42	19.1
15 ¼	38.7	12	5.4	23¼	59.1	45	20.4
15 ¾	40	13	5.9	23 ¾	60.3	48	21.8
16 ¼	41.3	15	6.8	24¼	61.6	51	23.1
16 ¾	42.7	17	7.7	24 ¾	62.9	54	24.5
17¼	43.8	19	8.6	25¼	64.1	57	25.8
17 ¾	45.1	21	9.5	25 ¾	65.4	60	27.2
18 ¼	46.4	23	10.4	26 ¼	66 7	63	28.6

Heart girth		Body weight	
(in)	(cm)	(lb)	(kg)
26¾	67.9	66	29.9
27¼	69.2	69	31.3
27¾	70.5	72	32.7
28 ¼	71.7	75	34
28¾	73	78	35.4
29 ¼	74.3	81	36.7
29 ¾	75.6	84	38.1
30¼	76.8	87	39.5
30¾	78	90	40.8
31 ¼	79.4	93	42.2
31¾	80.7	97	44
32 ¼	81.9	101	45.8
32 ¾	83.2	105	47.6
33¼	84.5	110	499
33¾	85.7	115	52.2
34 ¼	87	120	54.4
34 ¾	88.3	125	56.7
35 ¼	89.5	130	59
35 ¾	90.8	135	61.2
36¼	92.1	140	63.5
36 ¾	93.4	145	65.8
37 ¼	94.6	150	68.1
37 ¾	95.9	155	70.3

38 ¼	97.2	160	72.6
38 ¾	98.4	165	74.8
39¼	99.7	170	77.1
39 ¾	101	175	79.4
40¼	102.2	180	81.6
40 ¾	103.5	185	83.9
41 ¼	104.8	190	86.2
41¾	106.1	195	88.4

Source: Sinn (1983)

3.5.Experimental design

The experimental design used was Randomized Complete Block Design (RCBD). There were three (3) locations considered.

3.6.Statistical procedure

Data collected from the experiment were analyzed using descriptive statistics and were subjected to Analysis Of Variance (ANOVA) test using the general linear model procedure of SAS (v 9.4) (SAS 2013) to test the fixed effects of location, sex and their interactions and also Pearson and Spearman Correlation Analysis of SAS (2013) was employed. Data collected were subjected to PROC MEAN and CORR procedures of SAS (v 9.4). Means were separated using Tukey's Honesty significant difference at 5% probability level , standard error and bar charts were drawn in excel. Data obtained was subjected to cross tabulation to determine if sex and location was associated with coat colours. The strengths of the associations were measured using Cramer's V. The distributions of coat colour were determined using Chi-square statistics.

3.7.Statistical model

$Y_{ijk} = \mu + \alpha_i + \beta_j + S_k + e_{ij}$

Where:

Y_{ij} = general observations (record of body weight and body linear measurements of each animal)

μ = overall mean

α_i = effect of phenotypic characteristics on their growth

β_j = effect of the location

S_k = effect of the sex

e_{ij} = systematic error (residual) associated with the survey

CHAPTER FOUR

4.0.RESULTS

4.1.Phenotypic Characteristics of West African Dwarf (WAD) sheep from 3 LGA in Ekiti State

Table 4.1: Number of sheep, coat/skin colour and sex used in the study

			Location				
Total	**Ikole**		**Oye**		**Ado**		
Coat colour/Sex	Female	Male	Female	Male	Female	Male	Total
White/black	11	21	12	6	10	7	67
Brown	6	7	11	2	4	9	39
Black	3	0	0	0	2	4	9
White/brown	7	2	1	5	0	3	18
White	3	0	6	17	14	7	47
Total	30	30	30	30	30	30	180

Table 4.1 shows the sex and coat colour distribution of the WAD Sheep sampled in the study areas. Most of the sheep in the study area were thin-tailed, and the most common type of tail in both rams and ewes was long thin-tailed having different coat colors. Majority of the farmers prefer to keep the females for breeding while the males were majorly sold out or slaughtered for festival or for personal consumption.

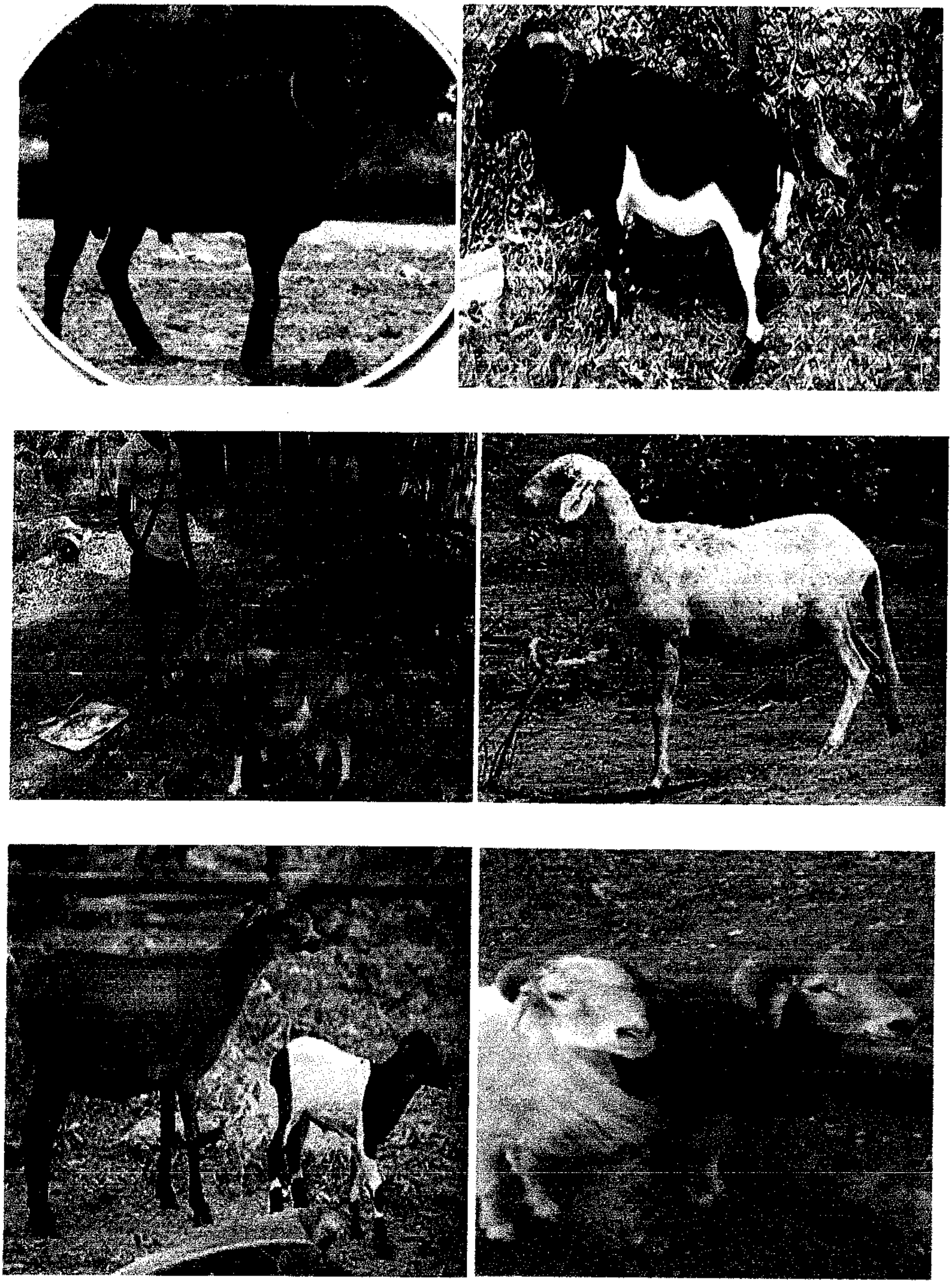


Fig. 4.1: Pictures of West African Dwarf (WAD) Sheep showing the various coat colours.

