GROWTH PERFORMANCE OF GROWING BUNAJI BULL CALVES FED *Digitaria smutsii* BASED DIET SUPPLEMENTED WITH CONCENTRATE CONTAINING CASSAVA PEEL MEAL

BY

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DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE,
AHMADU BELLO UNIVERSITY,
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FEBRUARY, 2020

DECLARATION

I hereby declare that this dissertation has been written by me and it is a record of my research work. This dissertation has not been presented in any previous publication for the award of a degree. All quotations are indicated and all sources of information acknowledged by references.

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Kalejaiye, Dorcas Motunrayo Date

CERTIFICATION

This dissertation entitled "GROWTH PERFORMANCE OF GROWING BUNAJI BULL CALVES FED *Digitaria smutsii* BASED DIET SUPPLEMENTED WITH CONCENTRATE CONTAINING CASSAVA PEEL MEAL" meets the requirements governing the award of Master Degree of Animal Science Department Ahmadu Bello University, Zaria and it is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This project is dedicated to God Almighty for His goodness and mercies, my beloved husband and children.

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ABREVIATIONS

% Percentage

ADF Acid Detergent Fibre

ADWG Average Daily Weight Gain

AOAC Association of American Analytical Chemist

ARC Agricultural Research Council

BSADP Bauchi State Agricultural Development Programme

CPM Cassava peel meal

CBN Central Bank of Nigeria

CF Crude Fibre

CP Crude Protein

CSC Cotton Seed Cake

DMD Dry matter digestibility

EE Ether extract

FAO Food and Agriculture Organization

FCR Feed Conversion Ratio

IAR Institute of Agricultural Research

ICAR Indian Council of Agricultural Research

IDRC International Development Research Centre

NDF Neutral Detergent Fibre

NH_3 Ammonia

NRC National Research Council

RIF Return to Investment on Feed

SEM Standard error of the mean

TCFC Total cost of feed consumed

TVFA Total Volatile Fatty Acid

WFB World Factbook

ABSTRACT

A study was conducted using sixteen (16)growing Bunaji bull calves with a live weight range of 95- 97kg, and age range of 6-12 months to evaluate the feeding value of cassava peels meal (CPM) inclusion levels at 0, 10, 20 and 30% as energy source. The animals were balanced for weight and allotted to four (4) dietary treatments in a completely randomized design. They were fed diets containing inclusion level of cassava peel meal (CPM) and *Digitaria smutsii*(Wolly Finger grass) hay at 1.0% of their body weight each. Feeding and metabolism trials were conducted for 90 days and 14 days respectively. Blood samples were collected for haematological and biochemical parameters and Rumen fluid were at the end of the trial.The result of the feeding trial showed that growing Bunaji bull calves fed diet containing 20% CPM significantly ($P<0.05$) higher final weight (111.75kg) which was followed by those fed 10% CPM inclusion levels. Those fed the control diet and 30% CPM had statistically similar and lower final weight gain (103.01 and 106.50kg, respectively). Feed conversion ratio (FCR) result indicated that growing Bunaji bull calves fed the 20% CPM had the significantly ($P<0.05$) best conversion (17.14). Total hay intake was significantly ($P<0.05$) higher at 10% (195.39kg) and 20% (188.10kg).The CP content of the diets CPM and *D. smutsii* vary between 2.13 and 5.90%. The ether extract varied from 12.57 and 2.51%. The crude fibre varied from 14.25 and 15.20%. The digestibility of ash was significantly ($P<0.05$) higher in bull calves fed concentrate diets containing CPM at 20 and 30% inclusion level while ether extract digestibility was significantly ($P<0.05$) higher at 20% inclusion level of CPM. The digestibility of CP was numerically higher (67.84%) at 20% level of CPM inclusion.PCV was numerically higher at 10% CPM (36.33%) and White blood cell was significantly ($P<0.05$) higher at 30% CPM (10.47×10^{6}µl). Blood glucose was highest for animals on diet containing 10% CPM inclusion (61.00mg/dl) and lowest for those on 30% CPM (42.67mg/dl). Rumen fluid were collected at 0, 3, 6 and 9hrs interval to determine rumen ammonia nitrogen and rumen total volatile fatty acids for growing bull calves. The result showed that TVFA was highest at 9hrs post feeding (46.83Mmol/L) but differed at 0hr (29.75Mmol/L), 3hrs (34.17Mmol/L) and 6hrs (39.42Mmol/L). Animals on diet containing 10% CPM had significantly ($P<0.05$) higher volatile fatty acids (41.58Mmol/L), when compared to the control (32.67Mmol/L). At 3hrs and 6hrs post feeding RAN (NH_3-N) was similar and highest at 20% (11.44mg/100ml) CPM.Temperature at 0hr, 3hrs and 6hrs post feeding was similar and also at 0, 10, 20 and 30% CPM inclusion.Feed cost to gain ratio was highest in the control (control (₦1,277.19/kg live weight gain) and lowest at 20% CPM inclusion level (₦685.34/kg live weight gain). The net benefits were ₦39,989.70, ₦75,417.40, ₦100,186.60 and ₦67,031.91 (60.08%) for feeding Bunaji bull calves on 0, 10, 20 and 30% CPM diets respectively. It was concluded the CPM can be included in concentrate diet up to 20% been optimum for growing Bunaji bull calveswithout any adverse effect and therefore be recommended to farmers for better production and profit margin.

