AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

GROWTH PERFORMANCE, PHENOTYPIC CORRELATION BETWEEN LIVE BODY WEIGHT AND CARCASS CHARACTERISTICS IN CAPTIVE MALE AND FEMALE AFRICAN GIANT RATS (*Cricetomys gambianus*)

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AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

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PHENOTYPIC CORRELATION BETWEEN LIVE BODY WEIGHT AND CARCASS CHARACTERISTICS IN CAPTIVE MALE AND FEMALE AFRICAN GIANT RATS (*Cricetomys Gambianus*)

BY

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JULY, 2025

DECLARATION

Candidate's Declaration

I hereby declare that except for quotations and references in published works that have been duly acknowledged, this thesis is the result of my own original work and that no part of it has been presented for another degree at this university or elsewhere.

STUDENT'S NAME **SIGNATURE** **DATE**

CHRISTTIAN DUAH **……** **……**

Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

SUPERVISOR'S NAME: ADDISON DUODU (PHD)

SIGNATURE …… **DATE…….**

ABSTRACT

This study was conducted to investigate some growth performance parameters, determine phenotypic correlation estimates between live body weight and carcass traits (dress weight, kidney, liver, tail, foreleg, thoracic, loin, hind leg, dressing percentage), and to predict the weight of carcass parts from live body weight in both sexes of African giant rats (AGRs). Forty (20 bucks and 20 does) African giant rats (*Cricetomys gambianus)* aged 3-4 months were used in the study; and data collected analyzed using t-test, Pearson's correlation, and linear regression models embedded in GenStat Eleventh Edition. Growth performance measurements (feed intake, feed conversion ratio, body weight gain); and live weights were taken bi-weekly up to the 22^{nd} week. The African giant rats were raised to the eleventh month before data on carcass performance were obtained. Results obtained showed that sex did not significantly ($p>0.05$) influence average daily feed intake, and feed conversion ratio but the male African giant rats had significantly ($p<0.05$) better bi-weekly body weight gain from the 8^{th} week to the 22^{nd} week and final body weight than the females. Sex had no significant influence ($p>0.05$) on protein, fat, moisture and pH of meat; except ash content which females had a higher percentage than their male counterparts. There was a significant ($p<0.05$) sex difference for carcass primal cuts (dressed, loin, foreleg, hind leg, thoracic weights) with male performing better than the females, however females recorded a heavier kidney weight than the males. There was no significant difference ($p>0.05$) in sexes for dressing percentages. The results also showed a significant positive correlation between live body weight and dressed weights in both males ($r=0.9517$, $p<0.01$) and females ($r=0.8367$, $p<0.01$). Similarly, significant positive correlations were observed between live body weight and almost all carcass cuts in both sexes. However, the highest positive correlation coefficients with primal cuts were observed in thoracic weight as ($r=0.\ 9544$), and ($r = 0.9892$) in males and females respectively. All the carcass traits recorded high values of adjusted coefficient of determination (R^2) which were significant ($p<0.05$) in males and females for predicting carcass cut traits from live body weight, but higher for pooled sex ($p<0.01$). In conclusion, live body weight can be used as an indirect selection criterion and predict carcass traits in both sexes of African giant rats.

DEDICATION

This work is dedicated to the God Almighty. This thesis is also wholeheartedly dedicated to my beloved mother, Salomey Atta-Osei, my father, Abubakar Isaac, and Elizabeth Yaa Nkrumah (Grandmother), friends and loved ones for their support and prayers.

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TABLE OF CONTENTS

LIST OF TABLES

TABLES **PAGES**

LIST OF PLATES

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Animal-sourced foods (ASFs) are known to be rich in nutrients and very effective in ameliorating protein-related malnutrition and micronutrient deficiencies relative to plant-based staples; but conventional domestic meat sources such as beef, chicken, mutton, chevon have relatively limited affordability; unlike bushmeat which is relatively available and nutritious wild food to mostly the resource-poor households (Vliet *et al.*, 2015; Zhang *et al.*, 2016).

Moreover, growth in global consumption of meat proteins over the next decade is projected to increase by 14 % by 2030 compared to the base period average of 2018-2020; with beef, pork, poultry, and chevon projected to grow by 5.9 %, 13.1 %, 17.8 % and 15.7 % respectively driven largely by income and population growth (OECD & Food and Agriculture Organization of the United Nations, 2021).This limited affordability of the aforementioned conventional animal sourced protein demands a relatively affordable and available alternative (Swamy & Pinedo-Vasquez, 2014).

Several hundred species of wild animals are hunted for as bushmeat in the tropics, to supplement the diets, support the customs, and livelihoods of many people (Ingram *et al.*, 2024)., 2024). Wild meat or 'bushmeat' which is considered relatively cheaper has long served as a major source of animal protein and a key contributor to the food security of millions across the developing world, most notably in Africa, Latin America and Asia (Schulte-Herbrüggen *et al.*, 2013a).

The Savanna which constitutes about one-third of wildlife species in Ghana is known to record several species of animals hunted for as bushmeat including various

indigenous rodents (cane rats, African giant rats), antelopes (duikers), reptiles and gastropods (Agana *et al*., 2018). Also, in the forest zone like the Kakum Conservation Area has poaching cases on species such as primates (Lowe's monkey, spot-nosed monkey and olive colobus), squirrels, royal antelopes, pangolins, rats, elephants, and Maxwel's Duikers. The type of species targeted by the hunters was not different from that of hunters in other rainforest areas (Wiafe, 2018). Bushmeat serves as a source of livelihood for most rural communities in sub-Saharan Africa and may be a crucial safety net for vulnerable households, especially during times of economic hardship. In contrast, little is known about the impacts of wildlife depletion on these functions (Schulte-Herbrüggen *et al*., 2013a).

Moreover, little is known about the relationship between hunting, biodiversity, nutrition, and food security surrounding many of the world's wildlife-protected areas (Borgerson *et al.,* 2019). Food security consultants are promoting wildlife farming to boost rural incomes and supply protein to a hungry world. Also, public health experts view properly managed captive breeding as a way to prevent emerging diseases in wildlife from spilling over into the human population (Conniff, 2016).

A major wildlife species which is by far one of Africa's largest rodents, encouraged as suitable for farming in captivity among local Africans for slaughtering for their own needs is the African giant rat. Moreover, farming this species on a large scale can make a quick and cheap way to enhance the production of meat in developing countries (Malekani, 2009; Makundi, 2018).

1.2 Problem Statement

The African giant rat is among one of the important bushmeat widely accepted and consumed in Ghana (Kuukyi *et al.*, 2014). The quantities of African giant rats provided by hunters have diminished due to an increase in human population growth; which has led to over exploitation through overhunting and black market for this species, and hence its progressive rarity in the wild (Alexander, 2021). The breeding of the African giant rat in captivity could therefore be an alternative to supply meat low in fat to people and thereby preserving its biodiversity (Oyeyinka *et al.*, 2019; Fonkem *et al.*, 2022). In contrast, much as utilization of bushmeat mainly from rodent meat is widespread, this is an underutilized or neglected source of protein in Africa. To supplement the over reliance on animal protein sourced from mainly cattle, sheep, goat, pig, poultry and fish purchase; harnessing rodents as a major source of bushmeat could be done by encouraging people to rear and breed them in captivity, process and package the meat for wider distribution to consumers (Schulte-Herbrüggen *et al.*, 2013; Makundi, 2018).

The African giant rat (*Cricetomys gambianus*) shows strong potential as an alternative meat species to the conventional sources, yet production systems and domestication frameworks remain uneven and relatively unsuccessful (Cudjoe et al., 2024); unlike other mini-livestock (Annor *et al*., 2014; Sam *et al.,* 2020). Also, empirical data on growth performance and carcass composition under captive conditions are few and geographically uneven, limiting evidence-based management; unlike live body weight which is widely used as a rapid proxy for meat yield in livestock, but its predictive accuracy for carcass cuts traits in African giant rats being sparse (Ajayi 2008). Although, there are reports on traits of economic importance including growth rate and association existing between live body weight and carcass traits in rodents; as knowledge of these relationships will enable breeders to predict the carcass traits from

live body weight before slaughter to enhance prediction of income/gain of each animal (Annor *et al.*, 2014; Sam *et al.*, 2020). Notwithstanding, currently there is dearth of information like phenotypic correlation estimates between live body weight and carcass traits, and growth rate in the male and female African giant rats. In other to adequately harness bushmeat such as the African giant rats there is the need to understand the association that exist between live body weight and carcass traits, as well as their growth patterns; since they are crucial in informing breeding strategies for improved meat yields.

1.3 Objective of the Study

1.3.1 Main objective

The main objective of the present study was to evaluate growth performance, prediction and phenotypic correlation estimates between live body weight and some carcass traits of the captive African giant rats.

1.3.2 Specific objectives

The specific objectives were to:

1. estimate average growth performance of the male and female African giant rats.
2. estimate phenotypic correlation between live body weight and carcass cut traits of the male and female African giant rats.
3. find the accuracy of using live body weight as a predictor of carcass cut traits in the African giant rats.
4. determine the effect of sex on meat composition in both sexes of the African giant rats in captivity.

1.4 Significance of the study

The main purpose of animal breeding practices is to improve traits of economic values**.** The study aims at providing useful information to breeders, farmers, and prospective African giant rats farmers on the influence of sex on phenotypic estimates between body weight and various carcass cut traits, and growth performance. This will enable the breeders and farmers to be abreast with the rate at which the animals get to their desired weight and hence their desirable salable product. An instance is information on feed conversion ratio will aid in estimating the amount of feed required in a growth cycle; hence knowing what choices to make to reduce the cost of production.

Again, the strength of the association and regression models between traits of economic importance in this research will serve as a useful tool for prediction based on other pieces of information on traits on the own performance of the animals for the same traits. This study will also provide empirical data on the growth patterns and phenotypic correlation estimates in filling knowledge gaps in existing literature. Finally, findings from the study will aid farmers select African giant rats with desired growth pattern and carcass cut traits to improve meat production and productivity.

CHAPTER TWO: LITERATURE REVIEW

2.1 Bushmeat

The consumption of wild animal meat, commonly known as bushmeat, is widespread throughout tropical regions. Bushmeat provides an essential source of protein and income for human livelihoods (Ordaz-Németh *et al*., 2017). Bushmeat can be defined as meat derived from any terrestrial mammal, bird, reptile or amphibian harvested for subsistence or trade, most often illegally fish, crustaceans, molluscs are exempted though an important dietary item for many communities, the focus is much on larger vertebrates that constitutes the bulk of terrestrial wild animal biomass consumed by humans (Cawthorn *et al.*, 2015). People in Ghana consume more bushmeat than anywhere else in the world. This is especially true in rural areas. Ghanian bushmeat includes baboon, aardvark, warthog and rats. Bushmeat represents the freshest and most affordable meat available for Ghana's rural citizens (Alexander, 2021).

2.1.1 Demand and Supply of Bushmeat

Bush meat, a term used for wild meat, is considered a delicacy in many African countries and has resulted in its growth as a commercial enterprise (Kuukyi *et al*., 2014). Wildlife is hunted in forest and savannah regions as a source of bushmeat, and income to control agricultural crop pests, reduce threats to livestock and human safety, and as trophies (Lindsey *et al*., 2011; Nasi *et al.*, 2011; Wilkie *et al.*, 2016). However, unsustainable bushmeat hunting across sub-Saharan Africa may lead to the loss of an important source of dietary protein, micro-nutrients and income for numerous rural ((Nasi *et al*., 2011), the endangering of the cultural identities of many indigenous and traditional people for which hunting is part of their heritage and sense of cultural identity (Van Vliet & Mbazza, 2011) and the emptying of Africa's forests and

savannahs of large-bodied species, eliminating the important ecological roles these play in the functioning of such ecosystems (Abernethy *et al.*, 2013). Across Africa, many sedentary rural communities consume wildlife as a primary or supplementary source of animal protein (Schulte-Herbrüggen *et al*., 2013b). For many rural households, bushmeat can constitute as much as half of their annual protein requirements (Wilkie *et al.,* 2016) but is typically much less than this in landscapes where wildlife have already been severely depleted or where livestock production is more common (Schulte-Herbrüggen *et al*., 2013).

Dependence on wildlife for food is greater in moist forests compared to savannah regions of Africa as the meat of livestock is more available in the latter (Lindsey *et al*., 2013a). Typically, repeated hunting close to settlements depletes large-bodied wildlife meaning that only small-bodied species, that reproduce relatively rapidly and are more resilient to hunting pressure, are available in or near farmers' fields to be hunted for food (Coad, 2008; Van Vliet *et al.*, 2011). Large-bodied species may still exist but further from hunters' homes (Kümpel *et al.,* 2010). In urban areas distant to sources of wildlife, where alternative animal protein is available, bushmeat is no longer a dietary necessity; rather, it is a seldom consumed 'treat' (Wilkie *et al.*, 2016). Despite this, given the large numbers of urban dwellers consuming bushmeat, their impact on wildlife can be nonetheless substantial (Nasi *et al.,* 2011).

2.1.2 Economic importance of bushmeat

Wildlife from land and sea is the primary source of meat and income for millions in economically developing countries. The "bushmeat trade," as it is popularly known, occurs across the planet and includes animals that vary in size from elephants to ants. The harvest of wildlife for human consumption is valued at several billion dollars

annually and provides an essential source of meat for millions of rural people living in poverty. Wild meat or 'bushmeat' in particular, serves as a key contributor to the food security and livelihoods of millions throughout the developing world (Brashares *et al.*, 2011).

Bushmeat makes its most significant and direct contribution to food security in places and at times when it is the only or main source of protein available, and is not easily withdrawn or replaced (Fa *et al.,* 2015). This situation potentially applies to millions of rural or forest dwellers across Africa, Latin America and Asia, who are amongst the poorest and most marginalized in their countries. This wild resource can also contribute indirectly to the food security of these people when some or all of their income is derived through the bushmeat trade, which in turn can be used to purchase other crucial food supplies (Lindsey *et al.*, 2011).

Bushmeat is more important in smaller and more remote communities, communities in the middle of the cash income distribution, communities with few domestic animals, countries characterised by poor governance, and with rising costs of living. Bushmeat is therefore likely to be most important to rural households as a source of protein and micronutrients unavailable through own domestic animal and staple crop production (Nielsen *et al*., 2017). In tropical forests worldwide, hunting of wild animals provides an important source of food and income for many rural peoples. West and Central Africa in particular, present hunting levels are considered unsustainable for many large-bodied fauna, driven largely by the demands of the burgeoning human population (Abernethy *et al*., 2013). The loss of wildlife in these forests will not only be detrimental to biological diversity and ecosystem integrity, but will also affect people's livelihoods (Nasi *et al*., 2011); their ability to eat recommended levels of dietary protein, and their

health and well-being. Over 300 distinct emerging disease events have been recorded in the last six decades, and the trend is accelerating (Jones *et al*., 2008). As the majority of emerging pathogens are zoonotic, originating largely from wildlife (Jones *et al*., 2008), increased human-wildlife contact is likely a major risk factor. Hunting, butchering and consumption of wild animals for food can potentially transmit zoonotic pathogens through animal bites, scratches, body fluids, tissues and excrement (Wolfe *et al.*, 2005).

Zoonoses can be transmitted from wildlife to humans by a range of routes (or pathways), yet research exploring the role of transmission pathways in past EID (Emerging Infectious Diseases) events has not been consolidated; results suggest that the relative importance of different transmission pathways varies by EID driver such as bushmeat consumption, land use change, climate and others. EID events are dominated by zoonoses (60.3 % of EIDs): the majority of these (71.8 %) originate in wildlife (for example, severe acute respiratory virus, Ebola virus), and are increasing significantly over time (Jones *et al.*, 2008).

2.1.3 Exploitation of bushmeat

Well-managed protected areas anywhere in the world are fundamental for the conservation of biodiversity (Coad *et al.*, 2015). If adequately managed, these can also play a significant role as a source of wildlife, important as food for park-adjacent communities. Indirect benefits from such wildlife include income and employment (Angelson and Wunder, 2003). However, even though these communities are nominally excluded from nearby protected areas, illicit extraction of wildlife remains a main threat. Understanding the role that protected areas play in supplying wild meat to adjacent communities is essential to resolve or even prevent conflict between

policymakers, local communities, managers and conservationists (Oldekop *et al.*, 2016). Unsustainable hunting of wild animals is the most reported danger to wildlife populations globally (Coad *et al*., 2019), and the permeability of protected areas remain the main threat to natural resources within their boundaries.

Terrestrial mammals are experiencing a massive collapse in their population sizes and geographical ranges around the world, but many of the drivers, patterns and consequences of this decline remain poorly understood. Analysis showed that bushmeat hunting for mostly food and medicinal products is driving a global crisis whereby about 301 terrestrial mammal species are threatened with extinction. Nearly all of these threatened species occur in developing countries where major coexisting threats include deforestation, agricultural expansion, human encroachment and competition with livestock. The unrelenting decline of mammals suggests many vital ecological and socio-economic services that these species provide will be lost, potentially changing ecosystems irrevocably (Ripple *et al.*, 2016).