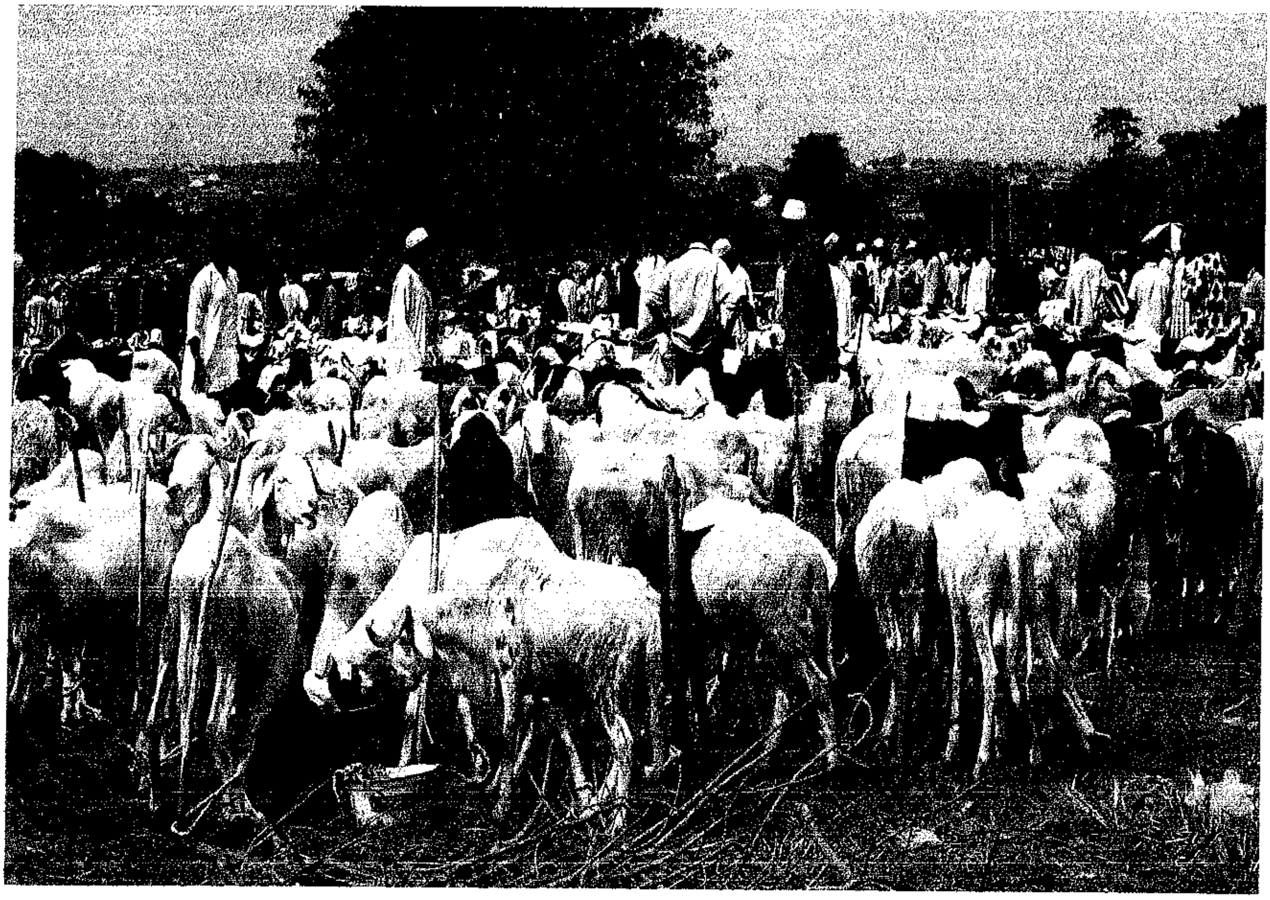


Fig 4.2: Flock of Sheep

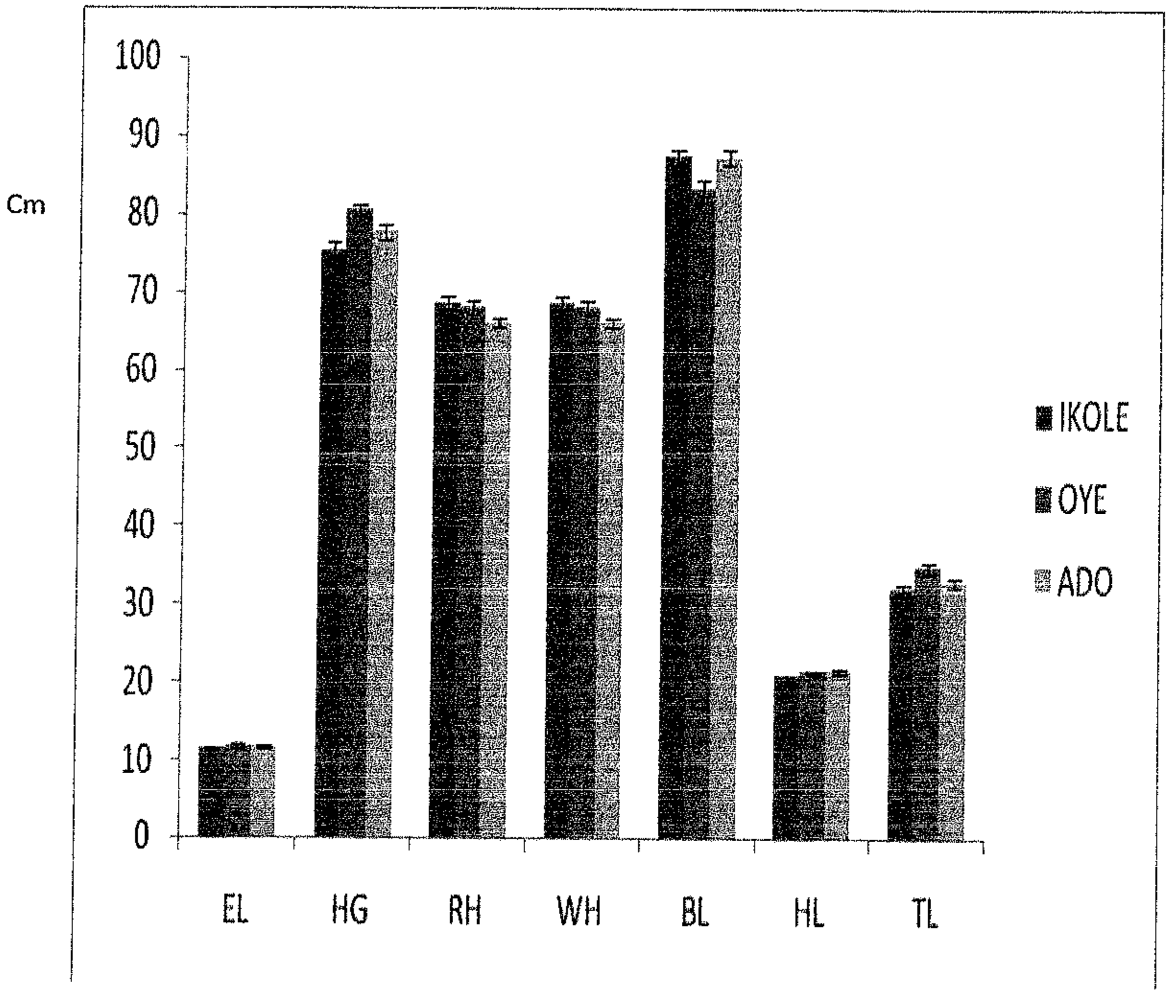


Figure 4.3: Phenotypic traits across the three locations

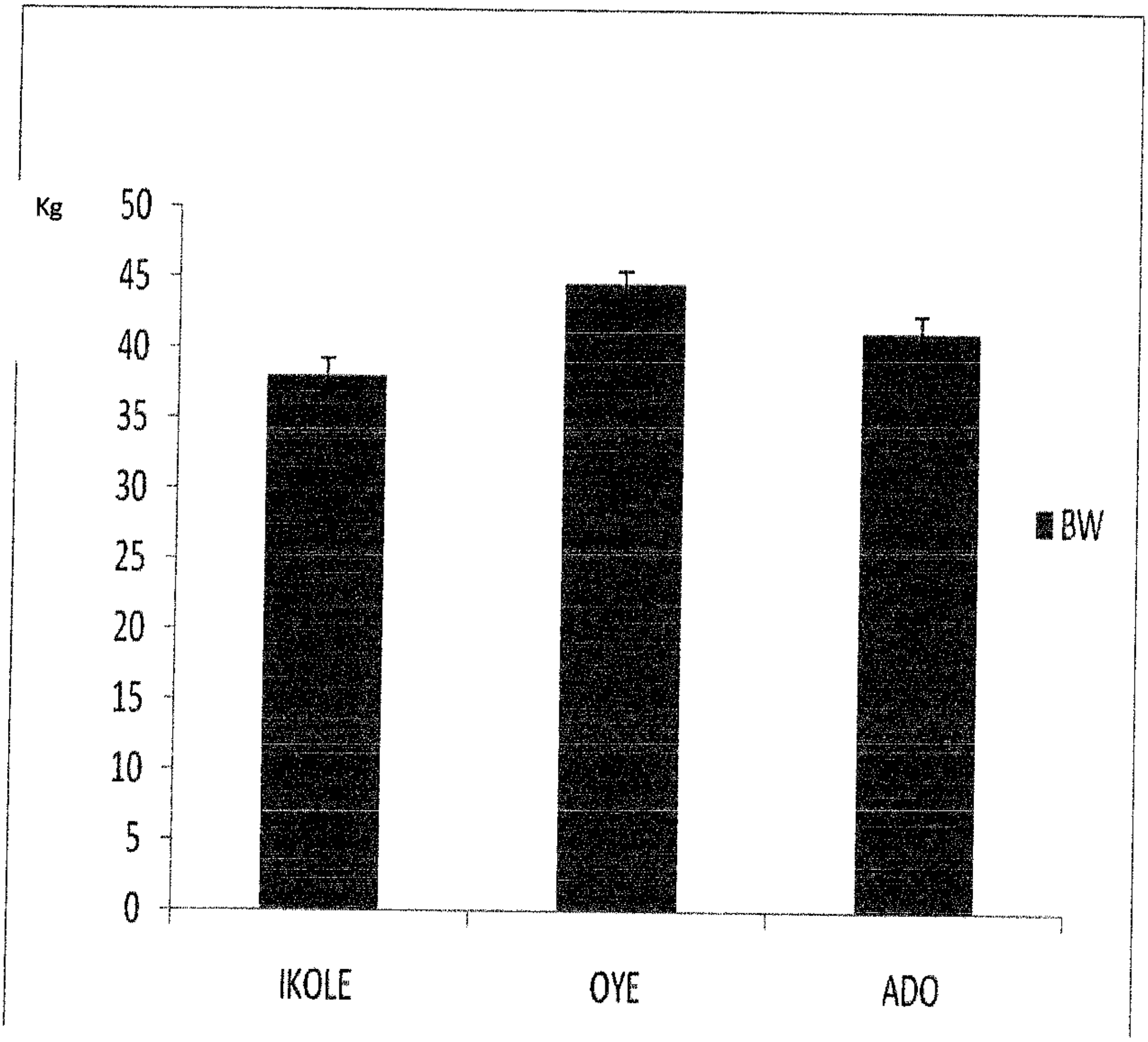


Figure 4.4: Body weight (Kg) across the three locations

4.1.1. Phenotypic characteristics of West African Dwarf (WAD) sheep in Ikole LGA

The effects of sex and colour and interaction on body traits are presented on Table 4.2a. The measurement taken from sheep in Ikole for different coat colour showed no significant differences ($p<0.05$) in all of the observed parameters for the different coat colours. There was slight numerical increase in values of white sheep over other colours for HG, BW, RH, WH, HL and TL. The least values were obtained for black in BW, HG, RH, WH, BL and TL., Also, Brown sheep is consistently higher than Black sheep for EL, HG, BW, RH, WH, BL and TL except for HL. Female was higher for parameters such as HG, BW, RH, WH and HL but lower than male for EL, BL and TL. Sex effect was not statistically significant ($p>0.05$) for all parameters except EL. Results showed that effect of interaction (colour x sex) showed no statistically significance ($p>0.05$) for all parameters. White colour x Female had consistently higher values for most parameters including HG, BW, RH, WH, HL and TL except EL and BL. Also, Black colour x Female had the least values for most parameters including HG, BW, RH, WH, BL and TL except in EL and HL. Results of measurement also showed that RH and WH values were the same for all the interactions.

