GROWTH PERFORMANCE, SERUM BIOCHEMICAL PROFILE AND MEAT QUALITY CHARACTERISTICS OF SAVANNA BROWN BUCKS FED WITH SOME FORAGES

BY

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MTech/SAAT/2018/7892

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SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY

MINNA

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLGY IN ANIMAL PRODUCTION

JUNE, 2023

DECLARATION

I hereby declare that this thesis titled **"Growth performance, serum biochemical profile and meat quality characteristics of Savanna Brown bucks fed with some forages"** is a collection of my original research work and that it has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been duly acknowledged.

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CERTIFICATION

This thesis titled **"Growth performance, serum biochemical profile and meat quality characteristics of Savanna Brown bucks fed with some forages"** by JIYA, Baba Kenneth (MTech/SAAT/2018/7892) meets the regulations governing the award of the degree of Master of Technology of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project work is dedicated to the Most High God and the Lord Jesus Christ. I also dedicate this work to my lovely wife and daughter, Mrs. Mary Madina Jiya and Gold Boye-Soko Jiya.

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ABSTRACT

A feeding trial was conducted to determine growth performance, serum biochemical profile and meat quality characteristics of Savanna Brown bucks fed with some forages. Fifteen Savanna Brown bucks were assigned into three dietary treatment groups of Groundnut and Cowpea Haulms (GCH), Cowpea Haulms (CH) and Groundnut Haulms (GH) using five bucks per treatment group while each buck served as a replicate. These experimental diets were supplemented with concentrate feed. The experiment lasted for a period of three months. Performance data recorded were initial body weight, feed intake, weight gain and final body weight. Blood collection was also done to determine serum protein, albumin, globulin concentration, creatinine concentration, serum glucose, nitrogen urea, cholesterol, serum sodium, potassium and serum hepatic enzymes namely Aspartate Amino Transaminase (AST), Alanine Amino Transferase (ALT) and Alkaline Phosphatase (ALP). At the end of the experiment, two goats were randomly selected from each treatment group and used for carcass evaluation. Growth performance data showed that there were significant influences ($P<0.05$) of the experimental diets on feed intake. Results obtained from the organoleptic quality of the fried goat meat, showed that the juiciness of meat samples recorded (6.80), aroma (7.25) and overall acceptability (7.80) from the GCH treatment group (6.80), which significantly higher ($P<0.05$) than those in the CH and GH treatment groups. Significant differences were also observed in the microbial analysis of the goat meat floss with the fungal load being significantly higher ($P<0.05$) in the control group, (GCH) in week 1 (23.00 cfu/g) and week 2 (24.50 cfu/g) while the bacterial count in the Groundnut Haulms (GH) group was significantly higher in GH than CH and GCH at week 1 (119.50 cfu/g), week 2 (138.50 cfu/g) week 3 (151.00 cfu/g) and week 4 (101.00 cfu/g). In week 2 meat floss from the Savanna Brown bucks showed significantly higher ($P<0.05$) crude protein content in the CH (40.31 %) group compared to the GH (38.61 %) group and the control, GCH (36.78 %). The serum biochemical indices were influenced by the experimental diets. Total proteins were significantly better ($P<0.05$) in the control group, GCH (5.40 g/dL), compared with the GH (4.53 g/dL) and CH (3.93 g/dL) groups, while Globulin, AST, ALT and ALP were better in the GH treatment compared with the CH and the control (GCH). It is therefore, recommended from the results obtained from this study that groundnut haulms (GH) should be included in diets for better feed intake and growth rate of the Savanna Brown bucks while the combination of groundnut and cowpea haulms (GCH) can be included in diets of goats to promote better sensory attributes of meat, health and physiological functions.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The increase in world population over the years has led to higher food requirements, especially animal protein. Ruminant animals constitute a vital part of the livestock sub-sector of the Nigerian agricultural economy. The potential of small ruminant production in alleviating the low animal protein intake by man in developing nations such as Nigeria has been reported (Fajemisin *et al.,* 2010). Recently, more attention has been paid to small ruminant production in the tropics as their advantages are to produce meat, milk and skin, even in hostile environments (Konlan *et al.*, 2012; Makun *et al.*, 2013; Okoruwa *et al.,* 2013).

Goat which is a small ruminant, has fast growth rate, short generation interval compared to other ruminant animals, multiple births, high fecundity and ability to utilize roughages which are not in competition with human food have made it suitable for profitable production as they possess special qualities that are not common to other ruminants (Silanikove, 2000). Goats are hardy and can survive under harsh environmental conditions where cattle and sheep cannot (Silanikove, 1997; Silanikove, 2010; Luo *et al.,* 2020). The manifestation of different qualitative characters in goats may signify some adaptive mechanisms developed for adaptation and continued existence in various ecological zones of Nigeria (Oseni *et al*., 2006).

Meat constitutes the foremost animal product that is highly explored by Nigerian households, particularly for direct consumption (ITA, 2004). Meat from goats contributes about 24 % of the total meat supply in Nigeria and goats rank next to cattle in income generation and the meat is quite popular and well-relished (Oni, 2002).

A lot of challenges have been encountered in livestock feeding over the years, particularly in finding ways to reduce the competition for available food resources between man and animals. Several animal nutritionists have carried out experiments on the effects of the inclusion of roughages on the growth of different breeds of livestock (represent a high proportion of total feed for herbivorous animals) and crop residues are characterized by a high content of fibre, usually above 40 %, low content of nitrogen (0.3-1.0 %) and low content of essential minerals such as sodium, phosphorus and calcium. Okoruwa, *et al.* (2012) reported that contemporary ruminant feeding development in Nigeria is now geared towards searching for inexpensive and readily available feed resources which can partially or wholly substitute the scarce and expensive feedstuffs and inadequate forages. Efforts have been made to reduce the effect of the yearly fluctuation of feed, particularly pasture, through researching non-conventional feedstuffs and roughages. Oluokun (2005) reported that cowpea (*Vigna unguiculata*) husk is a potential supplementary feed for ruminants in the dry season. Nigeria is the leading producer of groundnuts in Africa with an annual estimated output of 2 million metric tonnes and about 82,000 tonnes of cowpea husk and straws are produced in Nigeria annually. Thus vast quantities of groundnut haulms are available annually for livestock feeding (RMRDC, 2004). The large quantity of crop residues generated at the end of each harvest season are of no utilizable or consumable value to man, and these crop residues, if properly harnessed, can meet the nutritional needs of these animals as well as eliminate environmental nuisance associated when left unattended to (Babale *et al.*, 2018).

Meat floss (*danbu nama*), is referred to as an intermediate moisture meat (IMM) product with a low moisture content of less than 20 % which can be processed by cooking, pounding and pan frying with the addition of spice. Meat floss (*danbu nama*) is a meat product with good nutritive value and stays for long periods at room temperature. Meat floss is a dehydrated meat product and one of the traditional meat-based products popular among Malaysians and the Asian community (Huda *et al.*, 2012) while in Nigeria it is a popular traditional meat product among the Northerners that have been produced for years and popularly known as *danbu nama* (Ogunsola and Omojola, 2008).

1.2 Statement of the Research Problem

In the dry season, natural pasture decreases in quantity and nutritive value, and improved grasses cannot grow. Therefore, to bridge this gap and improve the growth performance of savanna brown goats, the need for nutritious forages that are rich but cheap supplementary concentrate are required. Over the years most of the forages are left abandoned by the farmers after the harvest season which could have been useful feeds to the ruminant animals, especially goats, but in recent years the need for the storage of these forages has become imperative.

Meat floss is primarily made in the northern region of Nigeria by the locals with little attention to meat quality, hygiene and the effect of diets on meat products. To extend the shelf life of meat and meat products, there is a need for novel methods of eliminating or reducing spoilage microorganisms, possibly in combination with existing methods (Boskovic *et al*., 2013).