CHAPTER ONE

1.0 INTRODUCTION

Intensive systems of cattle production improve animal performance and meat quality (Fugita *et al*., 2012). In recent years, beef cattle producers have operated with a narrow profit margin. To improve the production of beef cattle finished in feedlot, it is necessary to employ high energy density diets (NRC, 2000). The success of the livestock industry anywhere in the world depends greatly on feed quality and quantity (Babayemi and Bamikole, 2008). Animals receiving inadequate diets are more prone to disease and fail to reach their genetic potential. Inadequate nutrition has been the major factor limiting the expansion of animal production in Nigeria (Kassam and Andrew, 1975). To salvage this nutritional problem, there is need for utilization of cheap and indigenous sources of protein and energy particularly those that attract no competition from man and other types of livestock.

Feed accounts for 60-80% of the total cost in livestock production (Tewe, 1997). The increasing cost of feed resources in livestock production have been identified as a serious impediment to meeting the demand for animal protein particularly in developing countries (Adejinmi *et al*., 2000). This challenge resulted in research focus that could reduce the cost of feeding without negatively influencing the performance of the animals. This approach involves compounding of feed in a way that all the required nutrients come from cheap alternative energy and protein sources. The search for such alternatives has been the focus of Animal Nutritionists for over a decade (Onyimonyi and Okeke, 2005).

Crop residues such as yam and cassava peels are thus important because of the ability of ruminants to digest cellulose and other structural polysaccharides of plants origin (Adejinmi *et* *al.*, 2000). These tuber peels are regarded as 'waste product' that is ordinarily discarded, hence a cheap source of diet for the ruminant animals, most especially the domesticated ones. Cassava peel is also rich in metabolizable energy and very well degraded in the rumen (Smith, 1988).

One of the reasons for the poor growth performance from our indigenous cattle breeds stems from inadequate supply of quality and sustainable diets all year round. On a global scale, cassava (*Manihot esculenta*) represents both an important human food resource and, in many regions, an underutilized animal feed ingredient. Cultivated in tropical/subtropical environments, cassava can be grown on marginal lands; it is relatively drought-hardy, and all parts of the plant can be utilized; and its roots comprise an energy staple in many regions.

1.1 JUSTIFICATION

In Nigeria, and most part of Africa, feed rations for ruminant animals are usually composed of discarded food/crop product and browse leaves. For instance, it is uneconomical to feed yam to livestock, but yam peels which are often discarded are of great value as animal feed (Eka, 1998). The importance of yam as an indigenous and cheap source of nutrition cannot be over-emphasized, hence the necessity to evaluate its dietary importance. Another cheap source of feedstuff for ruminant animals in Nigeria is cassava peels. Cassava is a woody shrub native to South America and West Africa with Nigeria being the world's largest producer. It is extensively cultivated as an annual crop in tropical and sub-tropical region for its edible starchy tuberous root. Cassava peel regarded as 'waste' is readily available from the local processing of cassava tuber for garri (a popular staple food in West Africa) and in the production of industrial starch.