Table 4.2a: Phenotypic characteristics of WAD sheep in Ikole LGA

COLOUR	SEX	EL	HG	BW	RH	WH	BL	HL	TL
WB		11.37±0.18	75.02±1.16	38±1.5	67.78±0.96	67.78±0.96	86.63±1.19	20.49±0.31	32.68±0.57
Black		11±0.58	71.67±4.33	33.97±4.65	67.33±2.85	67.33±2.85	82.67±6.57	21.67±1.2	30±1.73
Brown		11.46±0.29	75.77±2.14	38.18±2.73	69±1.78	69±1.78	91.85±1.64	21.15±0.71	30.62±0.63
White		10.67±0.67	80.67±0.33	43.97±0.33	76.67±1.86	76.67±1.86	84±2.08	22.67±1.33	33.67±1.2
	F	11.23±0.21^{b}	75.53±1.2	38.29±1.57	69.17±1.31	69.17±1.31	86.67±1.42	21.1±0.39	31.4±0.44
	M	11.43±0.2^{a}	75.07±1.48	37.99±1.86	67.77±0.96	67.77±0.96	88.2±1.36	20.5±0.39	32.9±0.75
WB	F	11.39±0.31	75.61±1.5	38.86±1.98	67.83±1.74	67.83±1.74	86.17±1.81	20.33±0.44	31.72±0.57
WB	M	11.35±0.21	74.57±1.73	37.33±2.2	67.74±1.08	67.74±1.08	87±1.6	20.61±0.44	33.43±0.89
Black	F	11±0.58	71.67±4.33	33.97±4.65	67.33±2.85	67.33±2.85	82.67±6.57	21.67±1.2	30±1.73
Brown	F	11.17±0.31	74.67±3.33	35.92±4.5	70.33±2.96	70.33±2.96	91.5±2.93	22.33±0.95	30±0.37
Brown	M	11.71±0.47	76.71±2.95	40.13±3.44	67.86±2.24	67.86±2.24	92.14±1.96	20.14±0.91	31.14±1.12
White	F	10.67±0.67	80.67±0.33	43.97±0.33	76.67±1.86	76.67±1.86	84±2.08	22.67±1.33	33.67±1.2
COLOUR		0.85	0.51	0.62	0.17	0.17	0.11	0.43	0.15
SEX		0.49	0.83	0.66	0.52	0.52	0.76	0.16	0.18
SEX*COLOUR		0.42	0.52	0.35	0.55	0.55	0.97	0.07	0.79

$^{a,\ b}$ *Means with different superscripts in a row differ significantly; $P \leq 0.05$- Significant, $P \leq 0.01$- Very significant, $P \leq 0.001$- Highly significant*

4.1.2. Phenotypic characteristics of WAD sheep in Oye LGA

Results showed that there were no significant differences ($p>0.05$) in all the parameters across the treatments (coat colours) except in BL1, HL1 and TL1 that were statistically significant ($p<0.05$). WBR had consistently higher values than other colours for most parameters including HG1, BW1, RH1, WH1 and HL1. The least values were obtained for white sheep for EL1, RH1, WH1, BL1, HL1 and TL1 except for HG1 and BW1. WB, WBR and Brown sheep had similar values ($p>0.05$) for BL1 (88.11, 85.17, 85.62), (22.06, 22.17, 21.85) for HL1 which were higher and significantly different ($P<0.05$) from White sheep BL1 (77.91) and HL1 (20.39). TL1 values were significantly different across all the colours with the highest being WB (37.33) and least White (32.57). RH1 and WH1 values were exactly the same for all the colours.

Results showed that among all the parameters, only EL1 differed significantly ($P<0.05$) across the sexes. Female had the highest values for all the parameters with the male having the least values consistently for all the parameters though RH1 and WH1 were the same for both sexes.

Results showed that the effect of interaction (colour x sex) were not significant ($P>0.05$) in all parameters measured. The highest values for EL1, BL1, HL1 and TL1 were obtained in WB x Female followed by WBR x Female. The least values for EL1, BL1, HL1 and TL1 were obtained in WB x Female followed by WBR x Female. Highest values for HG1 and BW1 were obtained for WBR x Male and least values were obtained WB x Male.

Table 4.2b: Phenotypic characteristics of WAD sheep in Oye LGA

COLOUR	SEX	EL1	HG1	BW1	RH1	WH1	BL1	HL1	TL1
WB		12.44±0.34	81±1.25	45.41±1.85	67.56±1.44	67.56±1.44	88.11±1.89^{a}	22.06±0.51^{a}	37.33±1.14^{a}
WBR		11.67±0.56	84±2.54	50.07±3.92	72.83±3.32	72.83±3.32	85.17±2.04^{a}	22.17±0.75^{a}	34.5±2.01^{b}
Brown		11.62±0.43	78.38±1.11	41.45±1.49	70.38±1.64	70.38±1.64	85.62±1.86^{a}	21.85±0.54^{a}	35.31±1.93^{ab}
White		11.43±0.21	80.09±1.16	44.36±1.65	65.91±1.09	65.91±1.09	77.91±0.92^{b}	20.39±0.24^{b}	32.57±0.88^{b}
	F	12.2±0.26^{a}	81.1±1	45.65±1.48	68.73±1.16	68.73±1.16	85.87±1.47	21.87±0.37	35.6±1.1
	M	11.4±0.2^{b}	79.67±0.95	43.57±1.34	67.4±1.13	67.4±1.13	80.87±1.13	20.9±0.29	33.97±0.85
WB	F	12.92±0.38	83.33±1.2	48.68±2.01	68.42±2.02	68.42±2.02	90.08±2.12	22.5±0.62	37.83±1.34
WB	M	11.5±0.5	76.33±1.78	38.87±2.07	65.83±1.49	65.83±1.49	84.17±3.46	21.17±0.83	36.33±2.26
WBR	F	12±.	82±.	46.1±.	73±.	73±.	88±.	23±.	37±.
WBR	M	11.6±0.68	84.4±3.08	50.86±4.7	72.8±4.07	72.8±4.07	84.6±2.4	22±0.89	34±2.39
Brown	F	11.73±0.51	78.18±1.31	41.25±1.76	71.09±1.87	71.09±1.87	86±2.19	21.82±0.64	36.09±2.21
Brown	M	11±0	79.5±0.5	42.55±0.75	66.5±0.5	66.5±0.5	83.5±0.5	22±0	31±1
White	F	11.67±0.33	81.83±3.32	47.6±4.8	64.33±1.23	64.33±1.23	76.83±1.35	20.5±0.43	30±0.93
White	M	11.35±0.26	79.47±1.09	43.21±1.48	66.47±1.4	66.47±1.4	78.29±1.16	20.35±0.3	33.47±1.07
p-values									
COLOUR		0.3576	0.597	0.5153	0.1854	0.1854	0.0003	0.05	0.033
SEX		0.1437	0.4595	0.4589	0.5674	0.5674	0.2743	0.3922	0.433
SEX*COLOUR		0.6487	0.2007	0.2192	0.5623	0.5623	0.4013	0.7183	0.2447

$^{a, b}$ *Means with different superscripts in a row differ significantly; P≤0.05- Significant, P≤0.01- Very significant, P≤0.001- Highly significant*

4.1.3. Phenotypic characteristics of West African Dwarf (WAD) sheep in Ado LGA

Results showed that colour effect on all parameters except HL2 was not significantly different ($p>0.05$). Highest values in most parameters including EL2, RH2, WH2 and TL2 were obtained for Black sheep. Brown sheep was higher for HG2, BW2, BL2. Lower values for most parameters were however obtained for WBR and WB. Also, though significant differences were observed in the HL2 values across the treatments, highest value of HL2 was obtained in WBR and least in WB.

Sex effect was not statistically significant ($P>0.05$) for RH2, WH2, BL2, HL2 and TL2. However, significant statistical differences ($P<0.05$) were observed in EL2, HG2 and BW2 across the sexes. Male had highest values for EL2, HG2, BW2 and TL2 but least values for RH2, WH2, BL2 and HL2 while Female had slight increases than Male for parameters like RH2, WH2, BL2 and HL2.

Results of measurement revealed that there were no significant differences ($P>0.05$) in all the parameters across all interaction (colour x sex).