1.3 Justification of the Study

The utilization of crop residues as animal feed ingredients is attracting the attention of many researchers (Abdul-Hamid *et al.,* 2013; Adamu, 2015), as conventional feedstuffs are sometimes unaffordable to low-income farmers (Bello and Tsado, 2013). This study becomes pertinent in view of the need to reduce feed costs and to search for alternative feed sources that can economically supplement the conventional feed ingredients used in ration formulation without adverse effects on the health and performance of the animals.

Cowpea and groundnut haulms are both agro-industrial by-products found in areas where these crops are cultivated in large quantities. Most of the earlier research conducted on groundnut haulms shows that these residues are often left in the processing area after the seed had being removed (Malau-Aduli *et al.,* 2003; Arslan, 2005). The use of these crop residues will prevent environmental nuisance as they sometimes result in environmental hazards by blocking drainage thereby leading to flooding. Since it takes a longer period for the husk and haulms to decompose; farmers therefore do not appreciate it as a source of compost manure and burning it may lead to air pollution, thereby increasing atmospheric temperature that adds to global warming.

Meat products can be preserved in various ways. One of such ways is through a product called meat floss (*danbu nama)* which is a method employed in this study. This study is further relevant in view of the fact that such preservation methods of meat product is a means of adding value to the product and could promote desirability for such meat products.

1.4 Aim and Objectives

This study aimed to determine the influence of some dried forages on the growth performance, serum biochemical profile and quality characteristics of meat floss (*danbu nama*) made from Savanna Brown bucks fed selected forages and concentrate

The objectives of this study were to:

i. evaluate the growth performance of Savanna Brown bucks fed with concentrate and different types of forages

ii. determine serum biochemical analysis of Savanna Brown bucks fed with concentrate and different types of forages

iii. evaluate the carcass characteristics and sensory properties of Savanna Brown bucks fed with concentrate and different types of forages

iv. determine the proximate composition and the microbial load of meat floss from Savanna Brown bucks fed with concentrate and different types of forages.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Importance of Small Ruminants

Ruminants are the most important livestock species in converting grasses and other forages into marketable products like meat, milk, wool, hides and other by-products. Small ruminants, especially sheep and goats, form an integral part in the livestock economy system in Nigeria (Alhaji and Odetokun, 2013). The arid and semi-arid areas are home to over 80 % of small ruminants and their sustenance is reducing due to dependence on natural pastures (Kosgey *et al.*, 2008) supporting 46 – 58 % of pastoral households.

Small Ruminants play a significant role in the food chain and overall livelihoods of rural households, where they are largely the property of women and their children (Lebbie, 2004). Small ruminants are the principal domesticated animals in terms of total numbers and production of food and fibre products. This attribute may partly be due to their lower feed requirements compared to cattle, because of their body size (Okunlola *et al.*, 2010). The lower feed and capital requirement allows for easy integration into different farming systems (Pollot and Wilson, 2009). Small ruminants have served as means of ready cash and reserve against economic and agricultural production hardship (Alhaji and Odetokun, 2013). Small ruminant animals act as insurance against crop failure and provide alternative sources of livelihood to the farmers all year round (Selvam and Safiullah, 2002; Alhaji and Odetokun, 2013). Milk from small ruminants is an important source of nutrition for the population. Farmers use small ruminants as savings that generate cash when the environment is harsh such as during drought years (Blench, 1999; Alhaji and Odetokun, 2013). In Nigeria, sheep and goats are kept principally for meat, hides and skin. FAOSTAT (2009) however, reported that Nigeria has a population of 53.8 million goats and 33.9 million sheep being 6.2 and 3.1 % of the world's goat and sheep population, respectively. Small ruminants are very important livestock and contribute an estimated 35 % of the total meat supply in Nigeria (Oni, 2002).

According to Shiawoya *et al.* (2001), small ruminant production is already a prominent feature among rural families in Nigeria. Farmers in the Northern states are actively involved in rearing small ruminants which are marketed to supplement the family income from other sources (Adama and Ndako-Gona, 2003).

Goats occupy a significant niche in the rural economy of Nigeria, with their inherent qualities of early maturity, ability to thrive even under harsh environments, low capital investment etc. Thus, even with little financial input, the enterprise can be profitable. Therefore meeting the nutrient requirement of the animals is a major concern to nutritionists (Aka *et al*., 2009). This has necessitated the constant search by nutritionists for cheap and readily available feed resources that are nutritionally rich and can meet the needs of animals such as goats and sheep.

2.2 Goat Production in Nigeria

Goats are characterized by their efficient grazing behaviour and functional digestive system and thrive well in tropical arid and semi-arid regions. Compared to other farm animals, the population of goats has increased rapidly in the harsh environmental and feed scarcity zones of the tropics (Utaaker *et al.,* 2021). Goats are considered superior to other ruminant species in their utilization of poor quality and high-fibre feeds (Oyeyemi and Akusu, 2005). Goats are by far the most important domesticated small ruminants in Nigeria (FAOSTAT, 2009).

The world goat population is estimated at 790 million and most (96 %) are found in developing countries (FAO, 2006) where they are of great importance. Goats are the most prolific of all domesticated ruminants under tropical and subtropical conditions (Webb and Mamabolo, 2004).

The goat population in Nigeria makes it the most important livestock species. Goat contributes 24 % of Nigeria's meat supply (Oni, 2002) and features prominently in the economic and social lives of Nigerians (Ajala, 2004). Odeyinka and Ajayi (2004) reported that goats are used for customary rites in addition to meat production and religious purpose in South West of Nigeria. They are the “poor man's cow reared as sources not only of milk and meat for family consumption but also as a source of income. Goats in the country are kept mainly for meat production, as their milk is rarely used for human consumption (Butswat *et al.*, 2002; Midau *et al.*, 2010).

2.3 Meat as a Perishable Food

Meat has served as a food source for humans for thousands of years with proof of large holistic, scientific and social studies on humanity which exists (Pereira and Vicente, 2013; Boler and Woerner *et al*., 2017). The consumption of meat has been historical to humans because of meat sustenance qualities and because meat is known for its importance as an excellent source of protein, vitamin B, irons as well as many other nutrients and minerals. The definition of meat varies based on application. When an animal has been slaughtered, the living tissue is converted into edible meat. Fresh meat has approximately 75 % water, 20 % protein, 1 % vitamin and 4 % fat (Aberle *et al.*, 2012). Consumers eat meat majorly because of its good taste, desirable flavour and its association with social status as it is enjoyed during times of celebration or special occasions. Meat has desirable nutritional benefits and supports human health (Murphy *et al.*, 2011; McNeill, 2014; O'Connor *et al.*, 2017). Meat processing results in considerable and favourable modifications for improving the quality attributes of meat and meat products (Gichure *et al*., 2014). Meats can be processed using different methods such as curing, smoking, fermentation and salting. Meat processing procedures involve slaughtering, chopping, grinding, heat treatment, drying and addition of seasoning.

2.4 Goat Meat

Goat meat is referred to as chevon. It is the most popular meat product in the world and is often served in speciality dishes centred on festivals or holiday events (Sande *et al*., 2005). Globally, the consumption of goat meat is lower than the consumption of beef (Madruga and Bressan, 2011), but goats undoubtedly serve as a major source of red meat for people (Webb *et al*., 2005), particularly in developing countries. The production of fibre and milk was initially the purpose of rearing goats, with chevon as a by-product. With the decline in demand for fibre from goats, most producers have diverted attention to raising meat goats (Sande *et al*., 2005).