The increasing pressure on the use of maize by the human population and other industrial users may result in an escalating price of maize in Nigeria. The search for alternatives to maize as a feed source led to the introduction of cassava plant (*Manihot spp*). Cassava peels are a major byproduct of cassava processing and constitutes about 10-13 % of whole root weight (Tewe *et al.,* 1976). Cassava peel if incorporated in diets of ruminant will reduce feed cost since it is cheaper and it is clear that it has on alternative use in human and other livestock diets. Therefore, the study is targeted towards evaluating the performance of growing bulls fed cassava peel.

The main aim of this study is targeted towards evaluating the performance of growing Bunaji bull calves fed cassava peel.

1.2 Objectives of the study

The objectives of the study are to investigate the effect of:

1. Diet containing cassava peel meal on the growth performance of growingBunajibull calves
2. Diet containing cassava peel meal on the haematological and biochemical characteristics of growing Bunaji bull calves.
3. Diet containing cassava peel meal on the rumen metabolites of growingBunaji bull calves.
4. Evaluate the economics of feeding growing Bunaji bull calves on diets containing cassava peel meal.

1.3 HYPOTHESES

Null Hypothesis (Ho)

1. Diet containing cassava peel meal has no effect on the performance of growing Bunaji bull calves.
2. Diet containing cassava peel meal has no effect on the heamatological and biochemical performance of growing Bunaji bull calves.

3. Diet containing cassava peel meal has no influence on rumen metabolites of growingBunaji bull calves.

4.Diets containing cassava peel meal has no effect on the economics of growing Bunaji bull calves

Alternate Hypothesis (Ha)

1. Diet containing cassava peel meal has effect on the performance of growing Bunaji bull calves.

2. Diet containing cassava peel mealhas effect on the heamatological and biochemical characteristics of growing Bunaji bull calves.

3. Diet containing cassava peel meal has influence on rumen metabolites ingrowing Bunaji bull calves.

4. Diets containing cassava peel meal has effect on the economics of growing Bunaji bull calves.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Cattle production in Nigeria

Ruminants exert a greater effect on ecosystems than other animal species. In Nigeria, ruminant livestock are numerous and provide substantial quantities of animal protein. However, cattle production systems are predominantly traditional or village systems, nomadic or pastoral systems, mixed farming, and the peri-urban and modern livestockhusbandry. Aregheore (2009) opined that ruminant production and management system vary from free range in the less populated areas to year round confinement with cut and carry feeding of grasses and browse plants in densely populated areas.

Cattle population in Nigeria has been reported to be about 20 million (FAO, 2013). Data for meat and milk production, live animal imports and milk imports shows that beef and veal, sheep meat, goats and game meat production in 2009 are 280, 100.7, 147.1 and 120 metric tonnes, respectively (Aregheore, 2009).

Although, cattle are found in almost every zone of Nigeria, they are mostly found occupying about two-thirds (2/3) of the country. Aregheore (2009) noted that half of the total cattle population is permanently resident in the sub humid zone. Over 90% of the Nigerians' population of Zebu cattle is owned by agro-pastoral farmers, who adopt relatively inefficient production systems (Otchere and Nuru, 1988). The proportion of various breeds of cattle in Nigeria are 51%, 14%, 11.5%, 11.5%, 2.1%, 0.7%, 0.2% and 9% for Bunaji, Rahaji, Sokoto Gudali, Adamawa Gudali, Keteku, Muturu, N"dama and others, respectively (FAO, 1988 and Barje, 2006). Keteku, Muturu and Kuri/Chad cattle are predominantly found in the Southern-Western, Southern and North Eastern parts of Nigeria, respectively (Aregheore, 2009).