Results showed that the effect of interaction (colour x sex) did not significantly ($P>0.05$) in all parameters measured. The highest values for EL1, BL1, HL1 and TL1 were obtained in WB x Female followed by WBR x Female. The least values for EL1, BL1, HL1 and TL1 were obtained in WB x Female followed by WBR x Female. Highest values for HG1 and BW1 were obtained for WBR x Male and least values were obtained WB x Male.

Table 4.2c: Phenotypic characteristics of WAD sheep in Ado LGA

COLOUR1	SEX2	EL2	HG2	BW2	RH2	WH2	BL2	HL2	TL2
WB		11.47±0.38	77.71±1.66	41.39±2.23	65.82±1.36	65.82±1.36	86.12±1.63	20.29±0.44^{b}	32.94±0.83
WBR		11±0	73±1.53	35.37±1.6	64.67±1.2	64.67±1.20	85.67±0.33	23.00±0.58^{a}	28.33±0.67
Black		11.83±0.31	78±3.07	41.78±3.9	67.83±1.35	67.83±1.35	84.50±3.03	21.33±0.84^{b}	34.33±1.80
Brown		11.62±0.29	78.69±2.43	43.05±3.23	64.38±1.4	64.38±1.40	88.69±2.60	21.69±0.60^{b}	33.08±1.03
White		11.71±0.21	77.57±1.32	41.03±1.67	67.1±1.11	67.10±1.11	88.43±1.52	22.14±0.45^{a}	33.24±0.92
	F	11.27±0.19^{b}	75.87±1.09^{b}	38.8±1.31^{b}	66.73±1.03	66.73±1.03	88.80±1.26	21.50±0.43	32.97±0.69
	M	11.93±0.21^{a}	79.47±1.34^{a}	43.92±1.82^{a}	65.47±0.78	65.47±0.78	85.80±1.37	21.47±0.34	33.00±0.74
WB	F	10.8±0.33	75.3±1.89	38.01±2.11	67.1±1.86	67.1±1.86	85.90±2.23	19.90±0.57	33.10±1.16
WB	M	12.43±0.69	81.14±2.63	46.21±4	64±1.9	64±1.9	86.43±2.54	20.86±0.67	32.71±1.27
WBR	M	11±0	73±1.53	35.37±1.6	64.67±1.2	64.67±1.2	85.67±0.33	23.00±0.58	28.33±0.67
Black	F	11.5±0.5	81.5±3.5	45.75±4.95	68.5±2.5	68.5±2.5	86.00±0.00	20.50±1.50	34.50±0.50
Black	M	12±0.41	76.25±4.29	39.8±5.48	67.5±1.85	67.5±1.85	83.75±4.73	21.75±1.11	34.25±2.84
Brown	F	11.5±0.65	69.25±1.89	31.03±2	64±3.67	64±3.67	89.75±5.04	23.75±0.75	30.50±1.04
Brown	M	11.67±0.33	82.89±2.26	48.4±3.21	64.56±1.42	64.56±1.42	88.22±3.21	20.78±0.60	34.22±1.26
White	F	11.5±0.25	77.36±1.44	40.6±1.83	67±1.48	67±1.48	91.00±1.59	22.14±0.59	33.36±1.18
White	M	12.14±0.34	78±2.89	41.9±3.6	67.29±1.7	67.29±1.7	83.29±2.37	22.14±0.70	33.00±1.57
COLOUR		0.57	0.44	0.47	0.54	0.54	0.83	0.03	0.25
SEX		0.04	0.05	0.05	0.62	0.62	0.24	0.75	0.58
SEX*COLOUR		0.34	0.02	0.03	0.75	0.75	0.40	0.05	0.50

$^{a,\ b}$ *Means with different superscripts in a row differ significantly; P≤0.05- Significant, P≤0.01- Very significant, P≤0.001- Highly significant*

4.1.4. Least square mean of the linear measurement and weight of Sheep in Three (3) LGA of Ekiti

The effect of coat colour; location; sex; location and colour; sex and colour; location and sex; location, sex and colour on the different body traits between the three (3) locations are shown in table 4.2d.

The phenotypic parameter examined from WAD sheep in Ekiti State show that the coat colour has no significant effect on the phenotypic parameters of the animals except for the BL, brown and white were having higher significant body length than mixed colour and black.

There was significant increase in some parameters at location. HG, BW and TL were significantly highest in Oye than other locations with the least in Ikole. BL, WH and RH were significant higher in Ikole than other locations.

Sexes showed no significant difference among the examined parameters but males were numerically higher in values than their female counterpart for all the observed parameters, showing a sense of sexual dimorphism.

The interaction levels between location and the coat colour did not show significant differences in most of the observed parameter, except in RH, WH, HL and TL. HG and BW were significantly affected by interactions between sexes and the coat colour; while EL, HG and BW were significantly affected by location and sexes. Interactions among Location, sex and coat colour did not significantly affect any of the observed parameters.

Table 4.2d: Least square mean of the linear measurement and weight of Sheep in the three LGA of Ekiti

Location	SEX	COLOUR	EL	HG	BW	RH	WH	BL	HL	TL
		WB	11.64±0.16	77.04±0.83	40.51±1.09	67.29±0.69	67.29±0.69	86.87±0.85^{ab}	20.82±0.24	33.84±0.5
		WBR	11.44±0.38	80.33±2.5	45.17±3.55	70.11±2.56	70.11±2.56	85.33±1.32^{ab}	22.44±0.53	32.44±1.67
		black	11.56±0.29	75.89±2.57	39.18±3.14	67.67±1.2	67.67±1.2	83.89±2.74^{ab}	21.44±0.65	32.89±1.46
		brown	11.56±0.19	77.62±1.13	40.9±1.49	67.92±1	67.92±1	88.72±1.24^{a}	21.56±0.35	33±0.8
		white	11.51±0.15	79±0.83	42.85±1.11	67.13±0.82	67.13±0.82	83±1.11^{b}	21.32±0.28	32.94±0.59
Ado			11.6±0.15^{ab}	77.67±0.89^{b}	41.36±1.16^{b}	66.1±0.65^{b}	66.1±0.65^{b}	87.3±0.94^{a}	21.48±0.27	32.98±0.5
Ikole			11.33±0.14^{b}	75.3±0.95^{c}	38.14±1.2^{c}	68.47±0.81^{a}	68.47±0.81^{a}	87.43±0.98^{a}	20.8±0.28	32.15±0.44
Oye			11.8±0.17^{a}	80.38±0.69^{a}	44.61±1^{a}	68.07±0.81^{ab}	68.07±0.81^{ab}	83.37±0.97^{b}	21.38±0.24	34.78±0.7
	F		11.57±0.14	77.5±0.68	40.92±0.9	68.21±0.68	68.21±0.68	87.11±0.8	21.49±0.23	33.32±0.49
	M		11.59±0.12	78.07±0.76	41.83±1.01	66.88±0.56	66.88±0.56	84.96±0.8	20.96±0.2	33.29±0.45
COLOUR			0.71	0.71	0.72	0.41	0.41	0.04	0.13	0.26
Location			0.20	0.00	0.00	0.02	0.02	0.04	0.85	0.04
SEX			0.73	0.85	0.70	0.57	0.57	0.30	0.39	0.97
Location*COLOUR			0.42	0.07	0.07	0.04	0.04	0.05	0.03	0.03
SEX*COLOUR			0.98	0.03	0.03	0.73	0.73	1.00	0.31	0.73
Location*SEX			0.01	0.00	0.00	0.86	0.86	0.58	0.95	0.30
Location*SEX*COL			0.16	0.27	0.40	0.65	0.65	0.15	0.13	0.08

$^{a, b, ab}$ *Means with different superscripts in a row differ significantly; P≤0.05- Sig, P≤0.01- Very sig, P≤0.001- Highly sig*

4.2.Phenotypic Correlation of West African Dwarf (WAD) sheep from 3 LGA in Ekiti State

4.2.1. Phenotypic Correlation of body traits in Ikole LGA

Bivariate phenotypic correlation of WAD sheep in Ikole LGA using **Pearson's and Spearman correlation coefficient** is presented in Table 4.2ai and 4.2aii respectively. Phenotypic correlation of the measured parameters showed that only a few of the parameters have significantly different correlation ($p<0.05$). Also, that the highest significant correlation was between RH and WH ($r=1.000$ $P<0.01$) followed by correlation between HG and BW ($r=0.962$ $P<0.05$). The strongest positive correlation ($p<0.05$) were observed between HG and BW and RH and WH while the weakest positive correlation ($p>0.05$) was observed in correlation of RH-EL and WH-EL which are not significantly different. The strongest negative correlation was found in HL-EL and the weakest negative correlation was found in HL-TL.

Table 4.3ai: Phenotypic Pearson`s correlation of body traits of WAD sheep in Ikole LGA

Correlations

	EL	HG	BW	RH	WH	BL	HL	TL
EL		0.207	0.215	0.016	0.016	0.193	-0.113	0.214
HG			.962(**)	.325(*)	.325(*)	0.09	-0.072	0.23
BW				.339(**)	.339(**)	0.038	-0.088	0.236
RH					1.000(**)	.275(*)	0.07	0.212
WH						.275(*)	0.07	0.212
BL							0.168	0.106
HL								-0.035
TL								

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.3aii: Phenotypic Spearman correlation of body traits of WAD sheep in Ikole LGA

	EL	HG	BW	RH	WH	BL	HL	TL
EL		.122	.104	.067	.067	.229	-.096	.059
HG			.952**	.311*	.311*	.108	-.007	.201
BW				.305*	.305*	.058	-.005	.200
RH					1.000**	.300*	.069	.168
WH						.300*	.069	.168
BL							.169	.018
HL								.098
TL								

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

4.2.2. Phenotypic Correlation of body traits in Oye LGA

Bivariate phenotypic correlation of WAD sheep in Oye LGA using **Pearson's and Spearman correlation coefficient** is presented in Table 4.2bi and 4.2bii respectively. Results of phenotypic correlation reveals that correlation of most of the parameters are of statistical significance ($p<0.05$) with no negative correlations. Phenotypic correlation of parameters ranges from 0.134 to 1.000. Also, that the strongest significant correlation was between RH and WH (1.000) followed by correlation between HG and BW (0.992), BL-HL (0.860) and EL-BL (0.768) correlation respectively. The weakest correlation existed in EL-RH and EL-WH correlations respectively.