Goat meat has about the same nutritional value as sheep (precisely, more protein and less fat compared to sheep meat). Anaeto *et al.* (2010) stated that due to its molecular structure, goat meat is more easily digested compared to beef and pork. Due to the low content of saturated fatty acids and cholesterol, goat meat in the human diet is a healthier alternative compared to other types of red meat. According to Anaeto *et al.* (2010), polyunsaturated fatty acids are prevalent in goat meat, and a diet rich in unsaturated fatty acids is correlated with a reduced risk of stroke and coronary disease. Goat meat has a high amount of unsaturated fatty acids and is a source of conjugated linoleic acid, while having a lower lipid content than meat from other ruminants (Webb *et al*., 2005). According to Givens *et al*. (2006), these substances have positive impacts on human health as anti-inflammatory, anti-thrombotic, and atherosclerotic preventatives. In addition to the meat's chemical makeup, sensory qualities are crucial for the development of this product because the consumer's level of acceptability is mostly determined by the meat's appearance, aroma, flavour, and texture (Madruga *et al*., 2005).

2.5 Feed Quality and Productivity in Goats

Feed is the most important management factor that affects the productivity of farm animals. Goats reared for meat or other products (milk or wool), require high-quality feed in most situations together with an optimum balance of many different nutrients to reach their maximum profit potential. Inadequate and poor quality feeds will make it difficult for an animal to realize its genetic potential for production in the form of fertility, growth rate or milk yield. Nigeria is constrained by the perennial issues of insufficient and low quality feed resources for ruminant feeding. This has led to the poor productivity of our indigenous breeds of livestock. Large quantities of crop residues are often generated on an annual basis after harvest and these crop residues are left to constitute environmental nuisance. If properly harnessed, however, these crop residues can be harnessed and channelled to meet the nutritional needs of small ruminants such as sheep and goats (Babale *et al.*, 2018). Common crop residues used in feeding goats, especially in the dry season include groundnut haulms and cowpea haulms which are fed as forages and have considerable nutritional levels to sustain these animals during these periods.

The quality of most commonly fed forages or roughage is characterized by either low energy or low protein density or both, and a high level of fibre. Residues of legume crops such as groundnut haulms and cowpea haulms have been reported to be rich in protein, promote feed intake and enhance the digestibility of poor quality fodder (Tekle and Gebru, 2018). There is thus a wide gap between the nutrient requirements of the animal for production and the levels of nutrients supplied by forages or roughages.

Several studies have demonstrated that concentrate supplementation is required to complement forage nutrient supply, to enhance nutrient intake (Khalili *et al.,* 1994; Muinga *et al.,* 1995) and productivity in goats (Mba *et al.,* 1982). According to Sultana *et al.* (2012), concentrate supplementation enhances feed intake and live weight gain of kids. Concentrate feed is important in the nutrition of small ruminants, but it is costly and many rural farmers may not be able to afford it (Tolera *et al*., 2000). Although concentrate supplementation improves animal performance, the degree of response depends on the nature of the basal roughage fed, with production response higher with good quality than with poor roughage (Khalili *et al.*, 1994; Orr and Treacher, 1994). This further corroborates the need for the use of leguminous forages such as groundnut haulms and cowpea haulms.

2.6 Sensory Evaluation of Meat Products

The sensory qualities of meat are determined by characteristics relating to colour, texture, aroma, flavour and juiciness. These are influenced by several factors including preslaughter handling, muscle composition, post-slaughter biochemical reactions and technological factors (Nasir *et al.,* 2011). The sensory quality of the processed product has an indirect economic importance as it might influence the amount of sold product, especially how often a consumer buys the same product again (Aaslyng, 2002). It is known that the sensory properties such as smell, taste, colour, juiciness, texture and tenderness represent the principal factors able to condition drastically the choices of the consumers at the moment of purchase, therefore, they have a role of primary importance regarding the qualification of the product (Porcu *et al*., 2007; Pathare and Roskilly, 2016). Some sensory qualities include the following juiciness, flavour, texture, tenderness and colour.

2.7 Proximate Composition of Meat Products

Huda *et al*. (2012) revealed that the moisture content of meat floss samples they worked on was within the range of 8.60-13.56 % while lower moisture content (6.50-7.37 %) was reported by Ogunsola and Omojola (2008). According to Omojola *et al*. (2014), the moisture content of pork floss was 19.59%. Fat content between 3.20-31.14 % of meat floss samples was reported by Huda *et al.* (2012). Higher fat contents (35.57-40.85 %) were reported by Ogunsola and Omojola (2008) while Sukisman *et al*. (2014) reported that the fat content of deep-fried shredded beef (*abon*) was within the range of 21.55-39.00%. Huda *et al.* (2012) reported the protein content of meat floss samples to fall within the range of 19.86-30.15 % while Ogunsola and Omojola (2008) reported a higher protein content of 38.92- 41.21 %. Similar protein content, 34.09-42.90 %, was also reported for pork floss by Ockerman and Li (1999). Ash content within the range of 3.17-5.16 % was reported by Huda *et al*. (2012). Omojola *et al*. (2014) reported an ash content of 3.11% for chevon floss. The deep-fried shredded meat floss locally called *abon* in

Indonesia was reported to have a crude protein content between 23.98 and 36.39% (Sukisman *et al*. (2014). However, the study of Abubakar *et al.* (2011) revealed that meat floss from non-ruminants such as rabbit contains 59.2 % protein, 24.3 % ether extract and 5.3-7.4 % ash content.

2.8 Meat Floss

Foods of animal origin such as meat and meat products contain important nutrients like amino acids, vitamins, minerals and fatty acids which are essential for growth and development (Abubakar *et al*., 2011). Animal products such as fresh meat, egg and milk are highly perishable because of their high nutritional value, especially the moisture content. Also, the presence of easily usable carbohydrates, fat, and protein provide ideal environments for microbial spoilage. Exploitation of all avenues of meat preservation has been suggested but these methods rarely achieve their aim due to their sophistication, which requires a constant and reliable power supply that is almost absent in most developing countries (Abubakar, *et al*., 2011). Therefore, the evaluation of simple, appropriate and affordable technologies applicable to the local environment is pertinent. To prevent spoilage, meat may be processed into products using many techniques such as intermediate moisture processing.

Further processing of meat offers the opportunity to add value, reduce prices, improve food safety and extend shelf-life, resulting in increased household income and improved nutrition (FAO, 2010). Furthermore, growing consumer interest in foodstuffs of high nutritional value that guarantee safety from a toxicological point of view and proper hygienic conditions has prompted interest in different processed meat products. One of such product is called meat floss. Meat floss or shredded meat is a dehydrated meat product and is one of the traditional meat-based products that are popular among Malaysian and Asian communities (Huda *et al.*, 2012). In Nigeria, it is also a popular traditional meat product among the Northerners that have been produced for years and is popularly known as *danbu nama* (Ogunsola and Omojola, 2008). Due to its low moisture content, meat floss can keep without refrigeration and will not drastically change in room temperature storage. It can be consumed as part of the daily dish or consumed with *lemang* (glutinous rice cooked in bamboo tubes) in Malaysia (Huda *et al*., 2012) while Ockerman and Li (1999) reported that apart from consuming it as part of a daily diet, it can also be consumed as snacks. Raw materials such as chicken, beef and fish are suitable for meat floss preparation (Ogunsola and Omojola, 2008; Huda *et al*., 2012) its preparation from rabbit and poultry products has also been reported (Abubakar *et al*., 2011). The preparation of meat floss varies with different people, for instance, in Malaysia its preparation generally starts with steaming of washed meat until it is tender. The meat is then shredded into fine particles and mixed with spices and coconut milk and afterwards the mixture is fried (Huda *et al*., 2012). However, in Nigeria, it involves cutting meat into chunks, followed by boiling, shredding and finally frying. During cooking and frying, spices composition which consists of various spices such as pepper, salt, cloves, ginger, curry, and thyme are added (Ogunsola and Omojola, 2008). The types and proportions of these ingredients also vary among individuals. All these variabilities indicate that there is no standard preparation of meat floss. However, since this product is still being prepared mainly by the traditional homemade method in Nigeria, there may be some hygienic challenges. A detailed chemical and microbiological study is needed to improve the quality, increase availability, shelf life stability and acceptance of this dried meat product.