Population sizes of vertebrate species have been declining, mainly due to the twin threats of direct exploitation and habitat destruction (Hoffmann *et al*., 2011). Unsustainable hunting for consumption and trade of bushmeat by humans represents a significant extinction threat to wild terrestrial mammal populations, perhaps most notably in parts of Asia, Africa and South America (Darimont *et al.*, 2015). The global bushmeat hunting crisis is a fundamentally distressing problem to address because it is intimately tied to human development challenges such as food insecurity, emergent disease risks and land-use changes. While many ethnic groups have hunted wildlife for subsistence over millennia, often with highly detrimental effects, the unsustainability of this practice has accelerated in many areas due to growing human populations, an

increasing tendency for wild meat to be traded commercially, and the widespread adoption of firearms and motorized transport that increase the efficiency and spatial extent of hunting. Larger species are typically targeted by bushmeat hunters first and are also the least able to bear hunting offtakes *(Smith et al*., 2016). As wildlife populations outside protected areas decline, poaching pressure is increasing in many parks and reserves. As a consequence many forests, savannahs, grasslands and deserts in the developing world are now becoming 'empty landscapes' devoid of harvest-sensitive wild mammals (Ripple *et al.*, 2016).

Although bushmeat is one of the major sources of protein for rural communities, the unsustainable hunting and trade of bushmeat have become a widespread commercial activity, representing a significant extinction threat to wild animal populations (Wilkie *et al.*, 2016). While many tribes in rural communities have hunted wild animals for subsistence over millennia, the unsustainable nature of this practice has accelerated with severe negative consequences on wild animal population. The illicit methods of hunting, such as snaring, trapping, poisoning, night hunting, and flushing game with fire, have ramifications for both wildlife and the environment (Adom & Boamah, 2020a). The present rate of exploitation is not only unsustainable but also indiscriminate and poses a serious threat to biological diversity and ecological processes and also creates a growing problem for wildlife tourism development in Ghana as it pertains to other countries in the sub-region (Obour *et al.*, 2016).

2.1.4 Sustainable strategies to the overexploitation of bushmeat

The overexploitation of resources from the forest has led to the establishment of various forest and wildlife management and control programmes in most forest regions (Adom & Boamah, 2020). One of these programs is encouraging wildlife tourism in protected

areas; Wildlife tourism is a powerful tool country can leverage to grow and diversify their economies while protecting their biodiversity and meeting several Sustainable Development Goals. It is also a way to engage tourists in wildlife conservation and inject money into local communities living closest to wildlife. Success stories and lessons learned from nature-based tourism are thus emerging from across the globe (World Bank, 2018).

The meat of wild species, referred to in this report as 'wild meat', is an essential source of protein and a generator of income for millions of forest-living communities in tropical and subtropical regions. However, unsustainable harvest rates currently endanger the integrity of ecosystems and threaten the livelihoods of many vulnerable households. This report, produced in response to a call from the Secretariat of the Convention on Biological Diversity (CBD), is a technical tool to help users guide actions towards a more sustainable wild meat sector. Consumers in fast-growing urban centres largely drive demand for wild meat, where it is eaten as a luxury item rather than as a food staple. This greater pressure from large towns and cities has had significant impacts on wildlife populations and ecosystem integrity. In turn, this jeopardizes the financial 'safety nets and food security of remote rural and indigenous communities, for whom wild meat can account for much of their dietary protein, as well as an important source of other nutrients. Key to the success of sustainable management is ensuring that wild meat use is considered a cross-sectoral issue; firmly incorporated in national resource and land-use planning. The success of management strategies will depend on an enabling environment at the national level. In many countries a key first step will be the revision of national hunting laws and land tenure governance systems in consultation with multiple stakeholders. Research efforts must focus on producing science-based evidence that governments, communities, NGOs and industries can use

to improve management policies and practices. The creation of a sustainable wild meat sector requires interconnected interventions along the entire value chain – focused on local hunting communities, urban consumers and wider society. Well-designed, participatory approaches can enable sustainable management of wild meat supply for local communities, but only if this is strongly complemented by approaches that aim to reduce urban demand (Coad *et al.*, 2019).

2.2 The Concept of Minilivestock

The term minilivestock may be used to refer to small indigenous vertebrates and invertebrates which can be profitably and sustainably produced as food, animal feed, research work, income generation and lots more. Minilivestock comprise but not limited to the following: grasscutters, giant rats, Guinea pigs, frogs, giant snails, manure worms, economic and edible insects (bees, grasshoppers and termites) including other mini species of livestock that are probably obtainable from the wild. Reptiles and small birds such as quails can be considered as eligible for minilivestock production status. Minilivestock could be vertebrate or invertebrate usually short cycled that are adaptable to the feeds in their locality and can be used by man as food, provide employment/or income and several other benefits such as research and as bio instructional materials in educational institutions (Micheal, 2019).

2.2.1 Potential of minilivestock

Benefits abound if this unconventional animal agricultural system is adequately explored. These may include suitability for family backyard farming, source of employment, increase global food security, and environmental friendliness in the rearing process, indigenous adaptability and other yet to be mentioned merits of these unique but underutilized species (Michael, 2019).

The desire to thrive food sources from animal base has brought minilivestock production into the field of animal agriculture. Many large scale/intensive government and donor – sponsored animal production projects in the tropics have proved to be unsustainable. Probably as result of exorbitant initial capital outlay, large expanse of land required, high cost of feeding and management as feeding is known to be a major item of cost in animal production systems. To avert or reduce this negative trend, alternative livestock production should be sought (Opara, 2010).

Minilivestock requires less space compared to large expanse of land required for the conventional livestock farming hence it is suitable for backyard or in-house production system which is practicable in urban setting. The cost of production in terms of feeding, land requirement, labour cost and housing is lower compared to what is required for larger animals. Minilivestock like cane rat, snail, guinea pig are good research materials in which the outcome of the research can be used to further food production and enhance human health. The fact that some individuals are engaging in minilivestock production either on a commercial or subsistence basis has reduced the problem of unemployment in developing countries. The commercialization of minilivestock production will help to reducing hunting and poaching especially in developing countries where wild animals are hunted for food and livelihood. Therefore, minilivestock production will help to preserve our bio-diversity that is near extinction (Michael, 2019).

2.2.2 Potential of rodents for minilivestock

Rodents make up the Order Rodentia which is the largest mammalian order with approximately 2016 species in 28 families including Squirrels, Beavers, Chipmunks,

Gophers, Rats, Mice, Lemmings, Gerbils, Porcupines, Cavies, and the Capybara, with about fifty percent (50 %) of the species of living mammals being rodents. In Africa, rodent species commonly utilized for meat include the cane rats (*Thryonomys swinderianus*), African giant pouched rats (*Cricetomys spp*.), porcupines and some species of rats and mice (*Mastomys natalensis, Arvicanthis niloticus and Gerbilliscus spp*) (Makundi, 2018).

Rodents are ubiquitous animals that are distributed worldwide (Happold, 2013). In general rodents have short life spans, but they maximize breeding, growth and development when conditions are favourable, even if for short periods, which ensures that they can survive in harsh conditions. Rodents have highly developed senses that allow them to integrate themselves in social groups, secure food, mates and even enable them to avoid predators (Gorbunova *et al*., 2008). Their shape and general morphology (small size for the majority) enables them to hide in small spaces, away from potential predators. The majority of rodents are generalists in their food habits, a characteristic that enables them to colonize all possible habitats, while they are able to adapt very fast to changing environments ensuring that survival is not sacrificed (Wilson *et al*., 2018). Many species can occur together in the same habitat and therefore niche partitioning in suitable habitats ensures that available resources for co-existing species do not lead to extreme competition between them, which will have adverse effects on survival. Being prey to many species of animals, they have developed behavioural avoidance of other animals, strange objects and other substances in their surrounding environment, which enables them to keep away from predators, traps and poisons (Makundi, 2018).

In many African countries several species of rodents are highly valued as a source of food and income for local people. System of rearing are fully developed only in those

species, such as the cane rat (*Thryonomys swinderianus*) where the biology is already well known. Semi domesticated breeds have been selected and peri urban extension experiments have yielded satisfactory results in many countries. For other species such as the brush tailed porcupine (*Atherurus africanus*), its potential for minilivestock has not yet been fully assessed. It adapts well to captivity but shows little prospects for rearing because productivity of females is low. African giant rats or Cricetoma (*Cricetomys spp*.) are widely consumed and some countries have initiated research on them with promising results. Unfortunately, despite considerable improvements, no attempts have been made to develop extension programmes. Even though rodent production is slowly developing in some parts of Africa, with obvious ecological and socio- economic benefits, rodent farming projects are not the panacea and many problems still need to be solved to reach a large-scale production and to offer an alternative to the bushmeat trade (Jori *et al.*, 2005b).

Mammals representing the order Rodentia thrive in the wild in almost all regions across the globe. Their ability to succeed is mainly attributed to their capacity to survive on diverse diets, short gestation periods, early sexual maturity and large litter sizes, which make them suitable meat producers (Hoffman & Cawthorn, 2012). Hoffman (2008) suggested that among the various wildlife species that could be exploited by man, rodents exhibit the greatest promise in becoming large commercial commodities due to their increased reproductive rates and simple husbandry requirements; hence their domestication could be a better alternative for commercialization of bushmeat.

2.3 The African Giant Rat (AGR)

2.3.1 Taxonomy of AGR

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Rodentia

Sub Order: Myomorpha

Superfamily: Muroidea

Family: Nesomyidae

Subfamily: Cricetomyinae

Genus: *Cricetomys*

Species: *gambianus*

Binomial name: *Cricetomys gambianus* (Ayokunle, 2014).

2.3.2 Description of African Giant Rats

The African giant rat (*Cricetomys gambianus*), also known as the African giant rat, is a large rodent in the exclusively African family *Nesomyidae*. Their name comes from their large, hamster-like cheek pouches used for storing and transporting food. The African giant rats are nocturnal and very intelligent. They do need a lot of effort into taming down a pup, and it can be very difficult to tame a wilder adult. Their large size and powerful bite do not make them a good exotic for a beginner, or someone without the time to invest in them daily. Even a well-handled pup can change temperament upon sexual maturity or as an adult. This is one of the largest rodents in the world. It weighs between 1.0 and 1.4 kg and grows to approximately 0.9 m long, including the tail, which

makes up half of its total length Gambian pouched rats require a high level of care, attention and experience (Christine, 2022).

The African giant has a long tail, which is bear with a white tip. The body is covered with buff-grey, relatively long fur whereas the under parts are slightly paler. Front hands are white. Face is characterised by long dark whiskers. An average male weigh about 1.3 kg and the female 1.2 kg. Small eyes are surrounded by a black eye-patch (*African Giant Pouched Rat - Rodent - Africa*, 2022). African giant rat, (subfamily Cricetomyinae), any of the five species of the African rodents characterized by cheek pouches that are used for carrying food back to their burrows, where it is eaten or stored. All are terrestrial and have gray to brown coats with white or gray underparts. The two species of giant pouched rat (genus *Cricetomys*) are hunted in the wild and eaten by native peoples. Gentle animals, they are easily tamed and raised in captivity and thus have been studied to determine their marketability as a reliable source of food. Both species (*C. gambianus* and *C. emini*) are large, weighing nearly 3 kg and having bodies up to 42 cm (16 inches) long. Their long heads have large ears; the scantily haired tail is longer than the body and is white on the terminal half. African giant pouched rats have soft, grey coats with white fur on the belly. Their long tails are scaly and they have narrow heads with small eyes. The main physical characteristic of Gambian rats and all *Cricetomys* in general are their large cheek pouchespouches can expand to a great size, allowing them to transport massive quantities of food if necessary. Cheek pouches also exist in other families of rodentia, such as the African hamster and members of the subfamily *Cricetinae*. These rats also have a very low fat content, which may be the cause of their susceptibility to cold (Joo, 2004).

The African giant rats are strictly nocturnal and mostly solitary, except when breeding. The home range of adult males and female rats overlaps. The African Giant Rat is adapted to forests and forest scrub with a rainfall in excess of 800 mm per year. After a gestation period of 27 days, females give birth to litters of two to four altricial pups. The African Giant Rat breeds mostly during summer. Young first leave the nest to forage at the age of six weeks, and finally leave the nest at the age of three months (*African Giant Pouched Rat - Rodent - Africa*, 2022).

2.3.3 Distribution of African giant rats

The African giant rat or the Gambian pouched rat, *Cricetomys gambianus* (Waterhouse 1840) (order Rodentia; family Muridae), is the world's largest nocturnal rat and is native to tropical Africa, where it is recorded from 29 countries, many thriving in urban settings. Their ecological range extends from Senegal and the Gambia east across West Africa and the Congo Basin to the Indian ocean coast of East Africa (Cooper, 2008). African giant rats (*Cricetomys*) are native to tropical Africa, where they range from Senegal and Gambia east across West Africa and the Congo Basin to the Indian Ocean coast of East Africa. Ecological niche models show that *Cricetomys* species differ in their invasive potential. Although neither of the presently recognized *Cricetomys* species appears to have genuinely broad distributional potential in North America, models predict that *C. emini* would have extremely restricted distributional potential, whereas *C. gambianus* would have a broader potential across the southeastern United States (Peterson *et al*., 2006).

The African giant rats are widely distributed in Democratic Republic of the Congo, Nigeria, Cote d'lvoire, Guinea, Gabon, Kenya, Central African Republic, Gambia, Mauritania, Guinea Bissau, Ethiopia, Benin, Chad, Liberia, Sudan, Uganda, Mozambique, Angola, South Africa, Equatorial Guinea, Niger, Zimbabwe, Malawi,

Togo, Mali, Burkina are native to Faso, Cameroon, Burundi, Ghana, Senegal, Sierra Leone, Rwanda, Tanzania, Botswana, and Zambia. They are primarily solitary, nocturnal omnivores, exhibiting the tendency to live alone and feed on wide range of food materials including seeds, tubers, insects and small invertebrates enhancing adaptability to wide ecological environments. Individuals can grow to 362.64 mm. They rely on running to move around (Demoncheaux *et al.*, 2022a).

2.3.4 Habitats of African giant rats

In native Africa, this rat lives in colonies of up to twenty, usually in forests and thickets, but also found in termite mounds ('The Gambian Pouched Rat', 2015). African giant rats inhabit a variety of habitats ranging from arid to temperate areas, but need some form of shelter to survive. They are therefore not usually found in completely open areas, but in areas with cover ranging from hollow trees, rock outcroppings, or burrows made by other animals. They are occasionally known to venture into urban areas and can become pest animals. Predominantly nocturnal, giant pouched rats are omnivorous and are found throughout sub-Saharan Africa, except for southern South Africa. Habitats in which they live include forests and woodlands, as well as gardens, orchards (where they climb fruit trees during the day), and sometimes houses. Although these rats occasionally den in abandoned termite mounds, they live mostly in burrows dug in moist and shady areas (Ajayi, 1977a; Britannica, 2020) . Although Gambian rats are usually passive and shy in the wild, they are very protective of their nests and are aggressive in defending it.

2.3.5 Life span of African giant rats

The African giant rats live for about 5 to 7 years in captivity, although some have been known to live as long as 8 years. Life expectancy in the wild is hard to document because of the small size of these creatures, wide suffering from slash-and-burn hunting often by indigenous people and other destructive practices. The African giant rats are also known to live up to 14 years in captivity, reaching maximum body weights of approximately 2.80 kg in bucks and 1.39 kg in does (Ajayi & Tewe, 1978; Cooper, 2008; Makundi, 2018).

2.3.6 Behaviour of African giant rats

African giant rats are nocturnal animals, mostly due to the fact that they have little or no tolerance for the intense heat of a typical African day. They collapse readily under the hot Sun of Africa. Thus, they are nearly inactive during the day, and come out at night in search of food. Local hunters describe a vast system of tunnels or hollow trees rats for their nests, where they rest during the day and come out at night in search of food used by the Gambian (Paoletti, 2005).

Their nests are often located in cool areas, providing more evidence for their intolerance to heat. Interestingly, African giant rats find almost as much value in the act of carrying as much as the act of hoarding food (Biplang, 2018). The rats are also very good climbers and swimmers, and climb in excess of 2 meters easily. Both sexes are very territorial. Although African giant rats are generally solitary in the wild, females often form large groups containing many mothers and their litters while males usually remain solitary. African giant rats have also been known to huddle together when temperatures drop. Due to their low body fat, they do not retain heat easily (Ajayi *et al.*, 1978; Wilson, 2017)

2.3.7 Feeding habit of African giant rats

African giant rats are omnivores and feed on a variety of fruits, vegetables, nuts, and even insects when available. Some common foods include cassava, beans, sweet potatoes, and other roots. Termites have been known to be eaten and also snails but, apparently preferring palm fruits and palm kernels (Biplang, 2018).

The cheek pouches of African giant rat allow it to gather up to several kilograms of nuts per night for storage underground. It has been reported to stuff its pouches so full of date palm nuts so as to be hardly able to squeeze through the entrance of its burrow. The African Giant Rat is an omnivorous rodent which feeds on a wide range of food items. Its diet includes insects, termites, fruit and vegetable matter. They have cheek pouches in which they carry food and other items intended for storage (*African Giant Pouched Rat - Rodent - Africa*, 2022).

Hoarding of food for future consumption has been well studied in many avian and mammalian species (Brodin, 2010; Zhang *et al.*, 2022). There are two major food hoarding strategies – scatter hoarding and larder-hoarding; and there is a clear distinction between them. Larder-hoarding involves storage of food at a central site by animals that are able to defend their resources while scatter hoarders hide single food items in different locations because they are less able to defend stored food resources (Brodin, 2010; Zhang *et al*., 2022).

2.3.8 Role of African giant rats (AGR) in the ecosystem

African giant rats serve to keep insect populations under control, but also act as dispersers of seeds from different plants when they eat the fruits produced. Gambian rats serve to keep insect populations under control, but also act as transporters of seeds

from different plants when they eat the fruits produced. Several parasitic worms inhabit the gastrointestinal tracts of these rats, but the most prevalent of these are the Strongyloides. A study performed also showed minor presences of tape worms among other parasites (Halliez and Buret, 2015).