Table 4.3bi: Phenotypic Pearson`s correlation of body traits of WAD sheep in Oye LGA

Correlations

	EL	HG	BW	RH	WH	BL	HL	TL
EL		.604(**)	.614(**)	0.134	0.134	.768(**)	.672(**)	.645(**)
HG			.992(**)	0.15	0.15	.416(**)	.390(**)	.283(*)
BW				0.141	0.141	.394(**)	.369(**)	.269(*)
RH					1.000(**)	.277(*)	.303(*)	.258(*)
WH						.277(*)	.303(*)	.258(*)
BL							.860(**)	.712(**)
HL								.661(**)
TL								

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 4.3bii: Phenotypic Spearman correlation of body traits of WAD sheep in Oye LGA

	EL	HG	BW	RH	WH	BL	HL	TL
EL		.597**	.597**	.045	.045	.719**	.631**	.597**
HG			1.000**	.075	.075	.437**	.384**	.286*
BW				.075	.075	.437**	.384**	.286*
RH					1.000**	.217	.239	.187
WH						.217	.239	.187
BL							.845**	.708**
HL								.613**
TL								

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

4.2.3. Phenotypic Correlation of body traits in Ado LGA

Bivariate phenotypic correlation of WAD sheep in Ado LGA using **Pearson's and Spearman correlation coefficient** is presented in Table 4.2ci and 4.2cii respectively. Results showed that phenotypic correlation is significant ($P<0.05$) among only few of the parameters at the same time with a few negative correlations. Positive correlation ranged from 0.082 to 1.00 while negative correlation ranged from -0.033 to -0.132. The strongest positive correlation existed between RH-WH (1.000) while the weakest was found in EL-HL (0.004) correlation. The strongest negative correlation existed between HG and HL (-0.132) while the weakest negative correlation existed between RH-TL (-0.033) and WH-TL (-0.033) correlations respectively.

Table 4.3ci: Phenotypic Pearson`s correlation of body traits of WAD sheep in Ado LGA

Correlations

	EL	HG	BW	RH	WH	BL	HL	TL
EL		.412(**)	.444(**)	0.082	0.082	-0.051	0.004	0.087
HG			.991(**)	0.149	0.149	0.055	-0.132	0.191
BW				0.14	0.14	0.053	-0.117	0.209
RH					1.000(**)	0.011	0.02	-0.033
WH						0.011	0.02	-0.033
BL							0.056	0.022
HL								0.034
TL								

** Correlation is significant at the 0.01 level (2-tailed).

Table 4.3cii: Phenotypic Spearman correlation of body traits of WAD sheep in Ado LGA

	EL	HG	BW	RH	WH	BL	HL	TL
EL		.369**	.369**	.068	.068	-.057	.045	.082
HG			1.000**	.226	.226	0.28	-.134	.223
BW				.226	.226	.028	-.134	.223
RH					1.000**	-.012	.002	.052
WH						-.012	.002	.052
BL							.031	.065
HL								.046
TL								

** Correlation is significant at the 0.01 (2-tailed)

4.3. Pooled Phenotypic Correlation of WAD Sheep from the three (3) LGA in Ekiti State

Table 4.4: Pearson correlation coefficient of traits of selected Sheep in Ikole, Oye and Ado LGA of Ekiti State

	EL	HG	BW	RH	WH	BL	HL	TL
EL	1.00***							
HG	0.21^{ns}	1.00***						
BW	0.22^{ns}	0.96***	1.00***					
RH	0.02^{ns}	0.32*	0.34**	1.00***				
WH	0.02^{ns}	0.32*	0.34**	1.00***	1.00***			
BL	0.19^{ns}	0.09^{ns}	0.04^{ns}	0.28*	0.28*	1.00***		
HL	-0.11^{ns}	-0.07^{ns}	-0.09^{ns}	0.07^{ns}	0.07^{ns}	0.17^{ns}	1.00***	
TL	0.21^{ns}	0.23^{ns}	0.24^{ns}	0.21^{ns}	0.21^{ns}	0.11^{ns}	-0.04^{ns}	1.00***

Ns = Non significant, *= $p \leq 0.05$, **= $p \leq 0.01$, ***= $p \leq 0.001$

A pair of trait with *** means the traits are perfectly correlated and significant at p= 0.001 (i.e. 0.1%level), a pair of trait with ** are positively correlated at p= 0.01 (i.e at 1% level of significance), a pair if traits with * are positively correlated but significant at p= 0.05 (5% level), a pair of trait with **ns** may either be positively or negatively correlated but not significant.

Table 4.5: Pooled phenotypic correlation of WAD sheep from different LGA in Ekiti

Correlations

	EL	HG	BW	RH	WH	BL	HL	TL
EL		.415**	.442**	0.071	0.071	.285**	.209**	.398**
HG			.980**	.197**	.197**	0.087	0.055	.281**
BW				.194**	.194**	0.075	0.059	.285**
RH					1.000**	.178*	0.108	.160*
WH						.178*	0.108	.160*
BL							.316**	.255**
HL								.268**
TL								

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Pooled phenotypic correlation of WAD Sheep in the three (3) locations is presented in table 4.5 above. The result revealed that there was significant, positive and higher correlation of some parameters with the Body weights of the examined WAD sheep in the zone. EL (0.44) and HG (0.98) were moderately and highly correlated with the body weight; while RH (0.194), WH (0.194) and TL (0.281), though positive, were lowly correlated with the body weight of the examined animals. All observed parameters were significant, positive and lowly correlated with TL. All the parameters except EL and BL were not significant with HL.

4.4. Distribution of the Qualitative Traits of WAD Sheep

Table 4.6a: Frequency table of LGA by coat colour

LGA		White	White/ Black	Brown	White/ Brown	Black	Total
Ikole	**Frequency**	3	32	13	9	3	60
	Percent	1.67	17.78	7.22	5	1.67	33.34
Oye	**Frequency**	23	18	13	6	0	60
	Percent	12.78	10	7.22	3.33	0	33.33
Ado	**Frequency**	21	17	13	3	6	60
	Percent	11.67	9.44	7.22	1.67	3.33	33.33
Total	**Frequency**	47	67	39	18	9	180
	Percent	26.12	37.22	21.66	10	5	100

Table 4.6a shows the frequency and percentage of the relationship between LGA and coat colour. White coat colour was highest in Oye LGA followed by Ado LGA, and then Ikole. White/Black coat colour was more in Ikole LGA, followed by Oye LGA, then Ado LGA. Brown coat colour was observed equally among the three (3) LGA. White/Brown coat colour was more in Ikole LGA, followed by Oye LGA, then Ado LGA. Black coat colour was observed more in Ado LGA, then Ikole LGA but none was observed in Oye LGA.

Table 4.6b: Statistics for table of LGA by coat colour

Statistic	DF	Value	P-value
Chi-Square	12	57.0132	<.0001
Likelihood Ratio Chi-Square	12	68.6257	<.0001
Mantel-Haenszel Chi-Square	1	0.0558	0.8133
Phi Coefficient		0.5628	
Contingency Coefficient		0.4905	
Cramer's V		0.3980	

P-value = probability with values in parenthesis

The chi-square distribution of the qualitative traits of the experimental WAD sheep revealed that LGA was significantly (P < 0.001) associated with coat colours of the Sheep. The Cramer's V of 0.398 indicated a moderate association.

Table 4.6c: Summary Statistics for LGA by coat colour

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.0558	0.8133
2	Row Mean Scores Differ	2	5.1187	0.0774
3	General Association	12	56.6964	<.0001

Total Sample Size = 180

The general association was significant (P<0.0001)

Table 4.7a: Frequency table of sex by coat colour

SEX		White	White/ Black	Brown	White/ Brown	Black	Total
Male	**Frequency**	24	34	18	10	4	90
	Percent	13.33	18.89	10	5.55	2.22	49.99
Female	**Frequency**	23	33	21	8	5	90
	Percent	12.78	18.34	11.67	4.45	2.78	50.01
Total	**Frequency**	47	67	39	18	9	180
	Percent	26.11	37.23	21.67	10	5	100

White, White/Black, White/Brown coat colours were observed more in the males than the females while Brown, Black coat colours were observed more in the males. Generally, the females had a higher percentage for all the coat colours observed.

Table 4.7b: Statistics for Table of sex by coat colour

Statistic	DF	Value	P-value
Chi-Square	6	9.6013	0.1425
Likelihood Ratio Chi-Square	6	10.5656	0.1028
Mantel-Haenszel Chi-Square	1	1.1251	0.2888
Phi Coefficient		0.2310	
Contingency Coefficient		0.2250	
Cramer's V		0.2310	

P-value = probability with values in parenthesis

The chi-square distribution of the qualitative traits of the experimental WAD sheep revealed that sex was not significantly (P > 0.001) associated with coat colours of the Sheep. The Cramer's V of 0.231 indicated no association.