2.2Beef cattleproduction systems

In sub-saharan Africa beef cattle provide substantial quantities of animal protein. However, their production is based on age-old husbandry systems, which need to be gradually modified in order to improve their productivity, hence bridge the gap between supply and demand. Beef cattle production systems in Nigeria are predominantly grouped into; traditional or village systems, nomadic or pastoral systems, mixed farming (crop-livestock) and the peri-urban commercial dairy production system. In general, production and management systems vary from free range in less populated areas to year round confinement and cut and carry feeding of grass and browse in densely populated areas (Aregheore, 2009)

2.2.1 Nomadic or pastoral system (Extensive system)

The traditional grazing pattern is that at the end of the dry season the animals are either near permanent villages feeding on dry forage and browse or far enough south to find pasture and water but not so far as to encounter the tsetse fly (Payne, 1991). The migration to north begins and continues as long as the grass ahead is as green as the pastures at hand. When the northernmost grass and water are consumed (usually in November or December), there is a slow movement southwards to the home range, where there should be crop stubble and a full growth of grass to carry the animals through the dry season (Clyburn, 1974). Traditionally, the different clans or ethnic groups usually have their respective grazing areas, depending on their environment; they also tend to specialize in certain animals. For example, the Fulani in northern Nigeria are known for their cattle. Herding is a monumental task for the Fulani who are always trying to get the best grazing condition for their animals. Contrary to popular belief, moving with animals is not the delight of the pastoralists. The migrant Fulani in Nigeria move because they have no choice (Otchere *et al.,* 1985). In general terms the pastoral systems practiced by the Fulani herders fall into three groups;Exclusively pastoralists; transhumant pastoralists and agropastoralists.

2.2.2.1 Exclusive pastoralists

These are mainly livestock producers who do not grow crops and therefore depend on the sales of live animals and dairy products to buy grains, other food items and other necessities. Most pastoralists under this system may move very long distances every year. It is a popular assumption that they wander from place to place without any logic, but, they have set migration routes and often long-standing arrangements with farmers to make use of their crop residues (Tewe and Bokanga, 2001). It is only when there is drought, a failure of the pasture or the spread of diseases that they diverge from their existing patterns. The pastoralists in the Niger-Benue valley migrate very short distances between the wet and dry seasons. They use the same grazing areas and routes each year with the thatching on houses at each location repaired annually. Most of the pastoralists spend the dry season in the River Niger floodplains and only move to higher grounds before the flood rises during the rains (Aregheore, 2001).

2.2.2.2 Transhumant pastoralists:

Transhumance pastoralists in the drier north of the country rear a very high proportion of the cattle herd. Pastoralists under this production system have permanent homestead and base (Ehoche, 2002). Their animals depend on the natural forage legumes and grasses for subsistence but these are usually unavailable in the dry season (Preston and Leng, 1987). They move in response to seasonal changes in the quality of grazing resources and the tsetse fly challenges. The travelling unit is normally made of a common herd owned by close male relatives, father and son. Grain and other basic needs are purchased from sale proceeds of live animals (surplus male sheep, goats and cattle) by the men or selling of milk and other dairy products by the women in the local markets (Aregheore, 2001). They grow crops mainly for domestic use rather than for the market. The male folk take away the majority of the herd in search of grazing, however they leave older members of the community with the nucleus of lactating women. They return in the wet season to assist with crop cultivation. They do not have traditional grazing land rights and often move to the south during the dry season to fatten their animals for sale (Aregheore, 2001). The animals move from their arid home range to the wetter southern parts where vegetation remains green and suitable for grazing (Ehoche, 2002).

2.2.2.3 Agro-pastoralists (Semi-intensive)

These are semi-settled pastoralists and they are found in many parts of northern Nigeria (Payne, 1990). They cultivate areas sufficient to feed their families from their own cereal production. They hold land rights, use their own or hired labour to cultivate land and grow crops such as yams and cassava in addition to the staple cereals such as sorghum, millet and maize. In the system, the average herd of cattle is small compared to other pastoral systems, because they no longer rely solely on cattle and the finite grazing area around their environs that can be reached in a day will limit herd size. Most pastoralists in this system have preferences for particular breeds (Aregheore, 2001).