2.9 Growth Performance of Small Goats Fed with Groundnut and Cowpea Haulms

Crop residues play an important role in sustaining small ruminants and ensuring their productivity especially when such crop residues possess the nutrient required by the animals for growth and development. The influence of crop residues such as groundnut and cowpea haulms on the growth parameters of goats has been variously reported. In a study with West African Dwarf goats, Babale *et al.* (2018) reported that higher inclusion levels of groundnut haulms in combination with cowpea husk led to better efficient nutrients utilization, higher rate of weight gain and higher profit in goat fattening. The authors recommended that farmers could combine 70 % groundnut haulms, 30 % cowpea husk and 150g of brewers' dried grain for a higher rate of gain and profit. Similarly, in a study with Abergelle goats, Tekle and Gebru (2018) reported that when Abergelle goats were placed on a basal diet of indigenous browse tree species at the start of the dry season, a faster growth rate was observed when the goats' diets were supplemented with groundnut haulms or cowpea haulms forages. According to the authors, the goats that had their diets supplemented with groundnut haulms and cowpea haulms recorded higher final body weight and average daily gain compared to goats that were fed the control diet. Furthermore, Abatan *et al.* (2015) showed that the use of cowpea haulms in combination with cassava peels and cassava leaves at a ratio of 475kg/DM: 400kg/DM: 475kg/DM improved the growth performance and nutrient digestibility of West African Dwarf goats. When *Moringa oleifera* leaves were supplemented with a basal diet of cowpea husk, it was shown that Red Sokoto goats recorded better feed intake, daily weight gain and nutrient digestibility (Mafindi *et al.,* 2018) in goats fed cowpea husk in contrast with the control. The importance of dried groundnut and cowpea haulms to the growth performance of goats cannot be overemphasized. Available data showed that most of the

Nigerian indigenous breeds of goats performed better in terms of growth performance when leguminous forages were fed to them especially at the start of the dry season when fresh nutritious feed becomes scarce.

2.10 Biochemical Indices of Small Ruminants Fed with Groundnut and Cowpea Haulms

Apart from the fact that the use of leguminous forages as supplements for goats does not pose any deleterious consequences, they have also been reported to improve the blood biochemical profile of the animals (Anele *et al.,* 2010). In a study with Xhosa goats, Soul *et al.* (2019) reported that legume forages did not produce a significant influence on serum total proteins, globulins, urea, creatinine, alanine aminotransferase, alkaline phosphatase (ALP), and gamma-glutamyl transferase concentrations. The levels of urea and alkaline phosphatase were reported to have increased over time while creatinine and cholesterol levels decreased when *Lablab purpereus* and cowpea were fed to Xhosa goats. Similarly, Omotoso *et al.* (2021) reported significant differences ($P<0.05$) in serum biochemical values in a study with female West African Dwarf sheep. According to the authors, higher values of serum total protein, 8.68 to 9.78 g/dL, were observed in the study and this was associated with greater efficiency of protein utilization in the sheep which was also linked with better health status of the sheep. The concentrations of serum transaminases (ALT and AST) in the blood are reliable tests for liver damage. Therefore, values obtained for AST, indicate the functionality of the liver. Babale *et al.* (2019) showed that there were significant differences in total blood protein, albumin, globulin, glucose and total nitrogen. The authors showed that better values of these biochemical parameters were recorded in goats fed diets containing groundnut haulms and cowpea husks compared to goats that were fed the control diet without either cowpea husks or groundnut haulms. All the values recorded in the study were within the normal range of values for healthy goats. Better biochemical indices in animals are not just an indication of better health of such animals but also further reveal the nutritive value of the diet that the animals are being fed.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

This study was conducted at the Teaching and Research Farm of the School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State. Minna is located between latitude 9^{0} 37′ North and longitude 6° 33′ East of the equator. Minna has a mean annual rainfall of 1,300 mm, with an average highest temperature in the month of March and the lowest temperature in the month of August. The mean annual temperature is between 22 to 40^{o} C. Minna is located in the Southern Guinea Savanna vegetation belt of Nigeria and has two distinct seasons; wet from March to October and dry from November to March (Weather Spark, 2019).

3.2 Experimental Diets and their Sources

The experimental diets consisted of cowpea haulms, groundnut haulms and the concentrate supplement mixture formulated to contain 15 % crude protein. The concentrate mixture is composed of maize offal (59.37 %), wheat offal, groundnut cake, bone meal and common salt as shown in Table 3.1. The maize offal and common salt were obtained at the Minna local Market (Kasuwa Gwari) while wheat offal, groundnut cake, and bone meal were purchased, milled and compounded at the livestock feed store and milling centre behind Gidan Matasa, Bosso, Minna, Niger State. The cowpea and groundnut haulms were procured from a local Market (Kasuwa Gwari) in Minna, Niger State.

Table 3.1: Ingredient Composition of Concentrate Supplement (%)

Ingredient	Composition (%)
Groundnut cake	8.94
Maize offal	59.37
Wheat offal	29.69
Bone meal	1.50
Common salt	0.50
Total	**100**
Calculated values	
Crude protein (%)	15.00
Crude fibre (%)	21.91
Metabolizable energy (Kcal/kg)	2,155.80

3.3 Proximate Analysis

The proximate analyses of the experimental diets (Table 3.2) and meat floss from Savanna Brown bucks from the treatment groups were carried out according to procedure outlined by AOAC (2005).

3.4 Source and Management of Experimental Animals

The animals were purchased from Kuta Livestock Market in Shiroro Local Government Area of Niger State. A total of fifteen (15) Savanna Brown bucks with an average live weight of 8-10kg between five to six months old were purchased to ensure effective fattening. Their age was determined by dental examination. The purchased goats were acclimatized to the new environment for a period of three (3) days, during which they were administered with Ivomectin®; a broad spectrum anti-parasitic drug. Broad-spectrum antibiotics (Oxytetracycline) and multivitamin drugs were also administered to keep the animals in good health. The bucks were kept in separate pens under an intensive management system. They were served concentrate feed between 7 am to 8 am and roughages were offered after an hour, both the concentrate and forages were given to the experimental animals at 2% and 3% body weight respectively (Makun *et al.*, 2016) while fresh water was always served *ad libitum.* The experiment lasted for the period of three months (90 days).

3.5 Experimental Treatments and Design

Savanna Brown bucks were selected at random, balanced for weight and then assigned into three dietary treatment groups of GCH, CH and GH using five bucks per treatment group, with each buck serving as a replicate. Groundnut and cowpea haulms (GCH) was the first treatment (control) and bucks in this treatment were fed with the combination of groundnut and cowpea haulms with concentrate.

Table 3.2: Proximate Composition of Experimental Diet (%)

Parameters	GCH	CH	GH
DM	96.88	97.85	96.00
CP	9.42	7.64	7.10
CF	30.46	31.95	29.00
EE	2.94	3.10	2.78
ASH	4.92	8.20	5.00
NFE	52.26	49.11	56.12

DM=Dry matter, CP= Crude protein, CF= Crude fibre, EE=Ether extract, NFE= Nitrogen free extract, GCH: Groundnut haulms and Cowpea haulms, CH: Cowpea Haulms, GH: Groundnut Haulms

The CH was the second treatment group and bucks in this group were fed with cowpea haulms and concentrate while the third treatment group was the GH and bucks in this treatment were fed with groundnut haulms and concentrate. The experiment lasted for a period of ninety (90) days. The completely randomized design (CRD) was used for this experiment.