Table 4.7c: Summary Statistics for sex by colour

Cochran-Mantel-Haenszel Statistics (Based on Table Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	1.1251	0.2888
2	Row Mean Scores Differ	1	1.1251	0.2888
3	General Association	6	9.5479	0.1450

Total Sample Size = 180

The general association was not significant (P>0.0001).

CHAPTER FIVE

5.0. DISCUSSION

5.1. Phenotypic Characteristics of West African Dwarf (WAD) sheep in 3 LGA in Ekiti State

Sex is a key determinant of price in livestock marketing as consumers buy animals for specific purposes especially during festive occasions (*Birteeb and Dickson, 2016*). Fur/Coat texture of sheep could also influence price because animals with rough coat might be perceived to be showing signs of ill-health. Meanwhile, the sheep in this study, on the bases of physical appearance, were healthy animals, hence their rough coat could have resulted from exposure to thorny bushes and rains since they were reared under the extensive system.

The coat colour patterns observed in the experimental animals fall within the colours of WAD sheep which is usually characterized by coat colours of white, black, brown, with white having black or brown patches but most observed significant colours are black, brown and white. Mixture of these significant colours include either of black with white shades, brown with white shades and other mixtures. However, the most frequent occurrence is plain white with spots or shades of other colours – brown and or black. This result is consistent with that of Hassen *et al.* (2012), Hagan *et al.* (2012) and Birteeb and Lomo, (2015) which reported colours observed most frequently among observed sheep included black, brown and white with spots. WAD sheep observed in Ekiti State were characterized by five (5) coat colour patterns which were not equally distributed; White and black (37.2%) and White (26.1%) are the dominant color types while 36.7% comprises of Brown (21.7%), White and brown (10.0%) and Black (5.0%) colour types with long thin tail in both ewe and ram sheep. The predominance of white as a solid or pied with other colours may indicate the dominating influence or higher frequency of the underlying allele for white fur. The different colour patterns in the experimental sheep may be due to uncontrolled breeding since the animals were kept under the extensive management system.

The measurement taken from sheep in Ikole for different coat colour showed no significant differences ($p<0.05$) in all of the observed parameters for the different coat colours. i.e. the coat colour pattern did not have any significant influence on any biometric trait in the experimental sheep. There was slight numerical increase in values of white sheep over other colours for HG, BW, RH, WH, HL and TL. The least values were obtained for black in BW, HG, RH, WH, BL and TL. Also, Brown sheep is consistently higher than Black sheep for EL, HG, BW, RH, WH, BL and TL except for HL. This result is in agreement of Birteeb and Lomo, (2015) which stated the coat colour did not significantly influence any of the phenotypic body traits of the WAD sheep. The slight increase in values of body trait on measurement in white sheep over other colours could be because of selection of white sheep for its good adaptive colouration for body temperature maintenance. White sheep reflects heat thus serving a good advantage during hot season as heat stress is among the many factors that limit productivity in small ruminants (*Cam et al., 2010*).

Female was higher for parameters such as HG, BW, RH, WH and HL but lower than male for EL, BL and TL. Sex effect was not statistically significant ($p>0.05$) for all parameters except EL. This result agrees with that of Birteeb and Lomo, (2015) who reported that both male and female Sheep were similar in all the phenotypic traits. This result also showed that sex did not influence the body traits as opposed to the claim/report of Hagan *et al.* (2012). Also, body weight reported 37.99 for male and 38.29 for female were lower than values of 39.5 for male and 38.4 for female reported by Karnuah *et al.* (2018).

Results showed that effect of interaction (colour x sex) showed no statistically significance ($p>0.05$) for all parameters. White colour x F had consistently higher values for most parameters including HG, BW, RH, WH, HL and TL except EL and BL. This result agrees with that of Karnuah *et al.* (2018) which reported that effect of the interaction on the body traits are not significant for most traits except the Ear Length and Body Length. Also, Black colour x F had the least values for most parameters including HG, BW, RH, WH, BL and TL except in EL and HL. Results of measurement also showed that RH and WH values were the same for all the interactions. Also, as this research presented the body traits to be more prominent quantitatively in females at least for 2 out of the 3 LGA, this result agrees with the findings of Birteeb and Lomo, (2015) but however disagrees with findings of Okpeku *et al.* (2011) in which males were superior to females in all body measurements.

The significant differences in the phenotypic body traits of the WAD sheep in the 3 different local government areas could be attributed to the different plane of nutrition, availability of grazing reserves and management practices the animals are exposed to (*Cam et al., 2010, Karnuah et al., 2018*).

Sex effect was not statistically significant ($p>0.05$) for RH2, WH2, BL2, HL2 and TL2. However, significant statistical differences ($p<0.05$) were observed in EL2, HG2 and BW2 across the sexes. Male had highest values for EL2, HG2, BW2 and TL2 but least values for RH2, WH2, BL2 and HL2 while Female had slight increases than Male for parameters like RH2, WH2, BL2 and HL2. Result from Oye LGA showed that sex had an influence on body traits such as EL2, HG2 and BW2. This result agrees with findings of Rotimi *et al.* (2017) but the values reported however were higher than those reported by Rotimi *et al.* (2017). The results of this study is also consistent with findings of Isaac, (2005); Vargas *et al.* (2007) and Okpeku *et al.*

(2011) which reported higher values for males than females for body traits such as EL2, HG2 and BW2 though it disagrees with Fajemilehin and Salako, (2008) and Rotimi *et al.* (2017) who reported higher values for females than males. The disparity in the values of the body traits could be attributed to the sexual dimorphism in WAD Sheep. Although, other factors such as hormonal coordination and management practices may be involved which could cause disparity in growth rates in the different sexes of the Sheep (*Rotimi et al. 2017*).

5.2. Phenotypic correlation of the body traits of West African Dwarf (WAD) sheep in 3 LGA in Ekiti State

Results from bivariate correlation of the parameters was done using the Pearson's and Spearman correlation co-efficient. The result revealed that phenotypic correlation among the body traits is significant ($P<0.05$) between only few to many parameters which range from lowly to highly correlated: 0.004-1.000 for positive correlation and -0.33—0.132. Even though there were some negative correlation, and also that correlation of most traits range from moderate to high (0.20-0.40); the highest correlations were found between parameters such as RH and WH and HG and BW. The correlations in this study were consistent and generally higher than those reported in other studies (*Khan et al 2006; Pesmen and Yardimci 2008; Okpeku et al 2011*) but lower than those reported by Fajemilehin and Salako, (2008).

The result also revealed that HG and EL when correlated with BW yielded high correlation values indicating that both HG and EL could be used to make predictions for future body weight yield of the sheep. This result agrees with the findings of Oseni and Ajayi, (2014) and Birteeb and Lomo, (2015). Also, the BL when correlated with BW has low correlation coefficient as contrary to the reports of Karnuah *et al.* (2018) who reported a moderate to high correlation between Body Length and Body Weight. Heart Girth correlation with live body weight reported in this study is the highest correlation with live body weight ($r=0.962-0.999$ $P<0.01$) much higher than that reported by Oseni and Ajayi, (2014) ($r=0.88$ $P<0.001$). Correlation of HG with BL also ranges from low to high indicating the high probability of predicting the BL using the HG as normally, animals with longer body (BL) and height at withers (WH) should have bigger body frame unlike animals with short body length (*Oseni and Ajayi, 2014; Karnuah et al., 2018*).

RH and BW were low to moderately correlated which is inconsistent with findings of Fajemilehin and Salako, (2008).

The result of the study presented that the live body weight of the WAD sheep could be predicted using the HG and EL in consonance with reports of many earlier studies such as Fajemilehin and Salako, (2008), Oseni and Ajayi, (2014) and Birteeb and Lomo, (2015).

CHAPTER 6

6.0. CONCLUSION

The West African Dwarf (also Djallonke) is a domesticated breed of sheep and is the dominant breed from southwest to central Africa. This breed is primarily raised for meat. The WAD Sheep of Nigeria are very important not only because they are a source of quick revenue but also because their qualitative traits appear to possess selective properties which could serve as a reliable indicator when economic concerns mount pressure on the variety for genetic improvement. Sheep rearing is one of the most important means of livelihood and food security for majority of the rural populace, especially in developing countries (*Amadou et al. 2012*).

The various traits of the sheep considered were their Ear Length (EL), Heart girth (HG), Body Weight (BW), Rump Height (RH), Wither height (WH), Body Length (BL), Head Length (HL), and Tail Length (TL). Preliminary findings based on their computed means and their respective standard deviations shows some differences in the measured traits across the three locations. Rump height and Wither height, Heart girth and Body weight were highly correlated in all the three locations. Generally, positive and significant ($P < 0.01$; $P<0.05$) correlation was obtained between the body weight and most of the linear body measurement. Therefore, it strongly recommended that further genetic analyses should be used to determine the genetic variation between and within these small populations to develop an effective conservation and utilization program. The moderate to high correlation coefficients between body weight and linear body measurements for the Sheep suggests that either of these variables or their combination could provide a better evaluation for forecasting live weight of sheep. The result of this study showed that the live body weight of the WAD sheep could be predicted using the HG and EL in consonance with reports of many earlier studies. The chi-square distribution of qualitative traits of WAD Sheep showed that the LGAs (locations) were significantly ($P<0.0001$) associated with the coat colours of the Sheep. It also showed that sex was not significantly ($P>0.0001$) associated with coat colours of the Sheep.