2.2.3 Mixed farming (Integrated Crop/Livestock)

This is a system conducted by households or enterprises where crop cultivation and livestock rearing are more or less integrated components of a single farming system (Payne, 1990). Mixed farming exists in many forms depending on external and internal factors. External factors are weather patterns, market prices, political stability and technological developments. Internal factors are often related to local soil characteristics, composition of the family and farmers' ingenuity (Aregheore, 2001). Even pastoralists practice a form of mixed farming since their livelihood depends on the management of different feed resources and animal species. For example, sedentary Fulani in Futh and the Mambilia Plateau in Adamawa practice mixed farming. Furthermore, arable farming peoples like the Kanuri, Hausa, Borgu, Waja, Kibba, Chamba, Kaka and Mambilla often rear cattle and other animals and produce their own manure. With the rapid changes now taking place, ethnic groups which were traditionally arable farmers are ready to acquire cattle and pastoralists are increasing their arable farming (Aregheore, 2001).

Mixed farming is one of the more subtle qualitative changes that have taken place within local systems of Agriculture in Nigeria (Bourn *et al*., 1994). For example, the marked reduction in pastoral nomads; the widespread sedentarisation of pastoralists and their adoption of crop cultivation in addition to keeping livestock; the uptake of animal husbandry and the utilization of crop residues by livestock farmers in exchange for dairy products which is often secondary (Ehoche, 2002), manure for improving the soil fertility and primarily for drought power (Van Raay, 1975; Bourn *et al*., 1994 and Ehoche, 2002) are all indicative of a progressive and widespread trend towards mixed farming (FAO, 1983; and McIntyre *et al*., 1992). Mixed farming is firmly established in Nigeria as a production system and the further integration of livestock production within local farming systems will definitely become one of the major strategic goals of livestock development in Nigeria (Bourn *et al*., 1994). Mixed farming is practiced in almost all agro-ecological zones of Nigeria.

The principal objectives of this system are three fold: (i) complementary benefit from an optimum mixture of crops and livestock; (ii) spreading income and risks over both crops and livestock production, and (iii) scope to adjust crop/livestock ratio to social and economic needs and opportunities (Aregheore, 2001). Most retirees from government services embrace mixed farming and the interest is growing because it uses space more efficiently and spreads risks more uniformly (Bourn *et al*., 1994).

2.2.4 Peri-urban and modern ruminant livestock husbandry (Intensive system)

This system could be referred to as the commercial or intensive production system. Wealthy urban businessmen, wealthy Fulani and government officials practice this system. This type of farms which were found only on the periphery of major towns in northern and central Nigeria are also found today in the southern parts of the country. Rich individuals who own these farms capitalize on the potential of animals as investment, source of milk for their families and also a status symbol (Aregheore, 2001; Ehoche, 2002).

In this system, farmers normally have only cattle or cattle with small ruminants inclusive. Trained personnel are hired and expected routine management practices carried out in most modern ranching operations are also seen in these farms. In this type of intensive production system the use of crop residues and agricultural by-products are effectively and economically combined with grazing. Intensive dairy farms are usually stocked with exotic dairy breeds and upgraded local indigenous ones (Ehoche, 2002).

2.3 Cattle Feed Resources in the Tropics

2.3.1 Range forages and browse plants

Range forages are the most abundant feed resources available to smallholder farmers in the tropics. Natural forage species grow on uncultivated land on which animals have access for grazing. Most farmers rely on natural grass land for their animals. It account for 38 percent of the total feed energy resource available for ruminants in the whole world (Preston and Leng, 1987; Ehoche *et al.,* 2002). Adegbola (1979) and Aregheore (2009) reported that ruminants in Nigeria mostly subsist on mature native forage and crop residues in the dry season. The total land area of Nigeria is 94 million hectares; seventy five (75) million hectares out of the 94 million hectares is area of savannah land, out of which only about 45 million hectares are available for livestock grazing with all range hectarage per animal ratio as 5:1 (Agishi, 1985). The available grazing lands support Nine million Tropical Animal Units averaging (TAU) 250kg, (Aregheore, 2009). Herbage forms the most important and cheapest feed for ruminant livestock in Nigeria.