3.6 Data Collection

Data were collected on growth performance, serum biochemical parameters, carcass characteristics, sensory attributes, proximate composition and microbial analysis of meat floss from Savanna Brown bucks fed selected forages.

3.6.1 Growth performance

The goats were weighed at the beginning of the experiment to obtain their initial weight and subsequently on a fortnightly basis to evaluate average weight changes so as to adjust the diet to be offered. Data on feed intake and body weight gain were determined. Feed intake was obtained by subtracting left-over feeds from the quantity offered per head per day and weekly feed intake per replicate was also obtained. Weight gain was obtained by subtracting the initial weight from the final weight. Average daily weight gain (ADWG) was determined by dividing weight gain by the number of goats and the number of days of the feeding trial. The feed conversion ratio (FCR) was calculated by dividing the total feed intake by the total body weight gain per replicate.

3.6.2 Serum biochemical parameters

The blood samples were collected at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna. Blood samples from two goats in each treatment were collected. The goats were adequately maintained in a relaxed condition before blood collection. After locating the jugular vein, a thumb was used to press the lower part of the vein to stop blood from flowing and 5 ml of blood was taken by jugular venipuncture. The blood sample was dispensed into free and sterilized bottles (anticoagulant-free) and was labelled accordingly. The blood samples were transported to the Niger State Veterinary Clinic for analysis and clotted blood was used to determine the serum biochemical profile. The serum indices such as total protein, albumin, globulin concentration, creatinine concentration, glucose and urea. Other parameters determined were cholesterol, serum sodium, potassium and serum hepatic enzymes namely Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT) and Alkaline Phosphatase (ALP) were carried out using commercial test kits, Quimica Clinica Aplicada (QCA) test kits (QCA, Spain).

3.6.3 Carcass characteristics evaluation

Two goats were randomly selected from each of the treatment groups following the termination of the fattening study. They were starved of feed overnight to get shrunk body weight before slaughter. Each buck was weighed before slaughtering to determine its slaughter weight. They were later weighed after slaughtering and reweighed after evisceration to determine hot carcass weight. The external offals such as the head and skin were removed and weighed separately after slaughtering. Following evisceration, the internal offals (liver, lung, heart and spleen) were removed and weighed separately. The gastrointestinal tract (GIT) was measured. The dressing percentage was determined by using the method of Aganga and Tshwenyane (2003).

3.6.4 Sensory evaluation

The thigh muscle was cut and subjected to sensory evaluation to determine the sensory attributes of the meat. The parameters for the sensory attributes, flavour, juiciness, tenderness, colour, aroma and overall acceptability, were carried out based on a 9-point Hedonic scale (9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2- dislike very much, 1-dislike extremely)

3.6.5 Meat floss preparation

After the 90 days of fattening period, the bucks were fasted for 12 hours and the halal method of slaughtering was followed and the conventional procedure of flaying. Two kilograms (2kg) of chevon from the hind leg and loin were obtained from each of the bucks. All external fats and visible connective tissues were trimmed off from the meat surface. Meat floss was prepared according to the procedure described by Eke *et al.* (2012).

3.6.6 Microbial evaluation

The microbial analysis of meat floss from Savanna Brown bucks was carried out during the period of storage under refrigerated conditions from week 1 – 4.

3.6.6.1 *Fungal analysis*

Total fungal counts (yeast/moulds) were determined (AOAC, 2005). This was done by plaiting 0.1ml of the representative of the sample using potato dextrose agar which was incubated at 25^{o}C for 5 days. Fungal colonies were then counted and averaged, which was expressed as the total number of colonies counted multiplied by the dilution factor and volume of inoculum to give the colony forming unit per gramme (cfu/gm x10^{2}).

3.6.6.2 *Bacterial analysis*

This analysis was conducted to determine total aerobic mesophilic counts (cfu/g x 105) as per the procedures of (AOAC, 2005; Beyene and Seifu, 2005). Total aerobic mesophilic counts were made by plating dilutions of samples on plate count agar and incubated aerobically at 37^{o}C for 24 hours. After incubation, bacterial colonies were counted and averaged, which was expressed as the total number of colonies counted multiplied by the dilution factor and volume of inoculum thereby giving the colony forming unit per gramme (cfu/gm x10^2).

3.7 Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) using the statistical package for social science (SPSS, 2012). Significant differences in means were separated using Duncan's multiple range test.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Results

4.1.1 Growth performance of savanna brown bucks fed with some forages

The result of the growth performance of Savanna Brown bucks fed with some forages and concentrate is shown in Table 4.1. The result revealed significant differences (P<0.05) in the forage intake and total feed intake while the result of other parameters measured were not significantly (P> 0.05) influenced by the treatments. The results of the forage intake and total feed intake followed a similar trend with treatment GH being significantly (P< 0.05) higher in forage intake (24.40kg) and total feed intake (42.62kg). This was followed by GCH with a forage intake of 23.03kg and a total feed intake of 40.70kg while CH had a forage intake of 21.69kg and a total feed intake of 38.92kg.

4.1.2 Serum biochemical profile of meat from savanna brown bucks fed with some forages

The biochemical profile of meat from Savanna Brown bucks fed the forages and concentrate (Table 4.2) showed that there were significant differences (P<0.05) in Total proteins, Globulins, Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphatase (ALP). Total protein was highest (P<0.05) in the GCH treatment group (5.40), while CH (3.93) and GH (4.53) treatment groups had total protein values that were statistically similar (P>0.05). The Globulin content was more (P<0.05) in GH (32.67) but bucks in GCH and CH had Globulin contents that were statistically similar (P>0.05) with values of 28.67 and 28.00 respectively.

Table 4.1: Growth Performance of Savanna Brown bucks Fed with some Forages

Parameters	GCH	CH	GH	SEM	LS
Forage intake (Kg)	23.03^{ab}	21.69^{b}	24.40^{a}	0.42	*
Concentrate intake (Kg)	17.67	17.24	18.22	0.21	NS
Total feed intake (Kg)	40.70^{ab}	38.92^{b}	42.62^{a}	0.60	*
Initial body weight (Kg)	10.10	9.70	9.70	0.20	NS
Final body weight (Kg)	12.30	11.60	12.50	0.71	NS
Body weight gain (Kg)	2.20	1.30	2.80	0.74	NS
Daily weight gain (g)	24.44	14.44	31.11	3.30	NS
Feed conversion ratio	18.50	29.94	15.22	5.63	NS

GCH: Groundnut and Cowpea Haulms, CH: Cowpea Haulms GH: Groundnut Haulms, SEM: Standard error of Mean, ^{a,b}=Means within the same row bearing different superscripts differ significantly ($P<0.05$) *=Significant, NS= Not Significant, LS= Level of Significance

For AST, GCH (8.33) and CH (6.00) were similar statistically (P>0.05) while the GH group (12.33) recorded the highest value (P<0.05). ALT was most abundant in the GH group (93.33), closely followed by the GCH group (80.67) while bucks fed CH recorded the least value (69.33). For ALP, bucks fed GH recorded the highest value (38.33) while the values recorded in GCH (28.33) and CH (27.33) were statistically alike.

4.1.3 Carcass characteristics of meat from savanna brown bucks fed with some forages

The result of the carcass analysis of meat from Savanna Brown bucks fed with some forages and concentrate is shown in Table 4.3. The result revealed that there were no significant difference (P>0.05) in all the carcass attributes evaluated.

4.1.4 Organoleptic quality of boiled meat prepared from savanna brown bucks fed with some forages

The organoleptic qualities of boiled meat from Savanna Brown bucks fed with some forages and concentrate is shown in Table 4.4. The result revealed no significant (P>0.05) differences in all parameters. The parameters evaluated were statistically similar.