The rodent helps in dispersal of seeds from one place to another from different plants when they eat the fruits produced (Cooper, 2008). The droppings of African giant rats are a source of animal manure which can contribute to increased fertility of soil. They also break up soil larger particles into smaller particles leading to improved soil structure. The burrows made by them leads to aeration of the soil and consequently improved soil fertility (Mogbo, 2014).

2.3.9 Economic impact of African giant rats

The biggest economic impact of Gambian rats is as a source of food in Africa. They are considered rather tasty and are hunted and even raised on farms for their meat, this had led to a significant drop in their population. Their meat forms part of the bush meat trade and the smoked carcasses of these rodents are often sold in the villages and towns; attempts are being made in Nigeria and other countries in African to domesticate these animals in captivity for food and research (Oyarekua, 2010). A smaller industry is the pet industry, although these rats are rather large and sensitive to temperature changes, resulting in a need for high maintenance. The African giant rat (AGR) also known as giant pouched rat, is by size one of Africa's largest rodents and is arguably becoming Africa's most intriguing rodent because of its scientific attributes such as sniffing out landmines in Mozambique and in the diagnosis of Tuberculosis (Poling *et al.*, 2011).

The African giant rat is also known to be a disease vector (Demoncheaux *et al*., 2022) , potential pest species status (Peterson *et al.,* 2006) among many others. In the scientific community, these rats are often used for experiments, and these rats provide a wealth of information on rodent physiology and behavior (Bryda, 2013). Information gathered from local hunters revealed that traditionalists in Africa often at times use the African giant rat as a part of their elements for traditional rituals (Soewu, 2008). The ecology of the African giant rat ranges from Senegal and the Gambian east across West Africa and the Congo basin to the Indian ocean coast of East Africa. It is highly fecund, omnivorous and poses a threat to native ecological communities and agricultural crops specifically the nesting species. It is the commonest source of bush meat in the West African Sub region. The meat of the African giant rat is rich in protein and other nutritional values compared to meat sourced from some domestic animals (Mogbo & Akunne, 2014). The African giant rats are sometimes considered pests in urban areas where they may infest the sewers. In rural areas, they may destroy farm crops and build burrows in the soil which lead to soil desiccation and loss of plant crops. Gambian rats often inhabit barns and other farm buildings which can lead to property damage (Ajayi, 2008).

Gambian rats were termed as invasive species in some parts of Florida where it was feared that they may cause great ecological damage (Perry *et al.*, 2006); compete for food with native species, carry diseases, and damage the bird population by eating their eggs. Gambian rats also act as transporters of seeds from different plants when they eat the fruits produced. This African rodent is also believed to be responsible for the outbreak of monkey pox in the United States. In 2003, the United States' CDC (Center for Disease control) and the FDA (Food and drug administration) issued an order preventing the importation of the rodents following the first reported outbreak of

monkey pox. Several African species are believed to carry the disease (Centre for Disease Control and Prevention (USA), 2017).

2.3.10 Acceptability and Potential of AGR Domestication

To harness rodents as a major source of meat, there is need to encourage people to rear them in captivity, process and package the meat for wider distribution to consumers (Makundi, 2018).The meat from the African giant rat is widely accepted and has a potential to be used as an alternative protein source to domestic meat and chicken. Raw African giant rat meat is rich in protein and very low in fat mostly in its thigh (Oyeyinka *et al.*, 2019).

Though with reported breeding trials of difficult reproductive performance; giant rats have shorter gestation and weaning period with records of 5 litters in 9 months and have almost similar capacity of rabbits to produce animal protein. Also, there are certain areas in Africa where consumption of giant rats meat reaches important levels and where captive breeding programmes could perhaps allow the provision of markets with captive bred meat (Jori *et al.*, 2005).

2.3.11 Overview of research on the African giant rats

The analysis of the different sectors contributing to bushmeat exploitation has largely been looked at in isolation. Only recently have studies started investigating the detailed structure of communities in terms of a commodity chain, from its point of extraction to consumption (Alexander, 2015). Adebayo *et al.* (2010) examined the reproductive biology of the female African giant rat (*Cricetomys gambianus*, Waterhouse), providing detailed insights into the morphology and physiology of the uterus and mammary glands. Their findings contribute valuable information to the understanding of the

species' reproductive system and its potential for domestication and breeding management.

Moreover, research has been undertaken on these African giant rats in the medical field especially in Zoonosis. Operant discrimination training procedures have been used to teach giant African pouched rats to detect tuberculosis (TB) in human sputum samples. Available data suggest that pouched rats, which can evaluate many samples quickly, are sufficiently accurate in detecting TB to merit further investigation as a diagnostic tool (Poling *et al*., 2011).

Research on the African giant rat has covered diverse fields, notably its taxonomy and domestication processes (Cooper, 2008; Olayemi *et al.*, 2012). Further investigations have addressed aspects of neurological development and production performance, with particular attention to the anatomical structure of the reproductive organs in both sexes and their physiological adaptations that support breeding and domestication (Ibe *et al*., 2010; Olude *et al.*, 2015; Freeman *et al.*, 2019). Heamatological research has also been documented by various authors (Stokol *et al*., 2021). Survey of intestinal and blood parasites affecting the rats in the wild and possible public health implications (Mbaya *et al.*, 2011;Onah & Umeike, 2022).

In contrast of the vast studies on the African giant rats not much attention has been given to the beneficial effects of rodents to human food security (Assogbadjo *et al.*, 2005); and little information had been published on the composition and nutritive value of African giant rat carcass (Josephl & Abikoye, 1997; Oyarekua, 2010; Oyeyinka *et al*., 2019).

2.4 Sexual Dimorphism of Rodents

Sexual size dimorphism is likely to have originated in mammals during evolution due to competition among males for access to females; males would fight one another to gain access to females and the winner, generally the bigger, stronger animal would mate with more females (Doyle *et al.*, 2021). Sexual dimorphism is the phenomenon whereby males and females of the same species are distinctive in behaviour, size, or appearance (Berns, 2013). Also, sexual dimorphism is the condition where the sexes of same animal and/or plant species exhibit different morphological characteristics, particularly characteristics not directly involved in reproduction (*Encyclopedia of Animal Behavior*, 2019) . Sexual dimorphism can be referred to as the differences in morphology between the sexes, thus primarily concerning secondary sexual traits and not the primary sexual traits defining the sexes (eggs, sperm, gonads) (Blanckenhorn, 2018). Sexual size dimorphism (SSD) can be attributable to the combination of sex-specific genes on sex chromosomes, sex specific expression of genes, and other regulatory mechanisms that are not yet widely understood (Pointer *et al*., 2013). Studies have revealed key roles of sex hormones in regulating structure and/or function of nearly every tissue and organ in the mammalian body (Li *et al*., 2018).

Moreover, many animal lineages conform to "Rensch's rule", which states that male-biased SSD increases with body size. An instance was research conducted on African giant rats, which resulted in Male-biased sexual size dimorphism which was observed during all the seasons, but was highest during the hot-dry season. The seasonal variation in live weight may be because food was more available in the wild during the harvest (dry) seasons (harmattan and hot-dry seasons) than the planting (rainy) season. The relatively low ambient temperature and relative humidity of the harmattan season was more favourable to growth, which may account for the higher live weight recorded

during the season. The sex variation in live weight may be as a result of differential growth rate/time between the sexes. In conclusion, the African giant rats are lighter during the rainy season and the live weight of the male is higher than that of the female regardless of the season (Dzenda *et al*, 2010).

Sexual size dimorphism (SSD) is a widespread phenomenon in animals including mammals. It has been demonstrated that across species, the direction and magnitude of sexual dimorphism in body size often corresponds to social systems. However, a test conducted on ground squirrels on whether considerable differences in sociality and large variation in body size were connected with the evolution of SSD general trend of male-biased SSD; revealed a general trend of male-biased SSD in ground squirrels, however, male size increases nearly perfectly isometrically with female size among species and sociality does not explain departures from this relationship. Species with different sociality grades significantly differ in body size, with the most social species tending to be the largest (Matějů & Kratochvíl, 2013).

2.5 Growth Rate of Rodents

Growth may often be referred to as an increase in live weight gain or a progressive increase in size (length, height, girth, volume) or weight of an animal during a specific time period (Lonergan *et al.*, 2019).

2.5.1 Body weight

The body weight (BW) of animals represents their physiological status and growth rate and is an important basis on which animal management strategies are decided (Cho *et al.*, 2020). Live weights and body measurements taken on live animals have been used expansively for a diversity of reasons both in experiments and in breeding and selection

procedures (Cam *et al*., 2010). The accuracy of functions used to predict live weight or growth characteristics from live animal measurements is of immense financial contribution to livestock production enterprises. When these measurements are done it will ensure that livestock farmers are adequately rewarded rather than the middlemen and/or livestock product processors that tend to gain more profit in livestock production business, especially in the rural areas of developing countries (Birteeb & Ozoje, 2011; Decampos *et al*., 2013).

Breeding decisions are among the most critical aspects of livestock management. According to Kelvin (2018), monitoring herd health and body weight helps determine the optimal breeding period. Weight data also provide useful indicators for adjusting feed composition or improving nutrient intake. Achieving an appropriate feed conversion rate enables farmers to formulate balanced rations that promote desired growth performance within a specific timeframe. Studies generally indicate that male African giant rats exhibit higher body weights than females, both in the wild and under captive conditions. Average mature weights have been reported at approximately 2.80 kg for males (bucks) and 1.39 kg for females (does) (Ajayi & Tewe, 1978; Cooper, 2008; Dzenda *et al*., 2010). Similarly, Obadiah and Dzenda (2014) observed that males had a slightly greater mean body weight (1356.67 ± 51.74 g) compared to females (1313.33 ± 43.4 g), further supporting the trend of sexual dimorphism in body size within the species.

2.5.2 Feed intake

The feed intake of farm animals depends on factors such as their physiological status, age, state of production, dietary protein concentration and energy. An average daily live weight gain in a feeding trial for weanlings was 5·1-7·3 g with a daily feed intake of

26·9-36·3 g on 6 diets. Growth performance improved as the dietary protein level was raised from 10 to 13 %, but a further increase to 16% did not result in greater growth (Ajayi & Tewe, 1978b). Also, a feeding trial with untamed African giant rats revealed an average daily dry matter intake and daily gain of 24.88-27.07g and 1.17-3.25g respectively (Fonweban & Njwe, 1990).

2.6 Carcass Characteristics and Meat Quality

Meat ranks among one of the most significant, nutritious and favoured food items available to masses, which aids in fulfilling most of their body requirements. It has played a vital role in human evolution and is an imperative constituent of a well-balanced diet (Ahmad *et al*., 2018). Meat is a good source of proteins, zinc, iron, selenium, and phosphorus followed by vitamin A and B-complex vitamins. Average value of meat protein is about 23% that varies from higher to lower value according to the type of meat source. Quality traits of meat along with its nutritional composition become dependent upon animal breed type, feeding source (grains, pasture and grass), genetics of animal and post mortem techniques (Ahmad *et al*., 2018). Meat from the various species of rats is reported to be palatable, with a taste comparable with that of pork, chicken, or rabbit meat (Deutsch & Murakhver, 2012).

2.6.1 Meat quality and composition

The proximate chemical composition, minerals, and cholesterol contents of the skin, liver, limb muscle and brain of African giant rat were investigated using standard methods. The brain had the highest levels of phospholipids, moisture and phosphorus. Limb muscle and liver had highest content of protein while skin had the lowest value. Meat samples had protein contents approximately 20 % of the African giant rat muscle which was higher than the liver of 18%, the brain 12 % and the skin with the least of 9

% after the analysis. Liver and limb muscle had comparable fat values with brain having the lowest. The limb muscle appeared desirable in nutritive value. Also, the nutritional composition of African giant rat may vary with the sex, age, ration and the part of the meat (Oyarekua & Ketiku, 2010).

Chemical composition in a study showed that grasscutter had higher crude protein and lower fat contents than African giant rat. African giant rat had higher index of water holding capacity and ultimate pH and consequently lower percentage of cooking losses. Some variations in carcass quality due to sex were also observed (Josephl & Abikoye, 1997; Oyeyinka, 2019). Also, the proximate compositions of the raw African giant rat meat in their study were not affected by sex, since the values obtain after meat quality assay were very similar. Protein was the major nutrient in the meat with approximately 24 %, while fats, ash, fibre and carbohydrate were very low (Oyeyinka *et al.*, 2019b).

2.6.2 Carcass yields

Records of the live and carcass weights of the African giant rat (*Cricetomys gambianus Waterhouse*) and the domestic rabbit (*Oryctolagus cuniculus L.)* in a published paper revealed that male and female giant rats have an average killing out percentage of 51.4 % and 51.6 % respectively. The difference between the killing-out percentages of both sexes was not statistically significant at 5% probability level. There was also no significant difference at 5 % probability level between the killing-out percentages of giant rats and domestic rabbit (Ajayi, 2008).

The liver of the African giant rat, in a study, had a mean weight of 22.91g. This constituted 2.1 % of the mean body weight. This is also equivalent to one-fiftieth (1/50th) of the body weight. The mass of the laboratory rat liver accounts for a mean weight of 15.5g about 6% of the total body weight. This implies that, in relative terms,

the laboratory rat has a heavier liver than the African giant rat (Nzalak, *et al.*, 2011; Vdoviaková *et al*., 2016).

Carcass yield in African giant rat (*Cricetomys gambianus*) and grasscutter (*Thryonomys swinderianus*) were examined. Grasscutter was found to have higher live and carcass weights, higher lean meat yield, but lower dressing percentage than African giant rat. The weights of body components showed direct relationship with the animals' size and sex with male animals having higher values. The bucks and does of African giant rats had carcass weights 1515g, 1432.93g and dressing percentages of 69.71 % and 68.54 % respectively (Josephl & Abikoye, 1997; Oyeyinka, 2019).

2.7 Phenotypic Correlation Estimates

Phenotypic correlation is the term that describes animals with high values for one phenotype also tending to have high or low values for another phenotype. Correlations are positive when high values occur together and negative when high values in one trait occur with low values in another (Bennett *et al.*, 2014a). A simulation study of two correlated traits displaying heritability, genetic, environmental and phenotypic correlations equal to the average literature estimates was performed to investigate the effects of using phenotypic correlation estimates instead of genetic correlation estimates on the direct and indirect true selection responses and on the accuracy of the breeding values.

Based on the results of the descriptive and simulation analysis for the species, traits and correlation structure examined, phenotypic correlations may be substituted for genetic correlations when the latter are unavailable or are not precisely estimated (Kominakis, 2003). Genetic variances and correlations lie at the centre of quantitative evolutionary theory. Analysis indicates that squared genetic correlations were on average much

higher than squared phenotypic correlations and that genetic and phenotypic correlations had only broadly similar patterns. These results could be attributed to either biological causes or to imprecision of genetic-correlation estimates due to sampling error. Studies based on the largest sample sizes (effective sample size of 40 or more) were then included, squared genetic-correlation estimates were only slightly greater than their phenotypic counterparts and the patterns of correlation were strikingly similar. Hence, phenotypic correlations are likely to be fair estimates of their genetic counterparts in many situations. An instance, livestock breeders use genetic correlations to improve accuracy, reduce time needed for evaluation, and expand the scope of genetic evaluation. Example, carcass lean meat yield is difficult to obtain. Measurements on harvested progeny can delay accurate genetic evaluation and reduce intensity of selection. Ultrasound and other live animal measurements on correlated phenotypes like fat thickness and muscle area remove some constraints of successful and timely genetic evaluation of lean meat yield (Cheverud, 1988; Bennett *et al*., 2014).

Genotypic and phenotypic correlations are of value to indicate the degree of which various morpho-physiological characters are associated with economic productivity. A correlation coefficient is useful in quantifying the magnitude and direction of components influence in the determination of main traits. Correlation coefficient for analysed traits, direct and indirect effect, provide greater reliability in interpretations of cause and effect between studied traits (Baye *et al.*, 2020). The association between two characters can be directly observed as phenotypic correlation, while genotypic correlation expresses the extent to which two traits are genetically associated. Phenotypic correlation involves the combination of genetic and environmental with non-additive genetics effects (Yahaya *et al*., 2021).

Genetic and phenotypic correlations between performance and meat quality characteristics determine the amount of difference in meat quality due to changes in growth and carcass composition (Nasirifar *et al*., 2021). Findings in a study conducted on genetic and phenotypic parameters of grasscutter were in general agreement of what pertains to the grasscutter and other farm livestock species. The results could therefore be used to initiate grasscutter selection breeding programmes through estimating breeding values, defining breeding objectives and calculating annual rate of genetic gain (Annor *et al.*, 2012).

2.8 Prediction of Carcass Traits from Live Weight

In correlation analysis, the phenotypic correlation of the independent variables and dependent variables can be divided into direct and indirect actions. The direct action is the direct impact of the independent variable on the dependent variable, whereas the indirect action is the indirect impact of the independent variable on the dependent variable (Junjie *et al.*, 2019). Mohammed *et al*. (2024) studied African giant rats and observed a highly significant positive correlation existing between live body weight and morphological traits, especially heart girth which somewhat translates to thoracic weight. Carcass cuts weight can be predicted with reasonable accuracy from live body weight as reported by a study on rabbit breeds. This is aimed at helping breeders and farmers to fix prices and predict income/gain from each rabbit before slaughter (Sam *et al.,* 2020). In a study conducted on the prediction of carcass meat, fat and bone yield across diverse cattle genotypes using live-animal measurements, it was observed that live weight was the best for predicting carcass quantity components [meat (R^2=0.70) and bone (R^2=0.62) weight] (Afolayan *et al.,* 2002).