Of all available feed, forage is reported to form major proportion of ruminant diet accounting for more than 75 percent. It is more economical to use grassland as a source of meat and milk. Some of the most common grasses in the native grassland are; *Andropogon gayanus, Imperata cylindrical, Pennisetum pedicellatum, and Hyparrhenia spp.* The Northern Guinea Savanna which consists of open woodland and the Southern Guinea Savanna, that represents a transitional zone between forests and the savanna zones has many forage species. *Andropogon gayanus* from the tribes *Andropogoneae* and *Paniceae* is reported to constitute an average of 43 percent of the total forages classified (Onifade and Agishi, 1988). It is thus, regarded as the most dominant grass species in this zone.

During the wet season, herbages and pastures are particularly important in providing additional nutrients to animal subsisting on low quality feeds from sub – maintenance to production status (Malau-Aduli, 1992). However, during the dry season, these fodders mature and contain high levels of lignified carbohydrate and low total nitrogen (Chenost and Sansoucy, 1990) and remain the major component of the diet. Digestibility of tropical forages is observed to be lower than those of temperate ones. The maximum and minimum values of digestibility of herbage are 80 % and 30 % in tropical forages and 85 % and 45 % in temperate species. The major factors responsible for the variation in herbage digestibility are plant species, genotype, stage of maturity of the plant, fertilizer application practices, species of the animal, physiological state of the animal and level of feed intake (Aregheore, 2009). The carrying capacity of the native grassland is very low compared to that of planted fertilized pasture since productivity of natural grassland is affected by factors such as soil available density of canopy and management practices of grazing (Ademosun, 1974).

Legumes are not generally common in natural grassland therefore, the contribution of fixed Nitrogen is usually low or absent (Aregheore, 2009). Andropogon gayanus (Gamba grass) is tall perennial specie that grows in large tufts up to 2m high. Fifty percent of its roots are fibrous and less than 0.5mm in diameter with 40% of the root growing downward and 10% vertically to 80cm giving it drought tolerance (Bowden, 1963). It is a native to tropical Africa but now distributed to many countries. Gamba grows on wide range of soil including those of low fertility from sands to black cracking clays, but is known to prefer sandy clay of medium to high fertility with minimum inputs.

Gamba’s excellent growth and dry matter production is in acid infertile soils with minimum inputs, exceptionally tolerant to drought stress, burning and high levels of aluminum saturation, low phosphorus and nitrogen requirement. The major attribute of Gamba is that no toxicity has been reported (Everist, 1976) when grazed by ruminants. (WFB, 1978 in Aregheore, 2009). It combines naturally with *Stylosanthes, fruticosa, Desmodium ovalifolium* and other legumes. Gamba is adaptable to low-cost pasture establishment.

The pattern of growth of Gamba grass is well defined. At the beginning of wet season (June-July) the grass is in its vegetative phase of growth, at this time, the proportion of leaf to stem is very high (Haggar, 1970, Zemmelink, 1974; Mani, 1984). In August (mid wet season), there is a distinct increase in ratio of stem due to elongation (Nuru, 1996). At October level of wet season, stem and fresh leaves reach their maximum growth. In November (early dry season) inflorescence reaches it advanced stage (Haggar, 1970). At this stage, the vegetative development of gamba is completed. As with progression of dry season between Januarys to February, the grass gradually reduces to a tall straw-like material (Lufadeju *et al.,* 1992; Aregheore, 2001). The proportion of nitrogen, phosphorous and digestible energy of the straw-like hairy grass become low, but the proportion of ratio of cell-wall material becomes high. Under the natural grassland, gamba standing hay is available throughout the dry season thus, constituting a pivotal role as feed for grazing ruminants in most of the tropical developing countries (Goodchild and Mcmeniman, 1994).