4.1.5 Organoleptic quality of fried meat prepared from savanna brown bucks fed with some forages

The organoleptic properties of fried meat from Savanna Brown bucks fed with some forages and concentrate are presented in Table 4.5. The result revealed that there were significant (P<0.05) differences in juiciness (GCH: 6.80, CH: 5.25, GH: 5.65), aroma (GCH: 7.25, CH: 6.10, GH: 6.30) and overall acceptability (GCH: 7.80, CH: 6.54, GH: 7.0). However, there were no significant (P>0.05) differences in colour, tenderness and flavour.

Table 4.2: Serum Biochemical Profile of Savanna Brown bucks Fed with some Forages

Parameters	GCH	CH	GH	SEM	LS
Glucose (mmol/L)	4.67	3.47	4.67	0.32	NS
Urea (mg/dL)	4.77	3.87	4.73	0.21	NS
Sodium (mEq/L)	83.33	70.00	76.00	2.99	NS
Potassium (mEq/L)	5.07	4.93	5.30	0.16	NS
Creatinine (μmol/L)	80.00	77.33	77.67	1.27	NS
Cholesterol (mmol/L)	0.90	0.57	0.70	0.08	NS
Total Protein (g/dL)	5.40^{a}	3.93^{b}	4.53^{ab}	0.29	*
Albumin (g/dL)	3.30	2.27	2.83	0.24	NS
Globulin (g/dL)	2.87^{ab}	2.80^{b}	3.27^{a}	0.97	*
AST (iu/L)	8.33^{b}	6.00^{b}	12.33^{a}	1.06	*
ALT (iu/L)	80.67^{b}	69.33^{c}	93.33^{a}	3.79	*
ALP (iu/L)	28.33^{b}	27.33^{b}	38.33^{a}	1.85	*

GCH: Groundnut and Cowpea Haulms, CH: Cowpea Haulms GH: Groundnut Haulms, SEM: Standard Error of Mean, $^{a\ b}$=Means within the same row bearing different superscripts differ significantly (P<0.05), AST: Aspartate Aminotransferase, ALP: Alkaline phosphatase, ALT: Alanine Aminotransferase, *=Significant, NS= Not Significant, LS= Level of Significance

Table 4.3: Carcass Characteristics of Meat from Savanna Brown bucks Fed with some Forages

Parameters	GCH	CH	GH	SEM	LS
Live weight (kg)	11.50	11.50	11.25	0.27	NS
Slaughter weight (kg)	11.15	11.00	10.75	0.34	NS
Carcass weight (kg)	6.75	7.25	7.15	0.24	NS
Dress Percentage (%)	58.71	63.04	63.56	1.41	NS
Cut-off part					
(% of live weight)					
Head	4.81	9.01	8.63	0.671	NS
Neck	4.28	4.68	5.46	0.173	NS
Feet	3.61	3.55	3.16	0.071	NS
(% of dressed weight)					
Fore leg	10.39	10.24	10.21	0.028	NS
Hind leg	10.24	10.40	10.38	0.025	NS
Thigh	7.52	7.52	7.05	0.078	NS
Back	11.06	9.60	8.20	0.414	NS
Ribs	8.37	9.08	12.31	0.606	NS
Skin	8.54	7.37	6.97	0.236	NS
Tail	0.44	0.54	0.51	0.015	NS
(% of live weight)					
Rumen/Towel	1.85	2.36	1.57	0.116	NS
Small intestine	5.63	4.69	3.86	0.256	NS
Large intestine	5.12	4.44	4.07	0.154	NS
Liver	2.23	2.14	2.29	0.022	NS
Heart	0.71	0.57	0.52	0.029	NS
Lungs	1.12	1.20	1.56	0.070	NS
Spleen	0.16	0.15	0.18	0.111	NS
Kidney	0.43	0.33	0.45	0.019	NS
Testes	1.03	1.01	0.78	0.040	NS
Trachea	0.30	0.27	0.24	0.019	NS
Full Stomach	20.07	18.63	15.70	0.643	NS

GCH: Groundnut and Cowpea Haulms, CH: Cowpea Haulms, GH: Groundnut Haulms, SEM: Standard Error of Mean, ^{a,b}=Means within the same row bearing different superscripts differ significantly (P<0.05), *=Significant, NS= Not Significant, LS= Level of Significance

Table 4.4: Organoleptic Quality of Boiled Meat prepared from Savanna Brown bucks Fed with some Forages

Parameters	GCH	CH	GH	SEM	LS
Colour	5.65	6.70	5.70	0.26	NS
Juiciness	6.20	6.20	5.85	0.21	NS
Tenderness	6.50	7.05	6.05	0.23	NS
Flavour	6.10	5.80	6.00	0.26	NS
Aroma	6.00	6.05	7.20	0.26	NS
Overall Acceptability	6.90	6.60	7.50	0.19	NS

GCH: Groundnut and Cowpea Haulms, CH: Cowpea Haulms, GH: Groundnut Haulms, SEM: Standard Error of Mean, ^{a,b}=Means within the same row bearing different superscripts differ significantly ($P<0.05$), *=Significant, NS= Not Significant, LS= Level of Significance

Table 4.5: Organoleptic Quality of Fried Meat prepared from Savanna Brown bucks Fed with some Forages

Parameters	GCH	CH	GH	SEM	LS
Colour	8.05	7.30	7.35	0.18	NS
Juiciness	6.80^{a}	5.25^{b}	5.65^{ab}	0.26	*
Tenderness	6.80	6.80	6.35	0.19	NS
Flavour	7.05	6.95	6.20	0.20	NS
Aroma	7.25^{a}	6.10^{b}	6.30^{ab}	0.22	*
Overall Acceptability	7.80^{a}	6.54^{b}	7.00^{ab}	0.18	*

GCH: Groundnut and Cowpea Haulms, CH: Cowpea Haulms, GH: Groundnut Haulms, SEM: Standard Error of Mean, ^{a,b}=Means within the same row bearing different superscripts differ significantly (P<0.05), *=Significant, NS= Not Significant, LS= Level of Significance

4.1.6 Proximate analysis of meat floss from savanna brown bucks fed with some forages from week 1 - 4

The proximate composition of meat floss from Savanna Brown bucks fed with some forages and concentrates (Table 4.6) showed that there were significant differences ($P<0.05$) in the moisture content of the meat floss in week 1. In the second week, significant differences ($P<0.05$) were recorded in the crude protein contents of the meat while other proximate parameters did not differ significantly. However, in both weeks 3 and 4, ash (mineral) was significantly different ($P<0.05$) from other proximate fractions evaluated.