It was concluded that WAD sheep has a possibility for the versatile role to generate income for livestock keepers. Therefore, genetic improvement program should aim at farmers need to cope with trait preference and existing traditional herding and breeding practice. This study will help researchers to uncover the critical area of phenotypic characterization in WAD sheep population that many researchers were not able to explore. This study discovers the effect of location and sex on body weight and linear body measurements. These values can be used as reference in the future studies on the genetic characterization and improvement through conservation of the breeds.

6.1. RECOMMENDATION

- More attention should be paid to small ruminants, the breeds and their population. The characterisation of the small ruminant populations in developing countries as well as in Ekiti State will play a major role in the maintenance of the genetic resources as the basis for future improvement in livestock production.

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APPENDIX

Appendix 1: Frequency and Percentage of the sex of Sheep

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	3.2	3.2	3.2
	F	30	48.4	48.4	51.6
	M	30	48.4	48.4	100.0
	Total	62	100.0	100.0	

Appendix 2: Frequency and Percentage of the different Coat colours

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	White	47	26.1	26.1	26.1
	White and Black	67	37.2	37.2	63.3
	Brown	39	21.7	21.7	85.0
	White and Brown	18	10.0	10.0	95.0
	Black	9	5.0	5.0	100.0
	Total	180	100.0	100.0	

Appendix 3: Analysis of Variance Table I

Source	DF	Sum of Squares	Mean Square	F value	Pr>F	R-square	Coeff var	Root MSE	Mean
EL	2	6.577	3.288	2.28	0.1053	0.025	10.374	1.201	11.578
HG	2	776.433	388.216	8.99	0.0002	0.092	8.447	6.569	77.783
BW	2	1257.775	628.887	8.29	0.0004	0.086	21.058	8.712	41.372
RH	2	192.578	96.289	2.80	0.0637	0.031	8.687	5.868	67.544
WH	2	192.578	96.289	2.80	0.0637	0.031	8.687	5.868	67.544
BL	2	640.533	320.267	5.72	0.0039	0.061	8.697	7.482	86.033
HL	2	16.344	8.172	1.96	0.1442	0.022	9.627	2.043	21.222
TL	2	217.378	108.689	5.84	0.0035	0.062	12.958	4.316	33.306

Appendix 4: Analysis of Variance Table II

		Sum of Squares	df	Mean Square	F	Sig.
Ear length	Between Groups	.022	1	.022	.015	.902
	Within Groups	261.889	178	1.471		
	Total	261.911	179			
Heart girth	Between Groups	14.450	1	14.450	.306	.581
	Within Groups	8402.100	178	47.203		
	Total	8416.550	179			
Body weight	Between Groups	37.447	1	37.447	.455	.501
	Within Groups	14654.279	178	82.327		
	Total	14691.726	179			
Rump height	Between Groups	80.000	1	80.000	2.294	.132
	Within Groups	6206.644	178	34.869		
	Total	6286.644	179			
Wither height	Between Groups	80.000	1	80.000	2.294	.132
	Within Groups	6206.644	178	34.869		
	Total	6286.644	179			
Body length	Between Groups	209.089	1	209.089	3.599	.059
	Within Groups	10340.711	178	58.094		
	Total	10549.800	179			
Head length	Between Groups	12.800	1	12.800	3.069	.082
	Within Groups	742.311	178	4.170		
	Total	755.111	179			
Tail length	Between Groups	.050	1	.050	.003	.960
	Within Groups	3514.144	178	19.742		
	Total	3514.194	179			

Appendix 5: Means for all the body traits

Factor	N	Mean	StDev	95% CI
EL (CM)	180	11.5778	1.2096	(10.7073, 12.4483)
HG (CM)	180	77.783	6.857	(76.913, 78.654)
BW (KG)	180	41.372	9.060	(40.501, 42.242)
RH (CM)	180	67.544	5.926	(66.674, 68.415)
WH (CM)	180	67.544	5.926	(66.674, 68.415)
BL (CM)	180	86.033	7.677	(85.163, 86.904)
HL (CM)	180	21.222	2.054	(20.352, 22.093)
TL (CM)	180	33.306	4.431	(32.435, 34.176)

Pooled StDev = 5.95388

Appendix 6: Least Square Means for effect of LGA

	LGA (i/j)	IKOLE	OYE	ADO
EL	Ikole		0.0871	0.4453
	Oye	0.0871		0.6334
	Ado	0.4453	0.6334	
HG	Ikole		0.0001	0.1219
	Oye	0.0001		0.0635
	Ado	0.1219	0.0635	
BW	Ikole		0.0002	0.1086
	Oye	0.0002		0.1050
	Ado	0.1086	0.1050	
RH	Ikole		0.9261	0.0724
	Oye	0.9261		0.1610
	Ado	0.0724	0.1610	
WH	Ikole		0.9261	0.0724
	Oye	0.9261		0.1610
	Ado	0.0724	0.1610	
BL	Ikole		0.0093	0.9948

	Oye	0.0093		0.0124
	Ado	0.9948	0.0124	
HL	Ikole		0.2640	0.1622
	Oye	0.2640		0.9612
	Ado	0.1622	0.9612	
TL	Ikole		0.0029	0.5417
	Oye	0.0029		0.0606
	Ado	0.5417	0.0606	

Pr > |t| for H_0: LSMean(i)=LSMean(j)

Appendix 7: Means and Descriptive Statistics

	LGA	Mean	Std. Dev.	Std. Error	Variance	Minimum	Maximum
EL		11.57778	1.209624	0.09016	1.46319	10	15
	Ikole	11.33333	1.114871	0.143929	1.24294	10	14
	Oye	11.8	1.337845	0.172715	1.78983	10	15
	Ado	11.6	1.137943	0.146908	1.29492	10	15
HG		77.78333	6.857101	0.511098	47.0198	62	91
	Ikole	75.3	7.332999	0.946686	53.7729	62	90
	Oye	80.38333	5.342797	0.689752	28.5455	70	91
	Ado	77.66667	6.868416	0.886709	47.1751	63	91
BW		41.37167	9.059618	0.675264	82.0767	23.7	61.4
	Ikole	38.13833	9.321891	1.203451	86.8977	23.7	60.5
	Oye	44.61333	7.750571	1.000594	60.0713	31.5	61.4
	Ado	41.36333	8.984713	1.159922	80.7251	24.7	61.4
RH		67.54444	5.92629	0.44172	35.1209	60	85
	Ikole	68.46667	6.263877	0.808663	39.2362	60	81
	Oye	68.06667	6.243279	0.806004	38.9785	60	85
	Ado	66.1	5.007452	0.646459	25.0746	60	80
WH		67.54444	5.92629	0.44172	35.1209	60	85

	Ikole	68.46667	6.263877	0.808663	39.2362	60	81
	Oye	68.06667	6.243279	0.806004	38.9785	60	85
	Ado	66.1	5.007452	0.646459	25.0746	60	80
BL		86.03333	7.677072	0.572215	58.9374	69	102
	Ikole	87.43333	7.583136	0.978979	57.5040	70	101
	Oye	83.36667	7.546391	0.974235	56.9480	69	102
	Ado	87.3	7.314485	0.944296	53.5017	73	102
HL		21.22222	2.053898	0.153089	4.21850	17	25
	Ikole	20.8	2.153436	0.278007	4.63729	17	25
	Oye	21.38333	1.878438	0.242505	3.52853	19	25
	Ado	21.48333	2.087019	0.269433	4.35565	18	25
TL		33.30556	4.430843	0.330256	19.6324	25	45
	Ikole	32.15	3.404011	0.439456	11.5873	27	44
	Oye	34.78333	5.405871	0.697895	29.2234	28	45
	Ado	32.98333	3.88169	0.501124	15.0675	25	42

Appendix 8: Means and Descriptive Statistics for females

Traits	N	Mean	Std. Dev.	Sum	Minimum	Maximum
EL	90	11.56667	1.28998	1041	10	15
HG	90	77.50000	6.49157	6975	63	91
BW	90	40.91556	8.58438	3682	24	61
RH	90	68.21111	6.42064	6139	60	81
WH	90	68.21111	6.42064	6139	60	81
BL	90	87.11111	7.61643	7840	70	102
HL	90	21.48889	2.16844	2999	18	25
TL	90	33.32222	4.62487	2999	25	45

Appendix 9: Means and Descriptive Statistics for males

Traits	N	Mean	Std. Dev.	Sum	Minimum	Maximum
EL	90	11.58889	1.13072	1043	10	15
HG	90	78.06667	7.22947	7026	62	91
BW	90	41.82778	9.53746	3765	23.7	61.4
RH	90	66.87778	5.33976	6019	60	85
WH	90	66.87778	5.33976	6019	60	85
BL	90	84.95556	7.62744	7646	69	102
HL	90	20.95556	1.90747	1886	17	25
TL	90	33.28889	4.25387	2996	27	44

Appendix 10: Grouping Information Using the Tukey Method and 95% Confidence

Factor	N	Mean	Grouping
BL (CM)	180	86.033	A
HG (CM)	180	77.783	B
WH (CM)	180	67.544	C
RH (CM)	180	67.544	C
BW (KG)	180	41.372	D
TL (CM)	180	33.306	E
HL (CM)	180	21.222	F
EL (CM)	180	11.5778	G

Appendix 11: Tukey's Studentized Range (HSD) Test

Ear length

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	1.442561
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	0.5183

Tukey Grouping	Mean	N	LGA
A	11.8000	60	2
A			
A	11.6000	60	3
A			
A	11.3333	60	1

Means with the same letter are not significantly different.

Heart girth

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	43.1645
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	2.8352

Tukey Grouping	Mean	N	LGA
A	80.383	60	2
A			
B A	77.667	60	3
B			
B	75.300	60	1

Means with the same letter are not significantly different.