A study conducted to determine the phenotypic correlation between live body weight and carcass traits (dress weight, foreleg, thoracic, loin, hind leg and skin) and to predict the weight of carcass parts from live body weight in rabbits. The four genetic groups used involved: two purebreds Chinchilla (CHA) and New Zealand White (NZW) and their reciprocal crossing [CHA sire x NZW dam (CHA x NZW) and NZW sire x CHA dam (NZW X CHA). The prediction equations for carcass traits indicate that dressed weight, foreleg, thoracic and loin in the four genetic groups were predicted with more accuracy than the prediction of hind leg and skin. The actual and computed carcass weights were almost similar which indicate that carcass parts can be predicted from live body weight with accuracy. The investigation also demonstrated the applicability of regression equation to predict carcass traits in rabbit (Sam & Ekpo, 2020).

CHAPTER THREE: MATERIALS AND METHODS

3.1 Experimental Site and Period of the Study

The study was conducted at Microlivestock Section of the Department of Animal Science, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development Asante Mampong Campus. The study commenced from 13th May, 2022 to 8th April, 2023. Asante Mampong lies in the transitional zone between the Guinea Savanna zone of the North and the Tropical Rainforest of the south of Ghana, along the Kumasi-Ejura Road. The Municipality lies between latitude 07º 04' N and longitudinal 01º 24' W with an altitude of 457m above sea level and is about 65km north of Kumasi (MLGRD, 2022) with minimum and maximum average annual temperatures of 22.66ºC and 34.26ºC respectively and average humidity of around 82 %. Asante Mampong has an average annual rainfall of about 1224mm with two peaks of rainfall (Bimodal): the major season is from March to July and minor season is from September to November. The dry season occurs from December to March and is characterized by north-east dry winds (Harmattan) from Sahara Desert. The vegetation is transitional Savanna woodland (MSD, 2022).

3.2 Experimental Animals

The experimental animals of 3-4 months old for the study weighed between 250g-450g in both sexes; were purchased from the Ministry of Food and Agriculture (MOFA). The sourced experimental animals were given a similar two-week acclimation period, housing, feed and handling before measurements to reduce farm and post arrival effects. The African giant rats sourced for the experiment had a long tail, which is bare and with white tip. The body is covered with relatively grey long fur whereas the under parts are slightly

paler; with face characterised by long dark whiskers. The stock comprised 20 bucks and 20 does. There were two treatments representing males and females. Each treatment comprised twenty replicates. The twenty 20 does and 20 bucks were randomly assigned singly to each replicate.

3.3 Experimental Design

A completely randomized design (CRD) was employed, involving a comparative assessment between two groups comprising male and female African giant rats.

3.4 Management of Experimental Animals

3.4.1 Housing

The experimental units were housed singly in the cells of their respective hutches. The experimental animals were housed in a 3- tier wooden cages with each cell measuring 70cm x 69cm x 50cm. The wooden cages were partitioned by a 2cm by 2cm wire mesh. The floor of the wooden cages was also covered with a 2cm wire mesh. Wire mesh was also used to cover the exposed surface of the wood to prevent gnawing by the animals. The roof of each tier of the wooden cages was slanted and lined with corrugated iron sheets to aid in cleaning and drainage of waste. The three tier wooden cages were in turn placed in a sandcrete building roofed with corrugated iron sheets.

Plate 1: Three-tier wooden cage used to house the experimental animals.

3.4.2 Feeding and watering

Animals were fed a basal diet of chopped cassava tuber (*Manihot Spp*), palm fruits (*Elaeis guineensis*), maize grain (*Zea mays*) and guinea grass (*Panicum maximum*). An average of 500g feed was offered daily after weighing (Fonweban & Njwe, 1990). Left over feed were also weighed daily before successive feeding in the mornings between 6:30am and 8:00am. Clean water was provided *ad libitum*. The feed and water for each experimental animal were provided in clean concrete and clay troughs respectively.

3.4.3 Health care

Cleaning of cages and the housing unit accommodating the cages was carried out daily to prevent the accumulation of urine and faecal matter. Feeding and water troughs were also cleaned on daily basis. African giant rats are known to have strong immune system but internal parasites can be of a significant health issue. Routine deworming was

therefore performed using Albendazole, 2.5% (Mobedco-Vet Jordan). Each day animals were observed for the occurrence of sickness for isolation and treatment.

3.5 Data Collection

3.5.1 Growth and body weight parameters

The growth parameters taken included: body weight (g), feed intake (g), bi- weekly weight gain (g) and feed conversion ratio. The body weight of experimental animals from each replicate was taken every two weeks for six months during the experimental period. The experimental animals were restrained by holding the third of their tails into a rectangular designed metal cage to avoid injury to the handler and for precise readings hanged freely on a portable electronic hanging scale (WeiHeng brand 10kg capacity by 0.0001g sensitivity).

3.5.1.1 Feed intake

Feed intake was measured daily in grammes (g) with a digital kitchen scale with a sensitivity of 1g and recorded for individual animals in each treatment. Feed intake was calculated and taken as the difference between feed given and feed-left over.

3.5.1.2 Feed conversion ratio

Feed conversion ratio was calculated as the ratio of the total eaten feed weight (g) to the total weight gain (g) in the experimental period.

Arithmetically,

$$Feed\ conversion\ ratio = \frac{Total\ feed\ intake\ (g)}{Total\ weight\ gain\ (g)}$$

3.5.2 Live weight

The live weight of each experimental animal randomly selected for carcass analysis were taken prior to slaughtering.

3.5.3 Carcass analysis

A total of 10 experimental animals, five does and five bucks each were randomly selected from the tagged experimental animals at the end of the eleventh month. The selected animals were starved and only watered overnight for 12 hours before slaughter to aid in easy evisceration.

3.5.3.1 Carcass weight

The selected tagged animals were rendered unconscious and a clean sharp knife was used to cut the throats and the animals' head was hanged for about five minutes to bleed properly using method recommended (Sam *et al*., 2020). The carcass weights of the slaughtered animals were taken using a digital scale (SF-400 China) having a capacity of 10kg and an accuracy of 1g. The animals were properly dissected and the internal organs (kidney and liver, intestine, heart, liver, kidney, spleen) were carefully removed from the carcasses and weighed using methods recommended by Sam *et al*. (2020). The weights of parts of the carcasses including the forelimb, hind limb, loin, tail, liver, kidney and thoracic weights were taken after thorough removal using a digital kitchen scale balance (SF-400 China). The remaining carcasses were put on flame to burn furs. After scalding the carcasses were thoroughly washed in cold water weighed without the internal organs to obtain the dressed carcass weight using methods previously described (Oyeyinka *et al*., 2019).

3.5.3.2 Dressing percentage

The carcass dressing percentage was obtained as the ratio of eviscerated weight to live weight of the animals. This is expressed mathematically as:

$$\text{Dressing percentage} = \frac{Dressed\ weight}{Live\ body\ weight}\ x\ 100$$

3.5.3.3 Determination of meat composition

The carcass pH was determined 45 minutes post-slaughter using a portable Hanna pH meter (Hanna Instruments, Woonsocket, RI, USA). Measurements were taken from the quadriceps femoris muscle of the thigh. Prior to use, the device was standardized with buffer solutions of pH 4.0 and 7.0 to ensure precise readings and maintain accuracy within this calibration range. Protein, fat, ash, carbohydrate and moisture were determined using the Association of Official Analytical Chemists (AOAC, 2016) method at Faculty of Science Education laboratory unit of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) .

3.6 Statistical Analysis

Data collected from the male and female African giant rats were analysed using t-test, Pearson's correlation (r) and linear regression models independently using GenStat statistical package Eleventh Edition. Differences between means were separated by probability difference (PDIFF) procedure of GenStat at 5% probability level. The degree of association between live body weight and carcass traits and among two carcass traits including (dress weight, forelimb, hind limb, loin, tail, and thoracic cage weights) for both sexes of the experimental units were determined using the Pearson's correlation coefficient (ρ) below:

$\rho\ (X, Y) = Cov\ (X.Y) / \sigma X.\sigma Y$

where;

X and Y = The two samples representing the male and females respectively

Cov (X and Y) = Covariance of male and female samples

σX = Standard deviation of male sample

σY = Standard deviation of female sample

The simple prediction equations of carcass traits from live body weight were performed using the linear regression model,

$y = \alpha + \beta x + e$

where;

y = predicted carcass trait (dependent variable)

x = live body weight (independent variable)

α= intercept

β = slope of the regression

e = random error term that cannot be explained.

CHAPTER FOUR: RESULTS

4.1 Growth Performance of the Male and Female African Giant Rats

4.1.1 Bi-Weekly Total Feed Intake of the Male and Female African Giant Rats

The total bi-weekly feed intake was not significantly ($p>0.05$) influenced by sex of the African giant rats (Table 4.2).

Table 4.1: Bi-Weekly Feed Intake in Both Sexes of the African Giant Rats.

Week	BFI (g) Male	BFI(g) Female	SEM	P-value
2	363	421	85.8	0.144
4	546	470	130.2	0.208
6	532	426	130.6	0.088
8	528	445	153.1	0.240
10	460	489	126.9	0.612
12	516	507	156.9	0.898
14	457	421	105.0	0.450
16	435	490	86.9	0.176
18	400	458	127.6	0.323
20	402	482	99.7	0.091
22	473	443	101.8	0.517

BFI (g) = *Bi-weekly feed intake in grammes*, SEM = *Standard error of mean*, P-value= *probability value*

4.1.2 Bi-weekly body weight of the male and female African giant rats

The results of the average body weight measurements taken every two weeks for both sexes of African giant rats used in the study (Table 4.1). Sex had no significant influence ($p>0.05$) on bi-weekly mean body weight measurements from week 2 to week 8 However, sex had a significant influence ($p<0.05$) among bi-weekly body weights from week 8 to week 22. The male African giant rats recorded a better weight gain than the female African giant rats (Table 4.1).

Table 4.2a: Bi-Weekly Body Weight in Both Sexes of the African Giant Rats.

Week	BBW(g) Male	BBW(g) Female	SEM	P-value
2	417	365	101.2	0.265
4	501	439	100.8	0.188
6	587	510	98.4	0.095
8	671	584	97.8	0.064
10	754	659	96.5	0.041
12	837	733	95.8	0.026
14	920	807	94.9	0.016
16	1003	822	95.5	0.011
18	1086	957	95.9	0.007
20	1167	1030	95.0	0.004
22	1252	1104	94.8	0.003
24	1335	1178	94.4	0.002

P- value = Probability value, BBW(g) = Bi-weekly Body weight in grammes, SEM = Standard error of mean.

Table 4.2b: Bi-Weekly Body Weight Gain in Both Sexes of the African Giant Rats.

Week	BBWG(g) Male	BBWG(g) Female	SEM	P-value
2	83.8	74.1	4.086	<0.001
4	86.4	70.5	8.040	<0.001
6	83.5	74.7	2.292	<0.001
8	83.2	74.6	2.309	<0.001
10	83.0	73.8	2.181	<0.001
12	83.1	74.1	2.350	<0.001
14	82.9	75.1	3.332	<0.001
16	83.4	74.6	2.366	<0.001
18	82.3	73.6	2.167	<0.001
20	83.2	73.9	4.140	<0.001
22	83.2	73.5	2.583	<0.001

P- value = Probability value, BBWG(g) = Bi-weekly Body weight gain in grammes, SEM = Standard Error of Mean.

4.1.3 Growth Performance Parameters of the Male and Female African Giant Rats

Table 4.3 shows the effect of sex on the measured growth performance parameters. The effect of sex on the average initial body weight, feed intake and feed conversion ratio was not significantly different ($p>0.05$). However, there were significant differences between both sexes of the African giant rats for the bi-weekly weight gain ($p<0.001$) and the final body weight ($p<0.05$); with the males recording higher values than their female counterparts in both parameters respectively (Table 4.3).

Table 4.3: Growth Performance of the Male and Female African Giant Rats

Parameter	Male	Female	P-value
IBW	417	365	0.256
FI (g/d)	33.20	32.81	0.835
FBW (g)	1335	1178	0.002
ABBWG(g)	83.48	73.93	<0.001
FCR	5.56	6.22	0.066

FI (g/d) = Feed intake in grammes per day, FCR = Feed conversion ratio, IBW = Initial body weight, FBW = Final body weight, ABBWG = Average bi-weekly body weight gain

4.2 Carcass Characteristics in Both Sexes of the African Giant Rats

The results of the live body weight before slaughter and carcass traits measured for both sexes of African giant rats used are presented in (Table 4.4). The effect of sex on carcass traits were not significant ($p>0.05$) among liver weight, tail weight, and dressing percentage; but sex had significant ($p < 0.05$) effect on live body weight and other carcass traits measured including; dressed weight, bled carcass weight, foreleg, thoracic, hind, loin, and kidney weights (Table 4.4).

Table 4.4: Live Body Weight at Slaughter and Carcass Traits of the Male and Female African Giant Rats.

Carcass Trait	Male	Female	SEM	P-value
LBW (g)	2130	1782	169.8	0.012
CW (g) (%)	1982 (93.1)	1668 (93.6)	143.3	0.009
DRWT (g) (%)	1226 (57.5)	988 (55.4)	121.8	0.015
DR (%)	57.49	55.42	2.392	0.208
FOREL (g) (%)	97.3 (4.6)	81.2 (4.5)	5.53	0.002
THOR (g) (%)	162.7 (7.6)	142.4 (8.0)	12.20	0.030
HIND (g) (%)	183.6 (8.6)	142.0 (7.9)	20.98	0.014
LOIN (g) (%)	179.1 (8.4)	165.17 (9.3)	7.43	0.018
TW (g) /(%)	22.0 (1.0)	17.6 (0.9)	5.71	0.256
KIWT (g) (%)	4.56 (0.2)	5.38 (0.3)	0.424	0.016
LWT (g) (%)	16.46 (0.8)	17.42 (0.9)	1.221	0.248

P-value= probability value, g = grammes, and % = per cent, SEM = Standard error of mean, LBW= Live body weight, CW= Bled carcass weight, DRWT= Dressed weight, DR%= Dressing percentage, "FOREL= Foreleg, THOR=Thoracic, HIND= Hind leg, KIWT= Kidney weight, and LWT= Liver weight with percentages of LBW respectively in parenthesis".

4.3 Meat Composition

Effect of sex on percentage moisture, protein, fat, ash, carbohydrate and pH content of the African giant rat meat is presented in Table 4.5. Sex effect on percentages of protein, fat, carbohydrate, moisture, and pH contents were not significantly different ($p>0.05$). However, the percentage of ash content was significantly different ($p<0.05$) with higher values in females relative to their male counterparts (Table 4.5).

Table 4.5: Nutrient Composition and pH Content of the Male and Female African Giant Rat Meat

Parameter	Male	Female	SEM	P-value
Protein %	23.3	22.8	3.0900	0.808
Fat %	4.95	5.58	1.8010	0.634
Ash %	1.205	0.975	0.1152	0.030
Carbohydrate %	7.36	5.92	1.3130	0.172
Moisture %	58.4	59.9	6.9300	0.761
pH	5.76	5.78	0.9800	0.975

SEM= Standard Error of the Mean

4.4 Phenotypic Correlation Estimates Between Live Body Weight at slaughter and Carcass Traits of the Male African Giant Rats

4.4.1 Phenotypic correlation estimates between live body weight at slaughter and carcass traits of the male African giant rats

The recorded phenotypic correlation coefficients (r) between live body weight and carcass traits of the male African giant rats are shown (Table 4.6). In the male African giant rats, significant positive correlations were obtained between live body weight and all the carcass traits and among the carcass traits. The correlation coefficient (r) between live body weight before slaughter and the measured carcass traits ranged from low to high; with thoracic weight recording the highest (r = 0.9544) and the least recorded was with dressing percentage (r = 0.4843). The correlation coefficient between live body weight and the carcass traits followed in decreasing order as r =0.9544, 0.9517, 0.9517, 0.9271, 0.9168, 0.9125, 0.8486, 0.8077 and 0.4843 for thoracic, loin, dressed weight, hind, tail, liver, foreleg, kidney and dressing percentage respectively (Table 4.6). The phenotypic correlation coefficients among measured carcass traits were also positive ranging from low to high. The highest recorded correlation coefficient was between liver and tail weight (r = 0.9948); and the least between kidney weight and dressing

percentage (r = 0.0284). The highest correlation coefficient among external carcass traits measured was recorded between hind and thoracic weights (r = 0.9551) with the lowest between loin and foreleg weights (r = 0.7501) (Table 4.6).

Table 4.6: Estimate of Phenotypic Correlation Between Live Body Weight at slaughter and Carcass of the Male African Giant Rats.