4.1.7 Microbial analysis of meat floss from savanna brown bucks fed with some forages and concentrate from week 1 – 4

The microbial analysis of meat floss from Savanna Brown bucks fed with some forages and concentrate from week 1-4 (Table 4.7) showed that there were significant differences ($P<0.05$) in the bacteria and fungi count from week 1 to week 2. In the first week, GH had the highest bacterial count (119.50 cfu/g) while GCH (101.00 cfu/g) and CH (97.00 cfu/g) were statistically similar. The highest fungal count was recorded in GCH (23.00 cfu/g) while CH (20.50 cfu/g) and GH (19.50 cfu/g) were statistically similar. In the second week, the bacterial count was highest in the GH treatment group (138.50 cfu/g) with GCH (108.00 cfu/g) and CH (100.00 cfu/g) being statistically alike. In the third and fourth week, there were significant differences ($P<0.05$) in the bacterial counts of the meat floss. In the third week, GH (151.00 cfu/g) had the most bacterial count closely followed by GCH (115.00 cfu/g) while CH had the least bacterial count (105.00 cfu/g). In the 4th week, the bacterial count was more in GH (101.00 cfu/g) while statistical similarity was observed in GCH (93.00 cfu/g) and CH (91.50 cfu/g) treatment groups**.**

Table 4.6: Proximate Analysis of Meat Floss from Savanna Brown bucks Fed with some Forages during the Period of Storage (Week 1 – 4)

Parameters	GCH	CH	GH	SEM	LS
			WEEK 1		
Moisture	10.99^b	13.20^a	10.22^b	0.57	*
Crude protein	40.45	44.21	44.85	1.10	NS
Ash	6.50	5.59	8.20	0.56	NS
Fat	28.50	27.52	29.56	0.77	NS
			WEEK 2		
Moisture	21.36	24.72	24.23	0.75	NS
Crude protein	36.78^b	40.31^a	38.61^{ab}	0.67	*
Ash	7.75	7.91	8.68	0.30	NS
Fat	23.50	23.50	23.33	1.09	NS
			WEEK 3		
Moisture	25.64	24.00	26.50	0.92	NS
Crude protein	38.83	38.64	39.04	0.73	NS
Ash	9.50^a	9.53^a	7.00^b	0.56	*
Fat	15.37	15.57	19.83	1.96	NS
			WEEK 4		
Moisture	28.14	25.11	27.50	1.03	NS
Crude protein	33.94	37.56	36.96	1.06	NS
Ash	10.00^a	9.64^{ab}	8.83^b	0.25	*
Fat	19.33	18.06	22.83	1.48	NS

GCH: Groundnut and Cowpea Haulms, CH: Cowpea Haulms, GH: Groundnut Haulms, SEM: Standard Error of Mean, ^{a,b}=Means within the same row bearing different superscripts differ significantly ($P<0.05$), *=Significant, NS= Not Significant, LS= Level of Significance

Table 4.7: Microbial Analysis of Meat Floss from Savanna Brown bucks during the Period of Storage under Refrigerated Conditions from Week 1 – 4 ($x10^2$ cfu/g)

Parameters	GCH	CH	GH	SEM	LS
			WEEK 1		
Bacteria = CFU/g	101.00^{b}	97.00^{b}	119.50^{a}	4.65	*
Fungi = CFU/g	23.00^{a}	20.50^{b}	19.50^{b}	0.68	*
			WEEK 2		
Bacteria = CFU/g	108.00^{b}	100.00^{b}	138.50^{a}	7.62	*
Fungi = CFU/g	24.50^{a}	25.50^{a}	17.00^{b}	1.74	*
			WEEK 3		
Bacteria = CFU/g	115.00^{b}	105.00^{c}	151.00^{a}	8.89	*
Fungi = CFU/g	23.00	26.00	27.00	1.20	NS
			WEEK 4		
Bacteria = CFU/g	93.00^{ab}	91.50^{b}	101.00^{a}	2.07	*
Fungi = CFU/g	21.00	17.00	19.00	0.97	NS

GCH: Groundnut Haulms and Cowpea Haulms, CH: Cowpea Haulms, GH: Groundnut Haulms, CFU= Colony Forming Unit, SEM: Standard Error of Mean, NS: Not Significant, ^{a,b}=Means within the same row bearing different superscripts differ significantly (P<0.05), *=Significant, NS= Not Significant, LS= Level of Significance

4.2 Discussion

4.2.1 Growth performance of savanna brown bucks fed with some forages

From the result obtained in this study, Savanna Brown bucks showed more preference for the intake of groundnut haulms (GH) compared to cowpea haulms (CH). This could be a result of the fact that the groundnut haulms were more palatable to the bucks and this may have enhanced more dry matter intake of the goats. It is also an indication that there were minimal or tolerable levels of anti-nutrients in the GH forage which did not hamper forage intake in any way hence the improved consumption of groundnut haulms in contrast with cowpea haulms. Adequate forage intake promotes feed utilization efficiency and growth rate in small ruminants. In the current study, the impressive forage intake by the GH treatment group could also be linked with the weight gain outcomes with regard to daily weight gain, final weight and weight gain. This is in agreement with earlier reports stating that improved consumption of forage enables small ruminants to consume more of the nutrients in those forages which promotes better utilization of the nutrients thereby enhancing their growth rate (Babale *et al*., 2018).

4.2.2 Serum biochemical profile of meat from savanna brown bucks fed with some forages

The experimental diets did not have any marked effect on serum biochemical indices such as glucose, urea, sodium, potassium, creatinine, cholesterol and albumin. However, there were observed influences of the diets on parameters such as total protein, globulin, Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphatase (ALP). The total protein values of bucks in the current study ranged from 3.93g/dL to 5.40g/dL. Higher total protein values have been associated with excessive consumption of grains, starvation from water and inclement temperatures (Sandabe and

Chaudhary, 2000). The lower total protein values in the current study may be due to the sexes of the goats since male goats (bucks) were used for this study. This is in accordance with the findings of Sakha *et al.* (2009) who observed significant differences in the total protein values of goats between sexes. The values of globulin were also found to be within the normal range for goats. Higher values of globulin have been linked with infestation by parasites (Rumosa-Gwaze *et al.*, 2010). During the course of this study, routine deworming against internal and external parasites was carried out. This may have offered the goats some level of protection thereby helping to maintain the globulin levels within normal range. The system of management for goats has also been implicated as one of the reasons for high globulin levels. Goats in the current study were managed on an intensive basis. Higher globulin values have been reported in goats managed on an extensive system (Manish *et al.,* 2020). This may be due to the fact that on the extensive system, there is a high possibility of parasitic infestation which could culminate in raising the globulin levels. Furthermore, the mean range of values for AST (6.00 – 12.33 iu/L) obtained in the current study is lower than the range of 43.2-49.3 iu/L reported by Tibbo *et al.* (2009). The ALT range (69.33 – 93.33 iu/L) was higher than the 8.9 iu/L reported by Daramola *et al.* (2005) for West African Dwarf goats and the 39.0 iu/L reported by Taiwo and Ogunsanmi (2003) in a study with West African Dwarf goats in Oyo State, Nigeria. The ALP (27.33 – 38.33 u/l) fell within the range of 39.7 iu/L reported by Taiwo and Ogunsanmi (2003) and the 30.7 iu/L reported by Ikhimioya and Imasuen (2007). It has been observed that ALP abundance in the blood is an indication of bone formation. The values of ALP obtained in this study reveal acceptable levels with no serious pathological deviation from the normal values.

4.2.3 Carcass characteristics of savanna brown bucks fed with some forages

There were no significant differences observed in the carcass attributes of the bucks. All the carcass parameters were statistically similar. This might be due to the duration of the study. Usually, ruminant animals, unlike poultry, require a longer period to attain maturity and show marked differences in their carcass attributes. The duration of this study was three months (90 days). Carcass characteristics can also be influenced by sex, age, environment and the type of nutrition on which the animal was placed (Gurung *et al.,* 2022). In terms of nutrition, it has been observed that certain agricultural crop residues do not significantly influence carcass characteristics (Gurung *et al.,* 2009). Thus, longer periods of feeding and management might be required to attain significant weight differences in animals when feeding with crop residues.

4.2.4 Organoleptic quality of boiled meat prepared from savanna brown bucks fed with some forages

The views of the Panel of Tasters used for the evaluation of the organoleptic quality of boiled meat from Savanna Brown bucks used for this study did not differ significantly across the treatments. The responses of the Panelists were statistically alike with regard to meat colour, juiciness, tenderness, flavour, aroma and overall acceptability.