Body weight

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	75.89803
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	3.7596

Tukey Grouping	Mean	N	LGA
A	44.613	60	2
A			
B A	41.363	60	3
B			
B	38.138	60	1

Means with the same letter are not significantly different.

Rump height

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	34.42976
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	2.5321

Tukey Grouping	Mean	N	LGA
A	68.467	60	1
A			
A	68.067	60	2
A			
A	66.100	60	3

Means with the same letter are not significantly different.

Wither height

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	34.42976
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	2.5321

Tukey Grouping	Mean	N	LGA
A	68.467	60	1
A			
A	68.067	60	2
A			
A	66.100	60	3

Means with the same letter are not significantly different.

Body length

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	55.98456
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	3.2289

Tukey Grouping	Mean	N	LGA
A	87.433	60	1
A			
A	87.300	60	3
B	83.367	60	2

Means with the same letter are not significantly different.

Head length

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	4.173823
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	0.8816

Tukey Grouping	Mean	N	LGA
A	21.4833	60	3
A			
A	21.3833	60	2
A			
A	20.8000	60	1

Means with the same letter are not significantly different.

Tail length

Alpha	0.05
Error Degrees of Freedom	177
Error Mean Square	18.62608
Critical Value of Studentized Range	3.34270
Minimum Significant Difference	1.8624

Tukey Grouping	Mean	N	LGA
A	34.7833	60	2
A			
B A	32.9833	60	3
B			
B	32.1500	60	1

Means with the same letter are not significantly different.

Appendix 12: Tukey Simultaneous Tests for Differences of Means

Difference of Levels	Difference of Means	SE of Difference	95% CI	T-Value	Adjusted P-Value
HG (CM) - EL (CM)	66.206	0.628	(64.302, 68.109)	105.49	0.000
BW (KG) - EL (CM)	29.794	0.628	(27.890, 31.698)	47.47	0.000
RH (CM) - EL (CM)	55.967	0.628	(54.063, 57.870)	89.18	0.000
WH (CM) - EL (CM)	55.967	0.628	(54.063, 57.870)	89.18	0.000
BL (CM) - EL (CM)	74.456	0.628	(72.552, 76.359)	118.64	0.000
HL (CM) - EL (CM)	9.644	0.628	(7.741, 11.548)	15.37	0.000
TL (CM) - EL (CM)	21.728	0.628	(19.824, 23.632)	34.62	0.000
BW (KG) - HG (CM)	-36.412	0.628	(-38.315, -34.508)	-58.02	0.000
RH (CM) - HG (CM)	-10.239	0.628	(-12.143, -8.335)	-16.31	0.000
WH (CM) - HG (CM)	-10.239	0.628	(-12.143, -8.335)	-16.31	0.000
BL (CM) - HG (CM)	8.250	0.628	(6.346, 10.154)	13.15	0.000
HL (CM) - HG (CM)	-56.561	0.628	(-58.465, -54.657)	-90.12	0.000
TL (CM) - HG (CM)	-44.478	0.628	(-46.382, -42.574)	-70.87	0.000
RH (CM) - BW (KG)	26.173	0.628	(24.269, 28.077)	41.70	0.000
WH (CM) - BW (KG)	26.173	0.628	(24.269, 28.077)	41.70	0.000
BL (CM) - BW (KG)	44.662	0.628	(42.758, 46.565)	71.16	0.000
HL (CM) - BW (KG)	-20.149	0.628	(-22.053, -18.246)	-32.11	0.000
TL (CM) - BW (KG)	-8.066	0.628	(-9.970, -6.162)	-12.85	0.000
WH (CM) - RH (CM)	0.000	0.628	(-1.904, 1.904)	0.00	1.000
BL (CM) - RH (CM)	18.489	0.628	(16.585, 20.393)	29.46	0.000
HL (CM) - RH (CM)	-46.322	0.628	(-48.226, -44.418)	-73.81	0.000
TL (CM) - RH (CM)	-34.239	0.628	(-36.143, -32.335)	-54.56	0.000
BL (CM) - WH (CM)	18.489	0.628	(16.585, 20.393)	29.46	0.000
HL (CM) - WH (CM)	-46.322	0.628	(-48.226, -44.418)	-73.81	0.000
TL (CM) - WH (CM)	-34.239	0.628	(-36.143, -32.335)	-54.56	0.000
HL (CM) - BL (CM)	-64.811	0.628	(-66.715, -62.907)	-103.27	0.000
TL (CM) - BL (CM)	-52.728	0.628	(-54.632, -50.824)	-84.02	0.000
TL (CM) - HL (CM)	12.083	0.628	(10.180, 13.987)	19.25	0.000

Individual confidence level = 99.75%

Appendix 13: Frequency table of LGA by colour

Statistic	Value	ASE
Gamma	-0.0031	0.0927
Kendall's Tau-b	-0.0023	0.0674
Stuart's Tau-c	-0.0024	0.0717
Somers' D C|R	-0.0024	0.0717
Somers' D R|C	-0.0021	0.0634
Pearson Correlation	0.0177	0.0798
Spearman Correlation	-0.0035	0.0781
Lambda Asymmetric C|R	0.0769	0.0730
Lambda Asymmetric R|C	0.2417	0.0465
Lambda Symmetric	0.1603	0.0497
Uncertainty Coefficient C|R	0.1204	0.0177
Uncertainty Coefficient R|C	0.1735	0.0285
Uncertainty Coefficient Symmetric	0.1422	0.0218

Sample Size = 180

Appendix 14: Frequency table of sex by colour

Statistic	Value	ASE
Gamma	0.1322	0.1086
Kendall's Tau-b	0.0815	0.0671
Stuart's Tau-c	0.1001	0.0825
Somers' D C|R	0.1001	0.0825
Somers' D R|C	0.0664	0.0546
Pearson Correlation	0.0793	0.0741
Spearman Correlation	0.0900	0.0741
Lambda Asymmetric C|R	0.0000	0.0000
Lambda Asymmetric R|C	0.1111	0.0811
Lambda Symmetric	0.0483	0.0363
Uncertainty Coefficient C|R	0.0185	0.0103
Uncertainty Coefficient R|C	0.0423	0.0238
Uncertainty Coefficient Symmetric	0.0258	0.0143

Sample Size = 180

Appendix 15: Pooled Pearson correlation for females

	EL	HG	BW	RH	WH	BL	HL	TL
EL	1.00000	0.44882	0.47405	0.10613	0.10613	0.33660	0.35776	0.50392
		<.0001	<.0001	0.3195	0.3195	0.0012	0.0005	<.0001
HG	0.44882	1.00000	0.97911	0.24680	0.24680	0.10726	0.11095	0.35834
	<.0001		<.0001	0.0190	0.0190	0.3143	0.2978	0.0005
BW	0.47405	0.97911	1.00000	0.23019	0.23019	0.08588	0.09508	0.36479
	<.0001	<.0001		0.0291	0.0291	0.4209	0.3727	0.0004
RH	0.10613	0.24680	0.23019	1.00000	1.00000	0.08682	0.10549	0.18801
	0.3195	0.0190	0.0291		<.0001	0.4158	0.3224	0.0760
WH	0.10613	0.24680	0.23019	1.00000	1.00000	0.08682	0.10549	0.18801
	0.3195	0.0190	0.0291	<.0001		0.4158	0.3224	0.0760
BL	0.33660	0.10726	0.08588	0.08682	0.08682	1.00000	0.45589	0.34060
	0.0012	0.3143	0.4209	0.4158	0.4158		<.0001	0.0010
HL	0.35776	0.11095	0.09508	0.10549	0.10549	0.45589	1.00000	0.32695
	0.0005	0.2978	0.3727	0.3224	0.3224	<.0001		0.0017
TL	0.50392	0.35834	0.36479	0.18801	0.18801	0.34060	0.32695	1.00000
	<.0001	0.0005	0.0004	0.0760	0.0760	0.0010	0.0017	

Appendix 16: Pooled Pearson correlation for males

	EL	HG	BW	RH	WH	BL	HL	TL
EL	1.00000	0.38551	0.41470	0.02694	0.02694	0.23757	0.02269	0.26791
		0.0002	<.0001	0.8010	0.8010	0.0242	0.8319	0.0107
HG	0.38551	1.00000	0.98136	0.16059	0.16059	0.08115	0.01081	0.20835
	0.0002		<.0001	0.1305	0.1305	0.4470	0.9195	0.0488
BW	0.41470	0.98136	1.00000	0.17399	0.17399	0.08114	0.03737	0.21105
	<.0001	<.0001		0.1010	0.1010	0.4471	0.7266	0.0458
RH	0.02694	0.16059	0.17399	1.00000	1.00000	0.26029	0.08109	0.12524
	0.8010	0.1305	0.1010		<.0001	0.0132	0.4474	0.2395
WH	0.02694	0.16059	0.17399	1.00000	1.00000	0.26029	0.08109	0.12524
	0.8010	0.1305	0.1010	<.0001		0.0132	0.4474	0.2395
BL	0.23757	0.08115	0.08114	0.26029	0.26029	1.00000	0.13038	0.16766
	0.0242	0.4470	0.4471	0.0132	0.0132		0.2206	0.1142
HL	0.02269	0.01081	0.03737	0.08109	0.08109	0.13038	1.00000	0.19823
	0.8319	0.9195	0.7266	0.4474	0.4474	0.2206		0.0611
TL	0.26791	0.20835	0.21105	0.12524	0.12524	0.16766	0.19823	1.00000
	0.0107	0.0488	0.0458	0.2395	0.2395	0.1142	0.0611	