	FOREL	HIND	LOIN	KIWT	LBW	LWT	THOR	TW	DWRT	DR%
FOREL	1									
HIND	0.8077**	1								
LOIN	0.7501**	0.8608**	1							
KIWT	0.9255**	0.8695**	0.6340**	1						
LBW	0.8486**	0.9271**	0.9517**	0.8077**	1					
LWT	0.7262**	0.9773**	0.9091**	0.7525**	0.9125**	1				
THOR	0.9315**	0.9551**	0.9033**	0.8955**	0.9544**	0.9256**	1			
TW	0.6989**	0.9548**	0.9375**	0.6978**	0.9168**	0.9948**	0.9108**	1		
DRWT	0.7951**	0.7989**	0.9783**	0.6428**	0.9517**	0.8256**	0.8869**	0.856**	1	
DR%	0.3702	0.2158	0.6720**	0.0284	0.4843*	0.3284	0.4028*	0.408*	0.7294**	1

**P<0.05, **P<0.01, LBW= Live body weight at slaughter, DRWT= Dressed weight, FOREL= Fore leg, THOR=Thoracic, HIND= Hind leg, TW= Tail weight, KIWT= Kidney weight, LWT= Liver weight, DR% = Dressing percentage.*

4.4.2 Phenotypic correlation estimates between live body weight and carcass traits of the female African giant rats.

In the female African giant rats, significant positive correlations were obtained between live body weight and all the carcass traits and among the carcass traits; except between tail weight and dressing percentage (r = -0.23). The correlation coefficient (r) between live body weight before slaughter and the measured carcass traits ranged from low to high; with thoracic weight recording the highest (r = 0.9892) and the least recorded was with dressing percentage (r = 0.1128). The correlation coefficient between live body weight and the carcass traits followed in decreasing order as r =0.9892, 0.9896, 0.9867, 0.9784, 0.8940, 0.8744,0.8367, 0.8115 and 0.1128 for thoracic, kidney, foreleg, loin, hind, liver, dressed weight, tail and dressing percentage respectively. The highest correlation coefficient recorded among carcass traits was found to be between foreleg and kidney weight (r = 0.9995); and the least between tail weight and dressing percentage (r = -0.230). The highest among external carcass traits measured was recorded between foreleg and thoracic weights (r = 0.9977) with the lowest between loin and tail weights (r = 0.6769) (Table 4.7)

Table 4.7: Estimate of Phenotypic Correlation Between Live Body Weight at slaughter and Carcass Traits of the Female African Giant Rats.

	FOREL	HIND	LOIN	KIWT	LBW	LWT	THOR	TW	DWRT	DR%
FOREL	1									
HIND	0.9312**	1								
LOIN	0.9896**	0.8763**	1							
KIWT	0.9995**	0.9198**	0.9937**	1						
LBW	0.9867**	0.8940**	0.9784**	0.9869**	1					
LWT	0.9079**	0.9178**	0.8550**	0.8984**	0.8744**	1				
THOR	0.9977**	0.9401**	0.9838**	0.9962**	0.9892**	0.8951**	1			
TW	0.7434**	0.7710**	0.6769**	0.7301**	0.8115**	0.7117**	0.7742**	1		
DRWT	0.8831**	0.7989**	0.8713**	0.8832**	0.8367**	0.9427**	0.8520**	0.502**	1	
DR%	0.2124	0.1774	0.2065	0.2133	0.1128	0.47318*	0.1516	-0.23	0.6382**	1

**P<0.05, **P<0.01, LBW= Live body weight at slaughter, DRWT= Dressed weight, FOREL= Foreleg, THOR=Thoracic, HIND= Hind leg, TW= Tail weight, KIWT= Kidney weight, LWT= Liver weight, DR% = Dressing percentage.*

4.4.3 Phenotypic correlation estimates between live body weight at slaughter and carcass traits for pooled sexes of the African giant rats

Significant strong positive correlations were obtained between live body weight and the carcass traits except its relationship with the kidney. The correlation coefficient (r) between live body weight before slaughter and the measured carcass traits ranged from low to high. Dressed weight recorded the highest value followed by thoracic (r = 0.9669 and 0.9640 respectively) and the least recorded was with liver weight followed by dressing percentage (r = -0.183 and 0.5260 respectively) with live weight. The correlation coefficient between live body weight and the carcass traits followed in decreasing order as; r =0.9669, 0.9640, 0.9333, 0.9079, 0.8809, 0.8165, 0.5260, 0.2275 and -0.183 for dressed weight, thoracic, foreleg, loin, hind, tail, dressing percentage, liver and kidney respectively (Table 4.8).

Results in Table 4.8 show that the phenotypic correlation coefficient among measured carcass traits ranged from low to high; with some recording negative correlations. The highest recorded correlation coefficient was between foreleg and thoracic (r = 0.9486); and the least between kidney and thoracic weights (r = -0.031).

Table 4.8: Phenotypic Correlation Estimates Between Live Body Weight at slaughter and Carcass Traits and among the Carcass Traits for Pooled Sexes of the African Giant Rats.

	FOREL	HIND	LOIN	KIWT	LBW	LWT	THOR	TW	DWRT	DR%
FOREL	1									
HIND	0.9333**	1								
LOIN	0.9363**	0.9405**	1							
KIWT	-0.2820	0.8695**	-0.131	1						
LBW	0.9333**	0.8809**	0.9079**	-0.183	1					
LWT	-0.0384	0.0741	0.0869	0.7055**	0.2275	1				
THOR	0.9486**	0.9349**	0.9473**	-0.031	0.9640**	0.2678	1			
TW	0.6824**	0.7666**	0.7460**	0.1522	0.8165**	0.5408**	0.8403**	1		
DRWT	0.9028**	0.8360**	0.8883**	-0.225	0.9669**	0.2073	0.9209**	0.739**	1	
DR%	0.5053**	0.4313*	0.5306**	-0.242	0.5260**	0.0774	0.4809*	0.255	0.7249**	1

**P<0.05, **P< 0.001, LBW= Live body weight at slaughter, DRWT= Dressed weight, FOREL= Foreleg, THOR=Thoracic, HIND= Hind leg, TW= Tail weight, KIWT= Kidney weight, LWT= Liver weight, DR% = Dressing percentage.*

4.5 Prediction Equations for Carcass Traits from Live Body Weight of the African Giant Rats

4.5.1 Prediction equations for carcass traits from live body weight of the male African giant rats

Simple regression equations for predicting carcass traits from live body weight for the male African giant rats (Table 4.9). The adjusted coefficients of determination, R^2 for predicting bled carcass weight, dress weight, hind leg, loin, thoracic, and tail weight from live body weight were significant ($p<0.05$) for the male African giant rat with varied R^2 values of 0.964, 0.874, 0.813, 0.874, 0.881, and 0.786, respectively but only the R^2 value for predicting foreleg from live body weight was not significant ($p>0.05$) (Table 4.9).

4.5 Prediction Equations for Carcass Traits from Live Body Weight of the African Giant Rats

Table 4.9: Prediction Equation for Carcass Traits from Live Body Weight of the Male African Giant Rats

Sex	Carcass traits	Equation	R^2	P- value
Male	Carcass weight	Y = 319 + 0.7810(x)	0.964	0.002
	Dressed weight	Y = -235 + 0.686(x)	0.874	0.013
	Foreleg weight	y = 52.9 + 0.02086(x)	0.627	0.069
	Hind leg weight	y = 66.7 + 0.0549(x)	0.813	0.023
	Thoracic weight	y = 40.9 + 0.0572(x)	0.881	0.012
	Tail weight	y = -33.3 + 0.02597(x)	0.786	0.029

R^2 = Adjusted coefficient of determination, Y = dependent variable (carcass trait), X = independent variable (live body weight).

4.5.2 Prediction equations for carcass traits from live body weight of the female African giant rats

The individual adjusted coefficients of determination R^2 for predicting bled carcass weight, thoracic, foreleg, loin, and hind from live body weight in female African giant rats were significant ($p<0.05$) with varied R^2 values of 0.993, 0.971, 0.965, 0.943 and 0.732 respectively with the exception of R^2 values for predicting dress weight and tail weight from live body weight which were not significant ($p > 0.05$) for the female African giant rats (Table 4.10).

Table 4.10: Prediction Equation for Carcass Traits from Live Body Weight of the Female African Giant Rats

Sex	Carcass traits	Equation	R^2	P- value
Female	Carcass weight	y = -111.3 + 0.9985(x)	0.993	<0.001
	Dress weight	y = -64.0 + 0.590(x)	0.600	0.077
	Foreleg weight	y = -8.58 + 0.05036(x)	0.965	0.002
	Hind leg weight	y = -232 + 0.2099(x)	0.732	0.041
	Loin weight	y = 23.4 + 0.07958(x)	0.943	0.004
	Thoracic weight	y = -38.1 + 0.10127(x)	0.971	0.001
	Tail weight	y = -50.8 + 0.0384(x)	0.545	0.095

R^2 = Adjusted coefficient of determination, Y = dependent variable (carcass trait), X = independent variable (live body weight).

4.5.3 Prediction equations for carcass traits from live body weight for pooled sexes of African giant rats

The adjusted coefficients of determination, R^2 of pooled sexes for predicting bled carcass weight, dress weight, thoracic, foreleg, loin, and hind leg from live body weight were significantly influenced ($p<0.001$) for the African giant rat with varied R^2 values of 0.984, 0.927, 0.920, 0.885, 0.802 and 0.748 respectively. The coefficient of

determination for predicting tail weight from live body weight was also significantly ($p<0.01$) influenced for pooled sexes in the African giant rats (Table 4.11).

Table 4.11: Prediction Equation for Pooled Carcass Traits from Live Body Weight in Pooled Sexes of the African Giant Rats.

Sex	Carcass traits	Equation	R^2	P- value
Pooled	Carcass weight	y = 120.5 + 0.8715(x)	0.984	<0.001
	Dressed weight	y = -216 + 0.6765(x)	0.927	<0.001
	Foreleg weight	y = 14.4 + 0.03827(x)	0.855	<0.001
	Hind leg weight	y = -46.4 + 0.1069(x)	0.748	<0.001
	Loin weight	y = 98.2 + 0.03780(x)	0.802	<0.001
	Thoracic weight	y = 30.7 + 0.06233(x)	0.920	<0.001
	Tail weight	y =-18.67 + 0.01968(x)	0.625	0.004

R^2 = Adjusted coefficient of determination, Y = dependent variable (carcass trait), X = independent variable (live body weight)

4.5.3 Actual a

There were non-significant differences between actual and predicted values of primal carcass cut traits measure (Table 4.12).

Table 4.12: Actual and Predicted Values for Carcass Traits in African Giant Rats

Sex	Carcass trait (g)	Actual Value (g)	Predicted value (g)	Deviation	Significance
Male	Dressed weight	1226.0	1226.18	-0.18	NS
	Foreleg	97.3	97.3318	-0.0318	NS
	Hind leg	183.6	183.637	-0.037	NS
	Loin	179.1	179.0979	0.0021	NS
	Thoracic	162.7	162.736	-0.036	NS
	Carcass weight	1982.0	1982.53	-0.53	NS
	Tail weight	22.0	22.0161	-0.0161	NS
Female	Dressed weight	988.0	987.38	0.62	NS
	Foreleg	81.2	81.16152	0.03848	NS
	Hind leg	142.0	142.0418	-0.0418	NS
	Loin	165.17	165.21156	-0.04156	NS
	Thoracic	142.4	142.36314	0.03686	NS
	Carcass weight	1668	1668.027	-0.027	NS
	Tail weight	17.6	17.6288	-0.0288	NS

NS = Not significant

CHAPTER FIVE: DISCUSSION

5.1 Growth Rate in the African Giant Rats

The observed significant differences ($p<0.05$) in the mean weights of the male and female African giant rats after the third bi-weekly measurements in the current study agrees with findings in studies conducted; which revealed that male African giant rats exhibited superiority in body weight with a reported male-biased sexual size dimorphism resulting from differential growth rates between sexes (Dzenda *et al*., 2010, 2013). Similarly, the non-significant weight differences from the first to third bi-weekly weights recorded, also align with reports by Dzenda *et al.* (2010) who found no discernable sex differences in live weights during specific times at the onset, indicating a comparable sex growth rate at the early growth stages. Also, their findings corroborate the results on rodents showing sexual dimorphism towards larger size and weight for males coincide with the major influence of the sex factor on body weight in the present study, starting from weeks eight onward with greater weight accretion in males compared to females.

This pattern may be attributed to hormonal variation, especially the anabolic effects of androgens in males, which promote a denser musculature and overall body size Turner *et al*. (2020) likewise, stated that male laboratory rats could be larger and faster than females in size and growth rates through feed consumption and the regulation of growth hormones (Wang *et al*., 2023). The current trend in body weight difference also conforms to the general weight differences ($p< 0.05$) recorded in the sexes of the various breeds of rabbits used in their experiment where males on average recorded higher monthly body weight gain than their female counterparts (Agaviezor *et al*., 2017). Also, a study conducted with the New Zealand white rabbit revealed otherwise

with females recording a significantly better feed conversion ratio; though the males recorded higher feed intake and body weight gain; since males are proven to have inherently bigger weights than females (Mathika, 2023). Also, the present study agrees with other studies with grasscutter (Annor *et al.*, 2012; Enemali, 2019; Onadeko and Amubode, 2021; Durowaye *et al*., 2021); and goats (Surafel *et al.,* 2015). On the other hand, dissimilar results to the present study were reported , where females among the rodents recorded equivalent growth rates with or are sometimes even faster than their male counterparts (Amuzor *et al.,* 2024). Such differences exemplify and could be attributed more to the complex interaction of hormones, environment, and inheritance in determining growth paths.

5.2 Carcass Characteristics of the Male and Female African Giant Rats

The observation of greater live body weight on the part of the male African giant rats and heavier carcass traits agrees with the findings of Dzenda *et al.* (2010), who usually showed that male African giant rats gain more weight and develop heavier muscles than the female counterpart due to hormonal effects, especially testosterone. Likewise, Olude *et al*. (2017) stated that male rodents from different species have the better carcass traits, high dressed and bled carcass weights, faster growth rate, and wider skeletal structure. The recorded average internal organ weights, specifically that of liver in the current study are also complimentary with the fact that there are no significant differences in the weights of liver of the males and females with the earlier observations by Ibe *et al*. (2010), who established that the size of liver openness among rodent species is probably influenced by the metabolic need and health condition more than by their sex. Males often tend toward using testosterone to stimulate proteins to build

up and hypertrophy the muscles causing them to have heavier carcasses. Such evidence is supported by similar findings reported by Akinola *et al*. (2017) with cane rats (*Thryonomys swinderianus*) where males tend to score higher in terms of growth performance and carcass weights, thus indicating a sexual difference with reference to muscle deposition. Also reports from Cooper (2022) showed highly significant differences in growth performance and carcass traits of male and female cane rats. Present findings on slaughter weight trends between sexes also corroborate findings made by Obadiah (2014) on guinea pigs that male rodents by slaughter weight, weight gain, meat yield, leg weight, and loin weight have all the attributes above their female counterparts when compared, even though females had higher liver yield ($p < 0.05$). In their study with rabbits, Olga and Sylwia (2024) reported contrasting results where females recorded significantly higher weight of carcass parts than male; this can be ascribed to breed differences.

Dressing percentage from this study, which showed no significant difference ($p > 0.05$) between sexes, aligns with similar trends reported by Byanet *et al*. (2015) who found no significant disparity between sexes. In addition, the male and female African giant rats used in a study recorded a non-significant average dressing percentage (Ajayi, 2008); and those studied in rabbits by Olga and Sylwia (2024) affirms the non-significant dressing percentage in sexes at a point . Conversely, the present result which indicates a statistically similar liver weight in both sexes parallels findings in studies done on Wistar rats by Stalter *et al*. (2015), where females had, to a conclusive extent, a higher liver weight than males, due to a higher body fat percentage, reproductive demands, and different metabolic profiles, which contribute to the increase in weight of their internal organs.

Again, the present findings also oppose with those of a study involving rodents by Cait *et al*. (2022) where it was found that sex had no significant influence on live weight, carcass weight, and leg weight. That, of course, could be due to the difference in carcass traits among types, breeds, age of animals, gut content, handling practices, or more so, variation in measurements by researchers. In contradiction with the current findings, is that of Turner *et al*. (2020), who found similarities in weights in both sexes of laboratory rats in both loin and hindquarter weights when they were raised under identical conditions. These inconsistencies might primarily be due to variations in dietary compositions in the individual studies; that arguably might have favoured males for a greater muscle yield in the current study and other similar ones.

5.3 Effect of Sex on Protein, Fat, Ash, Carbohydrate, Moisture, and pH Content of Meat from the African Giant Rats

The current findings on the protein content existing in meat from African giant rat shows that there are no statistically significant differences in both sexes ($p>0.05$) agrees with findings in a study on proximate analysis of both farmed and wild meat of African giant rats (Cudjoe *et al.*, 2024) and those given by Dzenda *et al*. (2010) of African giant rats kept in captivity. In a similar stride, Obadiah (2014) found similar content of protein between male and female cane rats (*Thryonomys swinderianus*) and concluded that protein levels in rodents are a matter of dietary factors and not sex. Conversely, Byanet *et al*. (2015) found a significantly slight higher protein content in males than females and reported that the difference can be attributed to hormonal factors such as testosterone and growth hormones secreted by the pituitary gland, and other factors like how males in general exhibit hormonal regulation (release of insulin and cortisol) on one hand and metabolic rates that favour protein synthesis in males.

The non-significant differences ($p>0.05$) in fat contents recorded for males and females, corroborated with earlier findings of Olude *et al.* (2017) in male and female rodents raised under similar conditions. On the contrary, Ibe *et al.* (2010) reported a significant high fat content in females than their male counterparts, which could equally be attributed to the differences in diet composition and management practices as usually a high-fat diet enhances fat deposition in females. In terms of ash as an index for mineral content present in meat, it was noted that ash content in females is significantly higher ($p<0.05$) than in males, at 1.205% for females and 0.975% for males. This confirms the observation in the study done by Ajayi and Tewe (2008) that reported higher ash content in meat of female rodents than in males. On the other hand, Igbokwe *et al.* (2016) did not find any difference between the two sexes in respect to ash content in cane rats, and this may be as a result of species-specific difference in factors leading to the deposition of minerals. In the present study, carbohydrate content in meat of males was somewhat more compared with females, but the difference was not statistically significant. This finding in the present study conforms to the findings from Byanet *et al.* (2015), where carbohydrate contents in flesh reported in male and female rodents were not significantly different.