4.2.5 Organoleptic quality of fried meat prepared from savanna brown bucks fed with some forages

Organoleptic or sensory characteristics are measures of the quality of meat by making a sensory appraisal of its colour, flavour, juiciness, aroma and tenderness. In the current study, fried meat from the Savanna Brown bucks fed groundnut-cowpea haulms forages (GCH) were adjudged by the panelists as the juiciest compared to those fed groundnut haulms (GH) or cowpea haulms (CH). Meat juiciness is a vital aspect of meat quality that enhances its eating quality. Juiciness in meat is attributed to the intramuscular fat content of the meat. It is believed that the fat content in meat promotes better water holding ability of muscles and this eventually enhances the juiciness of the meat. The combination of groundnut and cowpea haulms fed to the goats in the GCH treatment group may have promoted better distribution of intramuscular fat which may also have promoted a better water holding capacity of the muscles leading to juicier meat. The view Panelists indicated that the meat was fried within tolerable heat limits for meat. This agrees with the findings of Aaslyng *et al*. (2009) who reported that the intramuscular fat content of meat increases its juiciness especially when such meat is not over fried. Also, the aroma of fried meat from bucks fed GCH differed significantly from those fed CH and GH; although values for aroma in CH and GH were statistically similar. Aroma and juiciness are considered to be the most important criteria that promote the palatability of meat (Robbins *et al.,* 2003). Desirable meat aroma emanates from the synergy between free amino acids and sugars (Madruga and Mottram, 1998). The impressive aroma recorded in the fried GCH meat could be a result of the fact there was adequate interaction between the free amino acids in the fried goat meat. Fried meat from bucks in the GCH group was rated by the Panelists to have the best overall acceptability compared to those in CH and GH groups. This could be associated with the juiciness and aroma of the meat which may have promoted better desirability for the meat, hence the decision of the Panelist to adjudge meat from the GCH as having the overall best in terms of acceptability.

4.2.6 Proximate analysis of meat floss from savanna brown bucks fed with some forages from week 1 – 4

The crude protein of meat floss from bucks in the current study (weeks 1-4) was generally lower than the 46.73 % reported by Omojola *et al.* (2014) for chevon meat floss. The moisture contents were, however, greater than 19.29 % reported by the authors especially from week 2 to 4. As opposed to the results obtained in the first week, a steady increase in the moisture content of the meat was observed across all treatment groups (GCH, CH and GH). This increase in the moisture content can be attributed to the refrigeration condition which may have promoted the acquisition of additional moisture by the meat during cold storage. The higher fat content of the meat floss was also observed. This might be due to the frying of the meat floss which may have led to the absorption of more fat from the frying medium thereby increasing the fat content. In the 4^{th} week, ash (mineral) content of 10.00 %, 9.64 % and 8.83 % for GCH, CH and GH respectively. This is superior to the ash content of 7.96 % reported by Akinleye *et al.* (2020) for meat floss from the Uda breed of sheep. This is an indication of the fact that meat floss from Savanna Brown bucks might be a mineral-rich meat product that could possess greater content of minerals with longer storage.

4.2.7 Microbial analysis of meat floss from savanna brown bucks fed with some forages from week 1 – 4

The results of the microbial analysis of meat from Savanna Brown bucks fed selected forages and concentrate indicated that there were significant effects ($P<0.05$) of the experimental diets across the treatments. Within the first week of inoculation, the bacterial count was most abundant in the meat samples from goats fed groundnut haulms (GH) with a count of 119.50 cfu/g while the fungal count was highest in the groundnut and cowpea haulms (GCH) group with a count of 23.00 $x10^2$ cfu/g. This result is contrary to the report by Balarabe *et al.* (2021) who recorded a high bacterial count of $24x10^5$ cfu/g and a fungal count of $4x10^5$ cfu/g from meat floss of broiler chickens fed diets containing *Guiera senegalensis* leaf meal. In the second week, the bacterial count differed across the treatment groups. Similar to the first week, bacterial count was highest in GH (138.50^{2} cfu/g) and this was significantly different from the control group, GCH (108.00^{2} cfu/g). The fungal counts in meat samples from CH were highest (25.50^{2} cfu/g) though statistically similar to the control, CGH (24.50^{2} cfu/g) while the least values were obtained from meat floss from goats in GH (17.00 $x10^{2}$cfu/g). This is at variance with the report by Akinleye *et al.* (2020) who reported a fungal count of $2.35x10^{2}$ cfu/g in meat floss of Yankasa sheep on the 14^{th} day under refrigerated conditions. As observed in weeks 1 and 2, the bacterial and fungal counts in the 3^{rd} and 4^{th} weeks followed a similar trend with bacterial counts being highest in the GH treatment groups and fungal counts being highest in the control, GCH. Generally, the microbial counts recorded in this study fell within the tolerable limit of 10^{7}cfu/g recommended by ICMSF (2014).

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the results obtained from this study, it is concluded that the groundnut haulms (GH) diet enhanced forage intake and total feed intake in the Savanna Brown bucks. In addition, the findings from this research revealed that a combination of groundnut and cowpea haulms (GCH) forages enhanced the total protein count while groundnut haulms (GH) forage had better Globulin, Aspartate Aminotransferase (AST), Alkaline Phosphatase (ALP) and Alanine Aminotransferase (ALT) counts in the Savanna Brown bucks.

It was also discovered that the carcass characteristics of the Savanna Brown bucks were not significantly different among dietary treatments. The combination of groundnut and cowpea haulms promoted better sensory attributes in fried goat meat regarding juiciness, aroma and overall acceptability.

Furthermore, under cold storage, meat floss from the GCH treatment group had more fungal load than CH and GH while samples from GH had more bacterial count than GCH and CH, nevertheless, the microbial load were within the recommended tolerable limits.

5.2 Recommendations

i) It is recommended that groundnut haulms (GH) should be included in diets for better feed intake and growth rate of the Savanna Brown bucks while the combination of groundnut and cowpea haulms (GCH) can be included in diets of goats to promote better sensory attributes of meat, health and physiological functions.

ii) More research efforts should be made towards incorporating larger quantities of forages such as groundnut and cowpea haulms in buck's diet to boost the productivity of small ruminants such as goats.

iii) Further research study may be carried out to:

a. Ascertain an optimum supplementation level of these forages (groundnut and cowpea haulms) in diets of bucks.
b. Determine the acceptability and performance of other species to these forages
c. Determine the response of Savanna Brown goats to other nutritionally-rich dried forages since concentrate feed is expensive and most smallholder farmers may not be able to afford it.

5.3 Contribution to Knowledge

The study revealed that Savanna Brown bucks fed groundnut haulms under intensive management had a better forage intake of 24.40kg compared with those fed cowpea haulms (21.69kg) and groundnut and cowpea haulms forage mixture (23.03kg). Also, bucks fed groundnut haulms had better total feed intake (42.6 2kg) in contrast to those fed cowpea haulms (38.92kg) and groundnut and cowpea haulms mixture (40.70kg).

It was discovered from this study that the serum biochemical parameters of the bucks fed the groundnut and cowpea haulms forage mixture had the best total protein (5.40 g/dL) compared to those fed groundnut haulms (4.53 g/dL) and cowpea haulms (3.93 g/dL). The findings from this research also revealed that bucks fed groundnut haulms had the best globulin (3.27 g/dL), aspartate aminotransferase (12.33 iu/L), alanine aminotransferase (93.33 iu/L) and alkaline phosphatase (38.33 iu/L) compared to those fed groundnut and cowpea haulms forage combination. There was an improvement in the protein content in the meat from the bucks fed cowpea haulms (40.31%) in the second week of storage compared to bucks fed groundnut haulms (38.61%) and groundnut and cowpea forage (36.78 %).

Notable information derived from this study showed that feeding groundnut haulms at 3% body weight of Savanna Brown bucks resulted in the improvement of overall performance and organoleptic qualities of the meat and its product.

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