The meat possessed moisture contents of 58.4% in males while that of 59.9% moisture content was found in females and thus statistically not significantly different ($p>0.05$). These remain consistent with the report of Dzenda *et al.* (2010), wherein moisture levels were from 57 to 60% in African giant rats, irrespective of sex. The influence of environment on rodent meat moisture generally includes various rearing conditions, as noted by Olude *et al.* (2017). The pH values for male and female stood at 5.76 and 5.78, respectively, and they were not significantly different ($p>0.05$). This goes on to confirm

the findings provided by Turner *et al*. (2020) regarding pH values among both sexes of laboratory rodents. Also to affirm the current results, according to Wang *et al*. (2023), the pH of meat was influenced by post-slaughter glycogen breakdown rather than by sex. The moisture and pH levels are subject to changes by slaughter age, processing time after slaughter, as well as glycogen depletion (Olude *et al*., 2017).

5.4 Phenotypic Correlation Between Live Body Weight and Carcass Traits in the African Giant Rats

5.4.1 Phenotypic correlation between live body weight and carcass traits in the male African giant rats.

There is a strong correlation between live body weight and thoracic weight, which further affirms the findings of studies conducted on both sexes of *Rattus norvegicus* (laboratory rats) by Igbokwe *et al*. (2016) who mentioned that thoracic weight correlates very well with live body weight in males, since it is one of the main elements in a carcass. Likewise, in an experiment with African giant rats (*Cricetomys gambianus*), Ajayi *et al*. (2008) mentioned a very strong correlation between thoracic and live weights, as well as its importance in carcass evaluation.

The very high correlation existing between live body weight and dressed weight is also confirmed in literature on rodents by Sam & Ekpo (2020) who did report similar findings stressed the importance of dressed weight as a predictor for the final meat yield. The liver and tail weight correlating highly compares favorably with the work of Adebayo *et al*. (2019) on African giant rats, who examined the physiological interconnections among internal organs and external features that may influence compositions of carcass. Josephl and Abikoye (1997) found that, in the study of carcass yield and composition of the African giant rat (*Cricetomys gambianus*), the weights of

body components correlate positively with both size and sex of the animals, with males accounting for higher values always. The low correlation between kidney weight and dressing percentage in males in this research mirrored the findings suggesting that entrails exert little influence on the dressing percentage of rodents (Henry *et al.*, 2013). Conversely, the existing low correlation between live body weight and dressing percentage of male African giant rats in this study is seen conflicting with those provided by Udechukwu *et al*. (2021) on African giant rats, which moderated their theme to genetic differences, variation in muscle-to-bone ratios, or environment.

5.4.2 Phenotypic correlation between live body weight and carcass traits in the female African giant rats.

The phenotypic correlation estimates recorded for female African giant rats in this study between live body weight and carcass traits; as well as among carcass traits which ranged from low to higher and except in fewer cases where negative estimates were recorded; are in agreement with reported estimates in female rabbits (Murshed *et al.,* 2014). In contrast, the higher correlation coefficients among the measured internal organs and external carcass traits of female African giant rats, conflicts that of Adebayo *et al.* (2019) who discovered that in African giant rats there was significant physiological linkages among only external carcass traits but negatively correlated to internal carcass traits and attributed it to the physiological petitioning rather than sex. They opined that the animal's body allocates resources between external traits (muscle and skin) and internal organs (such as the liver, kidney, and intestines) such that, when more resources are diverted to the development of external traits, the internal organs might receive fewer resources, leading to negative correlations.

5.4.3 Phenotypic correlation between live body weight and carcass traits in pooled sexes of the African giant rats.

The current study with its findings which established an indication that live body weight is a good predictor of carcass traits in the African giant rats, though varying widely across the adjusted coefficients of determination for pooled sexes corroborates findings of other authors on studies involving rodents (African giant rat and Grasscutter) under Josephl and Abikoye (1997), especially in African giant rats in terms of prediction capacity of live body weight on carcass characteristics; with increased live body weight generally translating to increased carcass component weights, a standpoint in agreement with the current works.

Mustapha *et al.* (2020) showed that in their study of cranio-facial and ocular parameters in Greater Cane Rat, all parameters measured were closely related to body weight for pooled sexes. Again, moderate to high positive correlations of live body weights with carcass components were reported by Sam & Ekpo (2020) for the trends observed in their study among a genetic grouping of rodents, except for some characters that depicted negative correlation coefficients; which are recorded likewise in this current research. Indeed, selection for higher live weight can improve carcass traits, as has been demonstrated in this study and in numerous others.

5.5 Prediction of Carcass Traits from Live Body Weight in the African Giant Rats

5.5.1 Prediction of carcass traits from live body weight in the male African giant rats

The present research showed that live body weight is a good predictor for almost all the carcass traits measured carcass traits in males. These findings were in agreement with that of Mohammed *et al*. (2024) who studied both sexes of African giant rats and observed a highly significant positive correlation existing between live body weight and morphological traits, especially heart girth which somewhat translates to thoracic weight, which had the highest correlation coefficient among various carcass cut traits in male African giant rats observed currently. Similarly, Igbokwe *et al*. (2016), in their study found that body measurements can predict carcass cuts and fat content across ages, sexes, and strains. This suggests that live body measurements may be reliable indicators of carcass traits in rodents. In contrast, to the present study the reported non-significant prediction between live body weight and foreleg weight in males unlike females may be ascribed to the complex biological differential growth patterns in particular body areas (Atta *et al*., 2024), differences in methodology or to various reasons such as slight errors in measuring smaller body parts like the foreleg, which could hugely skew the accuracy of the predictive equations

5.5.2 Prediction of carcass traits from live body weight in the female African giant rats

The female African giant rats live weight served as a good predictor for the measured carcass traits in this study. This is comparable with a study where, the traits used in the prediction equations (live weight and body condition score) were not complicated, precise, and non-invasive indicators of carcass weight in cull cow carcass characteristics in their findings (Minchin, *et al.*, 2009).

5.5.3 Prediction of carcass traits from live body weight pooled for both sexes of the African giant rats

The significant adjusted coefficients of determination ($p<0.01$) in pooled sexes predictive equations regarding live body weights versus carcass cut weights indicate carcass components of African giant rats (*Cricetomys gambianus*) could be predicted with live body weight. This finding corroborates with a study conducted on four various genetic groups of rabbits by Sam *et al*. (2020) reporting that body weight could significantly predict most external carcass cut traits with precision mostly in pure Chinchilla breed. Affirming predictions of carcass traits by body weight in the present is that of Marshall *et al.* (1969) who studied laboratory rats and found that by measuring the bodies of rats, carcass content could be estimated at various ages, sexes, and strains. Their study thus demonstrated significant correlations in live body dimensions with carcass composition among males and females to support the argument that these live measurements are robust indicators of carcass traits in rodents. Similarly, Ajayi (1975) studied the live and carcass weights of the African giant rat and the domestic rabbit, maintaining that there are no differences in killing-out percentages between both

species. Hence, it would imply that live body weight is a very strong predictor of carcass yield in the African giant rat, similar to that of other small mammals.

Thus, all these studies tend to corroborate the conclusion that live body weight is an essential predictor of carcass traits in African giant rats and in other rodent species as well. The consistency of their findings across different investigations and species only confirms the reliability of using live body measurements to estimate carcass characteristics in rodents. In disagreement with the present study, Martine *et al*. (2021) showed that altered energy levels influence feed intake and growth rates and, therefore, carcass yield more than sex. While the focus of their study was mainly on dietary influences, it certainly underscores the importance of the nutritional factor with regard to the capacity to determine carcass traits from live body weight rather than sex of the African giant rats.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

From the results of the study, the following conclusions could be made:

- Males outperformed females in body weight and most carcass traits in African giant rats.

  Raw meat of the African giant rats sourced from either males or females is rich in protein, low in fat and has suitable pH making it wholesome for consumption.
- There exist mostly moderate to high positive correlation between live body weight and carcass traits as well as among carcass traits in both sexes of the African giant rats.
- Weight of most carcass cut traits can be predicted suitably from live body weight with reasonable accuracy; best in determining thoracic weight in both sexes of captive African giant rats.
- Also, selection programme aimed at improving live body weight in both sexes of the African could indirectly produce a positively correlated response in most carcass cut traits.

6.2 Recommendations

Based on the conclusions drawn, the following recommendations were made:

- It is recommended that male and female African giant rats can be considered valuable genetic resources for sustainable meat production in captivity.
- Live body weight could be considered as a non-invasive proxy in determining most carcass cut traits in both sexes of African giant rats.
- The potential impact of strain and non-genetic factors on the growth performance and carcass traits of African giant rats should be investigated.

REFERENCES

Abernethy, K., Coad, L., Taylor, G., Lee, M., & Maisels, F. (2013). Extent and ecological consequences of hunting in Central African rainforests in the twenty-first century. *Philosophical Transactions of The Royal Society B Biological Sciences*, *368*. https://doi.org/10.1098/rstb.2012.0303

Adebayo Koyuum Akinloye & Bankole Olusiji Oke. (2010). Characterization of the Uterus and Mammary Glands of the Female African Giant Rats (Cricetomys gambianus, Waterhouse) in Nigeria. *International Journal of Morphology*, *28*(1). https://doi.org/10.4067/S0717-95022010000100012

Adom, D., & Boamah, D. A. (2020a). Local attitudes toward the cultural seasonal hunting bans in Ghana's Bomfobiri Wildlife Sanctuary: Implications for sustainable wildlife management and tourism. *Global Ecology and Conservation*, *24*, e01243. https://doi.org/10.1016/j.gecco.2020.e01243

Adom, D., & Boamah, D. A. (2020b). Local attitudes toward the cultural seasonal hunting bans in Ghana's Bomfobiri Wildlife Sanctuary: Implications for sustainable wildlife management and tourism. *Global Ecology and Conservation*, *24*, e01243. https://doi.org/10.1016/j.gecco.2020.e01243

Afolayan, R., Deland, M., Rutley, D., Bottema, C., Ewers, A., Ponzoni, R., & Pitchford, W. (2002). *Prediction of Carcass Meat, Fat and Bone Yield Across Diverse Cattle Genotypes Using Live-Animal Measurements*.

African Giant Pouched Rat—Rodent—Africa. (2022). https://www.krugerpark.co.za/africa_african_giant_rat.html

Agana, T., Kaunza, M. K., & Millar, D. (2018). Endogenous Forest Development Paradigm: Challenging Current Forest Conservation Practices in Ghana.

Open Access Library Journal, *5*(3), Article 3. https://doi.org/10.4236/oalib.1104169

Agaviezor B, Ologbose Fi, & Ajayi Fo. (2017). Effect of Breeds, Sex and Age on Interrelationship between Body Weight and Linear Body Measurement in Rabbits. *Journal of Fisheries & Livestock Production*, *05*(03). https://doi.org/10.4172/2332-2608.1000250

Ahmad, R. S., Imran, A., Hussain, M. B., Ahmad, R. S., Imran, A., & Hussain, M. B. (2018). Nutritional Composition of Meat. In *Meat Science and Nutrition*. IntechOpen. https://doi.org/10.5772/intechopen.77045

Ajayi, S. (2008). Field observations on the African giant rat Cricetomys gambianus Waterhouse in southern Nigeria. *African Journal of Ecology*, *15*, 191–198. https://doi.org/10.1111/j.1365-2028.1977.tb00397.x

Ajayi, S. (2008). Live and carcass weights of giant rat Cricetomys gambianus Waterhouse and domestic rabbit Oryctolagus cuniculus L. *African Journal of Ecology*, *15*, 223–227. https://doi.org/10.1111/j.1365-2028.1977.tb00402.x

Ajayi, S. S. (1977). Field observations on the African giant rat Cricetomys gambianus Waterhouse in southern Nigeria. *African Journal of Ecology*, *15*(3), 191–198. https://doi.org/10.1111/j.1365-2028.1977.tb00397.x

Ajayi, S. S., & Tewe, O. O. (1978a). Performance of the African giant rat (Cricetomys gambianus Waterhouse) on commercial rations and varying dietary protein levels. *Laboratory Animals*, *12*(2), 109–112. https://doi.org/10.1258/002367778780953224

Ajayi, S. S., & Tewe, O. O. (1978b). Performance of the African giant rat (Cricetomys gambianus Waterhouse) on commercial rations and varying dietary protein

levels. *Laboratory Animals*, *12*(2), 109–112. https://doi.org/10.1258/002367778780953224

Ajayi, S. S., Tewe, O. O., & Faturoti, E. O. (1978). Behavioural changes in the African giant rat (Cricetomys gambianus Waterhouse) under domestication. *African Journal of Ecology*, *16*(2), 137–143. https://doi.org/10.1111/j.1365-2028.1978.tb00434.x

Alexander, J. (2015). *An exploration of the role of bushmeat in Ghana's rural communities, MSc thesis*. https://doi.org/10.13140/RG.2.1.5152.3687

Alexander, L. (2021a). Ending Bushmeat Consumption in Ghana. *The Borgen Project*. https://borgenproject.org/bushmeat-consumption-in-ghana/

Alexander, L. (2021b). *Ending Bushmeat Consumption in Ghana*. The Borgen Project. https://borgenproject.org/bushmeat-consumption-in-ghana/

Amuzor, S. O., Agbon, A. N., Musa, S. A., Umana, U. E., & Ayo, J. O. (2024). Morphological Assessments and Sexual Dimorphism of the Visual Pathway Structures of *Cricetomys gambianus* (African Giant Rats Waterhouse-1840). *Journal of Experimental and Clinical Anatomy*, *21*(2), 149–158. https://doi.org/10.4314/jeca.v21i2.1

Angelson, A. and Wunder, S. (2003). *Exploring the forest—Poverty link*. Center for International Forestry Research (CIFOR). https://doi.org/10.17528/cifor/001554

Annor, S. Y., Ahunu, B. K., Aboagye, G. S., Boa-Amponsem, K., & Cassady, J. P. (n.d.). *Phenotypic and genetic parameter estimates for grasscutter production traits. 1. (Co) variance components and heritability*. 9.

Annor, S. Y., Ahunu, B. K., Aboagye, G. S., Boa-Amponsem, K., & Cassady, J. P. (2012). *Non-Genetic Factors Affecting Grasscutter Production Traits. 1. Growth Traits*.

Annor, S.Y, B., K. A., G., S. A., K., B.-A., & J.P., C. (2014). Relative economic value estimates of grasscutter production traits. *International Journal of Livestock Production*, *5*(8), 137–146. https://doi.org/10.5897/IJLP2013.0180

AOAC. (2016). *Official Methods of Analysis of AOAC International—20th Edition, 2016*. https://www.techstreet.com/standards/official-methods-of-analysis-of-aoac-international-20th-edition-2016?product_id=1937367

Assogbadjo, A., J.T.C, C., Sinsin, B., Ekué, M., & Mensah, G. (2005). Importance of rodents as a human food source in Benin. *Belgian Journal of Zoology*, *135*, 11–15.

Atta, M., Abu-baker, S. A., Mutasim, B. M., Huda, M. A.-D., & Hamad, S. A.-S. (2024). (PDF) Prediction of body weight using body measurements in some sheep and goats in Qatar. *ResearchGate*. https://www.researchgate.net/publication/376606567_Prediction_of_body_weight_using_body_measurements_in_some_sheep_and_goats_in_Qatar

Ayokunle, M. (2014). *Neurocellular Profile in the Brain of the African Giant Rat (Cricetomys gambianus, Waterhouse, 1840)*.

Baye, A., Berihun, B., Bantayehu, M., & Derebe, B. (2020). Genotypic and phenotypic correlation and path coefficient analysis for yield and yield-related traits in advanced bread wheat (Triticum aestivum L.) lines. *Cogent Food & Agriculture*, *6*(1), 1752603. https://doi.org/10.1080/23311932.2020.1752603

Bennett, G. L., Pollak, E. J., Kuehn, L. A., & Snelling, W. M. (2014a). Breeding: Animals. In N. K. Van Alfen (Ed.), *Encyclopedia of Agriculture and Food Systems* (pp. 173–186). Academic Press. https://doi.org/10.1016/B978-0-444-52512-3.00228-X

Bennett, G. L., Pollak, E. J., Kuehn, L. A., & Snelling, W. M. (2014b). Breeding: Animals. In N. K. Van Alfen (Ed.), *Encyclopedia of Agriculture and Food Systems* (pp. 173–186). Academic Press. https://doi.org/10.1016/B978-0-444-52512-3.00228-X

Berns, C. M. (2013). The Evolution of Sexual Dimorphism: Understanding Mechanisms of Sexual Shape Differences. In *Sexual Dimorphism*. IntechOpen. https://doi.org/10.5772/55154

Biplang G. Yadok. (2018). *Aspects of the behaviour of African giant pouched rats (Cricetomys sp. Nov) which impacts seed dispersal of largeseeded tree species in a West African montane forest landscape*. https://ir.canterbury.ac.nz/bitstream/handle/10092/16000/Yadok%2C%20Biplang_Final%20PhD%20Thesis.pdf?sequence=1

Birteeb, P. T., & Ozoje, M. O. (2011). *Prediction of live body weight from linear body measurements of west African long-legged and West African Dwarf sheep in Northern Ghana*.

Blanckenhorn, W. (2018). *Sexual Size Dimorphism*. Obo. https://www.oxfordbibliographies.com/display/document/obo-9780199941728/obo-9780199941728-0110.xml

Borgerson, C., Razafindrapaoly, B., Rajaona, D., Rasolofoniaina, B. J. R., & Golden, C. D. (2019). Food Insecurity and the Unsustainable Hunting of Wildlife in

a UNESCO World Heritage Site. *Frontiers in Sustainable Food Systems*, *3*. https://www.frontiersin.org/articles/10.3389/fsufs.2019.00099

Brashares, J. S., Golden, C. D., Weinbaum, K. Z., Barrett, C. B., & Okello, G. V. (2011). Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences*, *108*(34), 13931–13936. https://doi.org/10.1073/pnas.1011526108

Britannica. (2020). *Giant pouched rat (mammal genus) | Britannica*. https://www.britannica.com/animal/giant-pouched-rat/images-videos#Images

Brodin, A. (2010). The history of scatter hoarding studies. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1542), 869–881. https://doi.org/10.1098/rstb.2009.0217

Bryda, E. C. (2013). The Mighty Mouse: The Impact of Rodents on Advances in Biomedical Research. *Missouri Medicine*, *110*(3), 207–211.

Byanet, O., Abayomi, A. O., & Aondohemba, T. J. (2015). *Comparative morphometric analysis of the gastrointestinal tract of the captive greater cane rat (Thryonomys swinderianus) and African giant pouched rat (Cricetomys gambianus). Ital J Anat Embryol. 2015;120(1):49-58.PMID: 26738259.*

Cait, K., Turner, P. V., & Parkins, K. (2022). *The impact of environmental enrichment on the welfare of laboratory rats and mice: A systematic review. Laboratory Animals, 56(2), 113–127. Https://doi.org/10.1177/00236772211064247*.

Cam, M. A., Olfaz, M., & Soydan, E. (2010). Possibilities of Using Morphometrics Characteristics as a Tool for Body Weight Prediction in Turkish Hair Goats (Kilkeci). *Asian Journal of Animal and Veterinary Advances*, *5*(1), 52–59. https://doi.org/10.3923/ajava.2010.52.59

Cawthorn, D.-M., & Hoffman, L. C. (2015). The bushmeat and food security nexus: A global account of the contributions, conundrums and ethical collisions. *Food Research International*, *76*, 906–925. https://doi.org/10.1016/j.foodres.2015.03.025

Cheverud, J. M. (1988). A Comparison of Genetic and Phenotypic Correlations. *Evolution*, *42*(5), 958–968. https://doi.org/10.1111/j.1558-5646.1988.tb02514.x

Cho, H., Jeon, S., Lee, M., Kang, K., Kang, H., Park, E., Kim, M., Hong, S., & Seo, S. (2020). Analysis of the Factors Influencing Body Weight Variation in Hanwoo Steers Using an Automated Weighing System. *Animals*, *10*(8), Article 8. https://doi.org/10.3390/ani10081270

Christine, J. (2022). *Gambian Pouched Rat (Cricetomys gambianus) Emins Pouched Rat (Cricetomys Emini). Crittery Exotics.* https://crittery.co.uk/species-list/pouched-rats

Coad L, Fa J.E, Abernethy K, Van Vliet N, Santamaria C, Wilkie D, El Bizri H.R, Ingram D.J, Cawthorn D-M, & Nasi R. (2019). *Towards a sustainable, participatory and inclusive wild meat sector*. CIFOR.

Coad, L., Leverington, F., Knights, K., Geldmann, J., Eassom, A., Kapos, V., Kingston, N., de Lima, M., Zamora, C., Cuardros, I., Nolte, C., Burgess, N. D., & Hockings, M. (2015). Measuring impact of protected area management interventions: Current and future use of the Global Database of Protected Area Management Effectiveness. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *370*(1681), 20140281. https://doi.org/10.1098/rstb.2014.0281

Coad, L. M. (2008). *Bushmeat hunting in Gabon: Socio-economics and hunter behaviour* [Thesis, University of Cambridge]. https://doi.org/10/252091

Conniff, R. (2016). *Wildlife Farming: Does It Help Or Hurt Threatened Species?* Yale E360. https://e360.yale.edu/features/wildlife_farming_does_it_help_or_hurt_threatened_species

Cooper, R. (2022). *The African Giant/Pouched rat (Cricetomys gambianus) – it's Physiology, ecology, care & taming.*

Cooper, R. G. (2008). *Care, husbandry and diseases of the African giant rat (Cricetomys gambianus).*

Cudjoe, F. N., Duodu, A., Dotser, J. K., & Kwenin, W. K. J. (2024). Comparative Analysis of Consumer Preferences and Nutritional Composition of Wild and Farmed African Giant Rat. (Cricetomys gambianus) in Mampong Ashanti of Ghana. *Asian Journal of Advances in Agricultural Research*, *24*(6), 102–111. https://doi.org/10.9734/ajaar/2024/v24i6518

Darimont, C. T., Fox, C. H., Bryan, H. M., & Reimchen, T. E. (2015). The unique ecology of human predators. *Science*, *349*(6250), 858–860. https://doi.org/10.1126/science.aac4249

Decampos, J. S., Ikeobi, C. O. N., Olowofeso, O., Smith, O. F., Adeleke, M. A., Wheto, M., Ogunlakin, D. O., Mohammed, A. A., Sanni, T. M., Ogunfuye, B. A., Lawal, R. A., Adenaike, A. S., & Amusan, S. A. (2013). Effects of coat colour genes on body measurements, heat tolerance traits and haematological parameters in West African Dwarf sheep. *Open Journal of Genetics*, *3*(4), Article 4. https://doi.org/10.4236/ojgen.2013.34031

Demoncheaux, J.-P., Medkour, H., Louni, M., Laugier, L., Pasqualini, C., Fenollar, F., Davoust, B., & Mediannikov, O. (2022). Detection of Potential Zoonotic Bartonella Species in African Giant Rats (Cricetomys gambianus) and Fleas from an Urban Area in Senegal. *Microorganisms*, *10*(3), Article 3. https://doi.org/10.3390/microorganisms10030489

Deutsch, J., & Murakhver, N. (Eds). (2012). *They Eat That?: A Cultural Encyclopedia of Weird and Exotic Food from around the World*. ABC-CLIO.

Doyle, J. L., Purfield, D. C., Moore, T., Carthy, T. R., Walsh, S. W., Veerkamp, R. F., Evans, R. D., & Berry, D. P. (2021). Identification of genomic regions that exhibit sexual dimorphism for size and muscularity in cattle. *Journal of Animal Science*, *99*(5). https://doi.org/10.1093/jas/skab070

Durowaye, A. K., Salako, A. E., Osaiyuwu, O. H., & Fijabi, O. E. (2021). *Relationship among Live weight and Body Dimensions of the Greater Cane Rat*. 10.

Dzenda, T., Ayo, J. O., Lakpini, C. a. M., & Adelaiye, A. B. (2010). Seasonal and Sex Variations in Live Weights of Captive African Giant Rats Cricetomys gambianus, Waterhouse) in the Northern Guinea Savannah Zone of Nigeria. *International Journal of Zoological Research*, *7*(1), 49–58. https://doi.org/10.3923/ijzr.2011.49.58

Enemali, F. U. (2019). *Anatomical and Immunohistochemical Studies Of The Spinal Cord Of The Grasscutter (Thryonomys swinderianus)*.

Fa, J. E., Olivero, J., Farfán, M. Á., Márquez, A. L., Duarte, J., Nackoney, J., Hall, A., Dupain, J., Seymour, S., Johnson, P. J., Macdonald, D. W., Real, R., & Vargas, J. M. (2015). Correlates of bushmeat in markets and depletion of wildlife. *Conservation Biology*, *29*(3), 805–815. https://doi.org/10.1111/cobi.12441

Fonkem et al, S. (2022). Effect of Age at Breeding on Female African Giant Rat (Cricetomys gambianus) Fertility in Captivity. *International Journal of Veterinary Science*, *4*, *Volume 11*, 443–447. https://doi.org/10.47278/journal.ijvs/2022.143

Fonweban, J. N., & Njwe, R. M. (1990). Feed utilization and live weight gain by the African giant rat (Cricetomys gambianus Waterhouse) at Dschang in Cameroon. *Tropicultura*, *8*(3), 118–120.

Freeman, A. R., Sheehan, M. J., & Ophir, A. G. (2019). Anogenital distance predicts sexual odour preference in African giant pouched rats. *Animal Behaviour*, *148*, 123–132. https://doi.org/10.1016/j.anbehav.2018.12.010

Gambian pouched rat. (2023). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=Gambian_pouched_rat&oldid=1133918910

Gorbunova, V., Bozzella, M. J., & Seluanov, A. (2008). Rodents for comparative aging studies: From mice to beavers. *Age*, *30*(2–3), 111–119. https://doi.org/10.1007/s11357-008-9053-4

Halliez, M. C. M., & Buret, A. G. (2015). Gastrointestinal Parasites and the Neural Control of Gut Functions. *Frontiers in Cellular Neuroscience*, *9*, 452. https://doi.org/10.3389/fncel.2015.00452

Happold, D. C. D. (Ed.). (2013). *Mammals of Africa: Rodents, Hares and Rabbits: Vol. III* (1st edn). Bloomsbury Publishing; Bloomsbury Collections. https://doi.org/10.5040/9781472926937

Henry, A. J., Njume, G. N., & Wogar, G. S. I. (2013). *Carcass Evaluation of Intensively Reared Grasscutters Fed Diets With Varied Energy Levels*.

Hoffman, L. C. (2008). The yield and nutritional value of meat from African ungulates, camelidae, rodents, ratites and reptiles. *Meat Science*, *80*(1), 94–100. https://doi.org/10.1016/j.meatsci.2008.05.018

Hoffman, L. C., & Cawthorn, D.-M. (2012). What is the role and contribution of meat from wildlife in providing high quality protein for consumption? *Animal Frontiers*, *2*(4), 40–53. https://doi.org/10.2527/af.2012-0061

Hoffmann, M., Belant, J. L., Chanson, J. S., Cox, N. A., Lamoreux, J., Rodrigues, A. S. L., Schipper, J., & Stuart, S. N. (2011). The changing fates of the world's mammals. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1578), 2598–2610. https://doi.org/10.1098/rstb.2011.0116

Ibe, C., Onyeanusi, B., Hambolu, J., & Ayo, J. (2010). Sexual dimorphism in the whole brain and brainstem morphometry in the African giant pouched rat (Cricetomys gambianus, Waterhouse 1840). *Folia Morphologica*, *69*, 69–74.

Igbokwe, C. O., Agina, O. A., Onoja, R. I., & Okoye, C. N. (2016). *Haematological and serum biochemistry profile of the juvenile wild African giant rat (Cricetomys gambianus, Waterhouse – 1840) in Nsukka, South-Eastern Nigeria – a preliminary investigation. Journal of Applied Animal Research, 45(1), 190–194. Https://doi.org/10.1080/09712119.2016.1141772.*

Ingram, D., Lauren Coad, Ana Benítez-López, Elizabeth L. (2024). *(PDF) Annual Review of Environment and Resources Wild Meat Is Still on the Menu: Progress in Wild Meat Research, Policy, and Practice from 2002 to 2020*. https://www.researchgate.net/publication/378263388_Annual_Review_of_Environment_and_Resources_Wild_Meat_Is_Still_on_the_Menu_Progress_in_Wild_Meat_Research_Policy_and_Practice_from_2002_to_2020

Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, *451*(7181), Article 7181. https://doi.org/10.1038/nature06536

Joo, M. S. (2004). *Cricetomys gambianus (Gambian rat)*. Animal Diversity Web. https://animaldiversity.org/accounts/Cricetomys_gambianus/

Jori, F., Edderai, D., & Houben, P. (2005a). Potential of rodents for minilivestock in Africa. *Ecological Implications of Mini-Livestock ; Rodents, Frogs, Snails and Insects for Sustainable Development*.

Jori, F., Edderai, D., & Houben, P. (2005b). Potential of rodents for minilivestok in Africa. In *Ecological implications of minilivestock: Potential of insects, rodents, frogs, and snails / Paoletti Maurizio G. (ed.)* (pp. 25–45). Science Publishers. https://publications.cirad.fr/une_notice.php?dk=555161

Josephl, J. K., & Abikoye, O. G. (1997). Carcass evaluation and organoleptic assessment of the meat of giant African rat (*Cricetomys gambianus*) and grasscutter (*Thryonomys swinderianus*). *Agrosearch*, *3*(1–2), Article 1–2. https://doi.org/10.4314/agrosh.v3i1-2

Junjie, B., & Shengjie, L. (2019). Chapter 2—The Genetic Parameters of Growth Traits and Breeding Value Estimation in Largemouth Bass (Micropterus salmoides). In B. Junjie & L. Shengjie (Eds), *Genetic Breeding and Molecular Marker-Assisted Selective Breeding of Largemouth Bass* (pp. 43–88). Academic Press. https://doi.org/10.1016/B978-0-12-816473-0.00002-5

Kelvin Hill. (2018, April 9). *5 important reasons why you must weigh your livestock regularly | 2018-09-04 | The National Provisioner*.

https://www.provisioneronline.com/articles/106701-important-reasons-why-you-must-weigh-your-livestock-regularly

Kominakis, A. P. (2003). Phenotypic correlations as substitutes to genetic correlations in dairy sheep and goats*. *Journal of Animal Breeding and Genetics*, *120*(4), 269–281. https://doi.org/10.1046/j.1439-0388.2003.00397.x

Kümpel, N., Milner-Gulland, E., Cowlishaw, G., & Rowcliffe, M. (2010). Incentives for Hunting: The Role of Bushmeat in the Household Economy in Rural Equatorial Guinea. *Human Ecology*, *38*, 251–264. https://doi.org/10.1007/s10745-010-9316-4

Kuukyi, F. S., Amfo-Otu, R., & Wiafe, E. (2014). *3. Consumer Views of Bushmeat Consumption in Two Ghanaian Markets*. 9.

Li, Q., McDonough, A. A., Layton, H. E., & Layton, A. T. (2018). Functional implications of sexual dimorphism of transporter patterns along the rat proximal tubule: Modeling and analysis. *American Journal of Physiology-Renal Physiology*, *315*(3), F692–F700. https://doi.org/10.1152/ajprenal.00171.2018

Lindsey, P. A., Romañach, S. S., Tambling, C. J., Chartier, K., & Groom, R. (2011). Ecological and financial impacts of illegal bushmeat trade in Zimbabwe. *Oryx*, *45*(1), 96–111. https://doi.org/10.1017/S0030605310000153

Lonergan, S. M., Topel, D. G., & Marple, D. N. (2019). Chapter 6—Growth curves and growth patterns. In S. M. Lonergan, D. G. Topel, & D. N. Marple (Eds), *The Science of Animal Growth and Meat Technology (Second Edition)* (pp. 71–109). Academic Press. https://doi.org/10.1016/B978-0-12-815277-5.00006-8

Makundi, R. H. (2018). *Neglected and Underutilized Rodents*.

Malekani, J. M. (2009). *Cricetomys farming for improving animal production in developing countries.pdf*.

Marshall, M. W., Smith, B. P., Munson, A. W., & Lahmanhn, R. P. (1969). Prediction of carcass fat from body measurements made on live rats differing in age, sex and strain. *British Journal of Nutrition*, *23*(2), 353–369. https://doi.org/10.1079/BJN19690042

Martine, T. M. A. *, Kenfack, A., & Miegoue Emile, Mweugang Ngouopo Nathalie, Vemo Narcisse Bertin, Kwayep Nyah Cédric, Tafeukeng Atabonfack Poclain, W., Lavoisier,F. T., Doriane, Y. M. D. Jemima, G. N. A., Alexis, T. (2021). *Effects of Dietary Energy Level on Growth Performances of African Giant Rats (Cricetomys Gambianus). Scholars Journal of Agriculture and Veterinary Sciences, 10.36347/sjavs.2019.v06i10.001* .

Matějů, J., & Kratochvíl, L. (2013). Sexual size dimorphism in ground squirrels (Rodentia: Sciuridae: Marmotini) does not correlate with body size and sociality. *Frontiers in Zoology*, *10*(1), 27. https://doi.org/10.1186/1742-9994-10-27

Mathika_Zenande_2023.pdf. (2023). Retrieved 15 September 2023, from https://ukzn-dspace.ukzn.ac.za/bitstream/handle/10413/21468/Mathika_Zenande_2023.pdf?sequence=1&isAllowed=y

Mbaya, A. W., Kumshe, H. A., Luka, J., & Madara, A. M. (2011). Parasitic Infections of the African Giant Rat (Cricetomys Gambianus) in the Semi-Arid Region of Northeastern, Nigeria. *Nigerian Veterinary Journal*, *32*(1), Article 1. https://doi.org/10.4314/nvj.v32i1.69000

Micheal, K. (2019). *Minilivestock—The Invaluable Underutilised Genetic Species for Enhanced Protein Availability*. *2*(2).

Minchin, W., Buckley, F., Kenny, D., Keane, M., Shalloo, L., & O'Donovan, M. (2009). Prediction of cull cow carcass characteristics from live weight and body condition score measured pre slaughter. *Irish Journal of Agricultural and Food Research*, *48*.

Mogbo T. C & Akunne C. E. (2014a). Ecological Survey of Earwigs (*Hemimerus talpoides*) as Ectoparasites of Wild African Giant Rat (*Cricetomys gambianus*) in Awka, Nigeria. *American Journal of Zoological Research*, *2*(1), Article 1. https://doi.org/10.12691/ajzr-2-1-4

Mogbo T. C & Akunne C. E. (2014b). Ecological Survey of Earwigs (*Hemimerus talpoides*) as Ectoparasites of Wild African Giant Rat (*Cricetomys gambianus*) in Awka, Nigeria. *American Journal of Zoological Research*, *2*(1), Article 1. https://doi.org/10.12691/ajzr-2-1-4

Mohammed, M., Duodu, A., Coffie, I., Duah, C., Sako, H. M., & Amevor. (2024). *Sexual dimorphism between live body weight and morphological traits at various age categories of African giant rats (Cricetomys gambianus) in Ghana. World Journal of Advanced Research and Reviews, 2024, 24(02), 538–547, DOI: https://doi.org/10.30574/wjarr.2024.24.2.3241. 2024*.

Murshed, H. M., Shishir, M. S. R., Rahman, S. M. E., & Oh, D.-H. (2014). Comparison of carcass and meat characteristics between male and female indigenous rabbit of Bangladesh. *Bangladesh Journal of Animal Science*, *43*. https://doi.org/10.3329/bjas.v43i2.20718

Mustapha, O., Ezekiel, O., Olaolorun, F., Awala-Ajakaiye, M., Popoola, E., Olude, M., & Olopade, J. (2020). *Morphological Characterization of the Developing Greater Cane Rat (Thryonomys swinderianus) Brain. Dev Neurosci.*

2020;42(2-4):114-123. Doi: 10.1159/000510848. Epub 2020 Dec 15. PMID: 33321497.

Nasi, R., Taber, A., & Van Vliet, N. (2011). Empty forests, empty stomachs? Bushmeat and livelihoods in the Congo and Amazon Basins. *International Forestry Review*, *13*(3), 355–368. https://doi.org/10.1505/146554811798293872

Nasirifar, E., Rezvannejad, E., Maleki, M., & Sami, M. (2021). The impact of differential expression of the pectoral muscle proteome in two groups of Japanese quail with different growth rates on meat quality. *British Poultry Science*, *62*(1), 38–45. https://doi.org/10.1080/00071668.2020.1812526

Nielsen, M. R., Pouliot, M., Meilby, H., Smith-Hall, C., & Angelsen, A. (2017). Global patterns and determinants of the economic importance of bushmeat. *Biological Conservation*, *215*, 277–287. https://doi.org/10.1016/j.biocon.2017.08.036

Nzalak, J. O.,Ibe C. S., Dauda, S. E. and Suleiman, H. M. (2011). *Weight Assessment of Some Accessory Digestive Organs in the Adult African Giant Pouched Rat (Cricetomys Gambianus, Waterhouse-1840).* https://www.meritaward.ng/admin/files/publications/441523552225_NNMA68.pdf

Obadiah, B., & Dzenda, T. (2014). Quantitative Biometry of Body and Brain in the Grasscutter (Thryonomys swinderianus) and African Giant Rat (Cricetomys gambianus): Encephalization Quotient Implication. *Neuroscience Research*, *3*, 1–6. https://doi.org/10.5923/j.neuroscience.20140301.01

Obour, R., Asare, R., Ankomah, P., & Larson, T. (2016). Poaching and its Potential to Impact Wildlife Tourism: An Assessment of Poaching Trends in the Mole

National Park in Ghana. *Athens Journal of Tourism*, *3*, 169–192. https://doi.org/10.30958/ajt.3-3-1

OECD & Food and Agriculture Organization of the United Nations. (2021). *OECD-FAO Agricultural Outlook 2021-2030*. OECD. https://doi.org/10.1787/19428846-en

Olayemi, A., Nicolas, V., Hulselmans, J., Missoup, A. D., Fichet-Calvet, E., Amundala, D., Dudu, A., Dierckx, T., Wendelen, W., Leirs, H., & Verheyen, E. (2012). Taxonomy of the African giant pouched rats (Nesomyidae: Cricetomys): molecular and craniometric evidence support an unexpected high species diversity. *Zoological Journal of the Linnean Society*, *165*(3), 700–719. https://doi.org/10.1111/j.1096-3642.2012.00823.x

Oldekop, J. A., Holmes, G., Harris, W. E., & Evans, K. L. (2016). A global assessment of the social and conservation outcomes of protected areas. *Conservation Biology*, *30*(1), 133–141. https://doi.org/10.1111/cobi.12568

Olga, D., & Sylwia, P. (2024). *Effect of breed and sex on the body weight, slaughter traits, meat quality and meat texture parameters of rabbits*. https://zootechnical.com/article/544472/en

Olude, M. A., Idowu, A. O., Mustapha, O. A., Olopade, J. O., & Akinloye, A. K. (2015). Spinal Cord Studies in the African Giant Rat (Cricetomys gambianus, Waterhouse). *Nigerian Journal of Physiological Sciences: Official Publication of the Physiological Society of Nigeria*, *30*(1–2), 25–32.

Olude, M., Mustapha, O. A., & Olopade, J. O. (2017). Morphological Characterization of the African Giant Rat (Cricetomys gambianus, Waterhouse) Brain Across Age Groups: Gross Features of Cortices. Nigerian journal of physiological sciences, 31 (2, 133-138,

https://api.semanticscholar.org/CorpusID:13372041. *Asian Journal of Biological Sciences*.

Onadeko, S.A and F.O Amubode. (2021). *[PDF] Reproductive indices and performance of captive reared grasscutters (Thryonomys swinderianus Temminck) by S. A. Onadeko, F. O. Amubode · 10.4314/njap.v29i1 · OA.mg*. https://oa.mg/work/10.4314/njap.v29i1

Onah, I. E., & Umeike, E. C. (2022). Intestinal Parasitic Fauna and Prevalence in African Giant Rat (*Cricetomys gambianus*) In Nsukka Metropolis South Eastern Nigeria. *Fudma Journal of Sciences*, *6*(4), Article 4. https://doi.org/10.33003/6fjs-2022-0504-1016

Opara, M. N. (2010). The Grasscutter I: A Livestock of Tomorrow. *Research Journal of Forestry*, *4*(3), 119–135. https://doi.org/10.17311/rjf.2010.119.135

Ordaz-Németh, I., Arandjelovic, M., Boesch, L., Gatiso, T., Grimes, T., Kuehl, H. S., Lormie, M., Stephens, C., Tweh, C., & Junker, J. (2017). The socio-economic drivers of bushmeat consumption during the West African Ebola crisis. *PLOS Neglected Tropical Diseases*, *11*(3), e0005450. https://doi.org/10.1371/journal.pntd.0005450

Oyarekua, M. (2010). The Nutrient Composition of the African Rat. *Advance Journal of Food Science and Technology*, *2*.

Oyarekua, M. A., & Ketiku, A. O. (2010). The Nutrient Composition of the African Rat. *Advance Journal of Food Science and Technology*, 8.

Oyeyinka, S. A., Alabi-Ogundepo, T., Babayeju, A. A., & Joseph, J. K. (2019a). Consumer awareness, proximate composition, and sensory properties of processed African giant rat (Cricetomys gambianus) thigh meat. *Journal of*

the Saudi Society of Agricultural Sciences, *18*(4), 385–388. https://doi.org/10.1016/j.jssas.2017.12.006

Oyeyinka, S. A., Alabi-Ogundepo, T., Babayeju, A. A., & Joseph, J. K. (2019b). Consumer awareness, proximate composition, and sensory properties of processed African giant rat (Cricetomys gambianus) thigh meat. *Journal of the Saudi Society of Agricultural Sciences*, *18*(4), 385–388. https://doi.org/10.1016/j.jssas.2017.12.006

Paoletti, M. G. (Ed.). (2005). *Ecological implications of minilivestock: Potential of insects, rodents, frogs, and snails*. Science Publishers.

Perry, N. D., Hanson, B., Hobgood, W., Lopez, R. L., Okraska, C. R., Karem, K., Damon, I. K., & Carroll, D. S. (2006). New Invasive Species in Southern Florida: Gambian Rat (Cricetomys gambianus). *Journal of Mammalogy*, *87*(2), 262–264. https://doi.org/10.1644/05-MAMM-A-132RR.1

Peterson, A. T., Papeş, M., Reynolds, M. G., Perry, N. D., Hanson, B., Regnery, R. L., Hutson, C. L., Muizniek, B., Damon, I. K., & Carroll, D. S. (2006). Native-Range Ecology and Invasive Potential of Cricetomys in North America. *Journal of Mammalogy*, *87*(3), 427–432.

Pointer, M. A., Harrison, P. W., Wright, A. E., & Mank, J. E. (2013). Masculinization of Gene Expression Is Associated with Exaggeration of Male Sexual Dimorphism. *PLOS Genetics*, *9*(8), e1003697. https://doi.org/10.1371/journal.pgen.1003697

Poling, A., Weetjens, B., Cox, C., Beyene, N., Durgin, A., & Mahoney, A. (2011). Tuberculosis Detection by Giant African Pouched Rats. *The Behavior Analyst*, *34*(1), 47–54.

Prof.Makundi-CHAPTER5 Rodents-REVISED4July2018.pdf. (2018).

Ripple, W. J., Abernethy, K., Betts, M. G., Chapron, G., Dirzo, R., Galetti, M., Levi, T., Lindsey, P. A., Macdonald, D. W., Machovina, B., Newsome, T. M., Peres, C. A., Wallach, A. D., Wolf, C., & Young, H. (2016). Bushmeat hunting and extinction risk to the world's mammals. *Royal Society Open Science*, *3*(10), 160498. https://doi.org/10.1098/rsos.160498

Sam, I. M., Essien, C. A., & Ekpo, J. S. (2020a). Phenotypic correlation and carcass traits prediction using live body weight in four genetic groups of rabbit raised in tropical rain—Forest zone of Nigeria. *Nigerian Journal of Animal Science*, *22*(2), Article 2.

Sam, I. M., Essien, C. A., & Ekpo, J. S. (2020b). Phenotypic correlation and carcass traits prediction using live body weight in four genetic groups of rabbit raised in tropical rain—Forest zone of Nigeria. *Nigerian Journal of Animal Science*, *22*(2), Article 2.

Sam, I. M., Essien, C. A., Ukpanah, U. A., & Ekpo, J. S. (2020a). Influence of Sex on Relationship Between Morphometric Trait Measurement and Carcass Traits in Broiler Chicken Raised in Humid Tropic. *Journal of Animal and Veterinary Advances*, *18*(10), 309–314. https://doi.org/10.36478/javaa.2019.309.314

Sam, I. M., Essien, C. A., Ukpanah, U. A., & Ekpo, J. S. (2020b). Influence of Sex on Relationship Between Morphometric Trait Measurement and Carcass Traits in Broiler Chicken Raised in Humid Tropic. *Journal of Animal and Veterinary Advances*, *18*(10), 309–314. https://doi.org/10.36478/javaa.2019.309.314

Schulte-Herbrüggen, B., Cowlishaw, G., Homewood, K., & Rowcliffe, J. M. (2013a). The Importance of Bushmeat in the Livelihoods of West African Cash-Crop

Farmers Living in a Faunally-Depleted Landscape. *PLoS ONE*, *8*(8), e72807. https://doi.org/10.1371/journal.pone.0072807

Schulte-Herbrüggen, B., Cowlishaw, G., Homewood, K., & Rowcliffe, J. M. (2013b). The Importance of Bushmeat in the Livelihoods of West African Cash-Crop Farmers Living in a Faunally-Depleted Landscape. *PLoS ONE*, *8*(8), e72807. https://doi.org/10.1371/journal.pone.0072807

Smith, F. A., Doughty, C. E., Malhi, Y., Svenning, J.-C., & Terborgh, J. (2016). Megafauna in the Earth system. *Ecography*, *39*(2), 99–108. https://doi.org/10.1111/ecog.02156

Soewu, Durojaye A. (2008). *Wild animals in ethnozoological practices among the Yorubas of southwestern Nigeria and the implications for biodiversity conservation.* https://academicjournals.org/article/article1380788373_soewu.pdf

Stalter, J., Yogeswaran, V., Vogel, W., Sörös, P., Mathys, C., & Witt, K. (2015). *The impact of aging on morphometric changes in the cerebellum: A voxel-based morphometry study. Front Aging Neurosci. 2023 Jan 20;15:1078448. Doi: 10.3389/fnagi.2023.1078448. PMID: 36743442; PMCID: PMC9895411.*

Stokol, T., Brandt, L. E., Shuman, M., Jeffery, D. A., Blank, B., Silvela, E., & Singh, B. (2021). Hematologic and Biochemical Reference Intervals and Urinary Test Results for Wild-caught Adult Southern Giant Pouched Rats (Cricetomys ansorgei). *Journal of the American Association for Laboratory Animal Science: JAALAS*, *60*(6), 616–629. https://doi.org/10.30802/AALAS-JAALAS-20-000154

Surafel, Melaku, & Alayu, Kidane. (2015). Characterization of the goat population and breeding practices of goat owners. In *Mitigating Land Degradation and Improving Livelihoods*. Routledge.

Swamy, V., & Pinedo-Vasquez, M. (2014). *Bushmeat harvest in tropical forests: Knowledge base, gaps and research priorities*. CIFOR.

The Gambian Pouched Rat. (2015, January 22). *Backpacker Filth*. https://ccccomedy.wordpress.com/2015/01/22/the-gambian-pouched-rat/

Turner, P. V., Hickman, D. L., Van Luijk, J., & Ritskes-Hoitinga, M. (2020). *Welfare impact of carbon dioxide euthanasia on laboratory mice and rats: A systematic review. Frontiers in Veterinary Science, 7, 411. Https://doi.org/10.3389/fvets.2020.00411*.

Udechukwu, C. C., Kudi, C. A., Abdu, P. A., Pilau, N. N., Abiayi, E. A., Jolayemi, K. O., Okoronkwo, M. O., Orakpoghenor, O., Ogbuagu, N. E., & Oyetunde, J. S. (2021). *Haematology of captive wild African giant (Cricetomys gambianus) and brown (Rattus norvegicus) rats sero-positive for Leptospira spp. Around Zaria. Comparative Clinical Pathology 30:3, pages 441-444.*

Van Vliet, N., & Mbazza, P. (2011). Recognizing the Multiple Reasons for Bushmeat Consumption in Urban Areas: A Necessary Step Toward the Sustainable Use of Wildlife for Food in Central Africa. *Human Dimensions of Wildlife, 16*(1), 45–54. https://doi.org/10.1080/10871209.2010.523924

Vdoviaková, K., Petrovová, E., Krešáková, L., Maloveská, M., Teleky, J., Jenčová, J., Živčák, J., & Jenča, A. (2016). Importance Rat Liver Morphology and Vasculature in Surgical Research. *Medical Science Monitor : International*

Medical Journal of Experimental and Clinical Research, *22*, 4716–4728. https://doi.org/10.12659/MSM.899129

Vliet, N. van, Nebesse, C., & Nasi, R. (2015). Bushmeat consumption among rural and urban children from Province Orientale, Democratic Republic of Congo. *Oryx*, *49*(1), 165–174. https://doi.org/10.1017/S0030605313000549

Wang, X. J., Dai, B. S., Wei, X. L., Shen, W. Z., Zhang, Y. G., & Xiong, B. H. (2023). *Vision-based measuring method for individual cow feed intake using depth images and a Siamese network. International Journal of Agricultural and Biological Engineering, 16(3), 233–239. Https://doi.org/10.25165/j.ijabe.20231603.7985.*

Wiafe, E. (2018). Hunted species and hunting equipment used by rainforest poachers in Ghana. *Journal of Threatened Taxa, 10*, 11285–11289. https://doi.org/10.11609/jott.3416.10.2.11285-11289

Wilkie, D. S., Wieland, M., Boulet, H., Le Bel, S., van Vliet, N., Cornelis, D., BriacWarnon, V., Nasi, R., & Fa, J. E. (2016). Eating and conserving bushmeat in Africa. *African Journal of Ecology*, *54*(4), 402–414. https://doi.org/10.1111/aje.12392

Wilson Kasolo, George Chemining'wa and August Temu. (2018). *Neglected and Underutilized Species (Nus) for Improved Food Security and Resilience to Climate Change*. http://www.fondazioneedu.org/wp-content/uploads/2019/03/NUS-Teaching-Manual-Final-Format.pdf

Wilson, S. P. (2017). Modelling the emergence of rodent filial huddling from physiological huddling. *Royal Society Open Science*, *4*(11), 170885. https://doi.org/10.1098/rsos.170885

Wolfe, N. D., Daszak, P., Kilpatrick, A. M., & Burke, D. S. (2005). Bushmeat Hunting, Deforestation, and Prediction of Zoonotic Disease. *Emerging Infectious Diseases*, *11*(12), 1822. https://doi.org/10.3201/eid1112.040789

World Bank. (2018). *Growing Wildlife-Based Tourism Sustainably: A New Report and Q&A* [Text/HTML]. World Bank. https://www.worldbank.org/en/news/feature/2018/03/01/growing-wildlife-based-tourism-sustainably-a-new-report-and-qa

Yahaya, M. S., Bello I., Unguwanrim A. Y, Y. M. S., Bello I. , A. Y. (2021). *Correlation and Path-Coefficient Analysis For Grain.pdf*.

Zhang, Y., Yu, F., Yi, X., Zhou, W., Liu, R., Holyoak, M., Cao, L., Zhang, M., Chen, J., Zhang, Z., & Yan, C. (2022). Evolutionary and ecological patterns of scatter- and larder-hoarding behaviours in rodents. *Ecology Letters*, *25*(5), 1202–1214. https://doi.org/10.1111/ele.13992

Zhang, Z., Goldsmith, P. D., & Winter-Nelson, A. (2016). The Importance of Animal Source Foods for Nutrient Sufficiency in the Developing World: The Zambia Scenario. *Food and Nutrition Bulletin*, *37*(3), 303–316. https://doi.org/10.1177/0379572116647823