Gamba requires intervals of more than six weeks between cuttings and a cutting height of about 4cm to maintain productivity and a good stand (Aregheore, 2001). It cannot stand heavy grazing until it is well established; however it requires high stocking rates to maintain reasonable height. Gamba is better utilized when young because once flowering stems appear, it becomes coarse with little nutritional value and after maturity with only 1.5 percent crude proteins (Gohl, 1981). Boudet (1975) reported that crude protein content of gamba in all categories of leaf and stem rose to a maximum at ear emergence. Maximum digestible nutrients are obtained by cutting at ear emergence stage of growth (Haggar and Ahmed, 1971). Gamba has low digestibility but high nitrogen levels (WFB, 1978). Dry matter yield is observed to increase during wet season from June to October in Nigeria, reaching a maximum of about 3800 kg/ha in October declining then until February. Haggar (1970) noted that cutting gamba in early October gave best balance of bulk and quality. A selection of gamba No 621 from Shika, Nigeria yielded 4,000kg DM//ha without fertilizer nitrogen, but with adequate phosphorus (WFB, 1978). Gamba when fresh and young is palatable and ruminants eat it up to flowering (Bowden, 1963) with high yield. In Nigeria natural grassland containing 60 percent of *Andropogun gayanus* (gamba) resulted in a weight gain of 0.31kg per day when grazed by N'dama and Keteku cattle. But when consumed as silage the weight gain was 0.11kg/day (Adegbola, 1979).

2.3.2 *Digitaria smutsii*

Digitaria smutsii (*D. smutsii*) belongs to the family Poecea and is commonly referred to as Digitaria grass or Crab grass. It is said to be native to Southern Africa. Digitaria is a genus of about 300 species of grass family poaceae native to tropical and warm temperature regions. Common names include crabgrass, finger grass and fonio. They are slender monocotyledonous annual and perennial lawn, pasture and forage plants; some are often considered lawn pest. Digitus is the latin word for finger and they are distinguished by the long finger-like inflorescence they produce (Hacker *et. al*., 1993). *Digitaria smutsii* is indigenous to Africa and grows well in the dry part of tropical and sub-tropical climates.

The grass was first introduced into Nigeria from South Africa in 1956. Digitaria performs well in areas with annual rainfall ranging from 600-1800mm, but best rainfall optimum is 900mm/year. Well-drained sandy-1oam soil is preferable for the successful establishment of *D. smutsii*, which is by means of stem cuttings or stolons because no viable seeds are produced. D. smutsii is tolerant to acidic or alkaline soils and withstands limited-water logging.

The genus Digitaria has world-wide distribution in tropical areas (Henrard, 1950). It is found in area characterized by fertile soil, seasonal rainfall and generally high temperature (Osbourn, 1969). It is easily established, and is vigorous and adaptable. It persists under intensive grazing and is palatable to livestock (Osbourn, 1969). Its stoloniferous habits make vegetative propagation relatively easy in that both stolons and mature stems will produce. The plants cover the ground within 6-8 weeks, even when only 3 plants take root per square yard (Ronney, 1961).

2.3.2.1 Propagation and planting:

Digitaria is usually sown at the beginning of the rainy season. Soil preparation is minimal; the fallow vegetation is burnt and the ashes spread, and the soil may be loosened by superficial cultivation. Digitaria is normally grown as a sole crop, but sometimes intercropped with sorghum or pearl millet. Farmers in Guinea Savannah commonly sow various digitari types together and later fill in any gaps with guinea millet (Hilu *et al*., 1997).

2.3.2.2 Cultivation:

In Africa, digitaria is known as a savannah plant, which does not prosper in soils with salinity problems that has low water demands and survives strong drought (Harlan, 1993; Hilu *et al.*, 1997). Propagation can be achieved by transplanting young plants. Organic fertilization has been used to increased plant biomass and grain yield. Attempts to improve grain yield with chemical fertilizers have been successful, although not necessary economical. There appears to be low response to chemical fertilizers especially Nitrogen. When digitaria grows in association with legumes (possibly due to Nitrogen fixation by the legumes) other agrochemical input appears to be very limited.

2.3.2.3 Chemical composition:

Digitaria grass comprises a number of different species (D. Eriantha, D. Umfolozi, D. Smutsii, D. setivalva, D. Peitzii, D. Polevansii, and D. Decumbens) and they differ in their chemical composition. Minson (1984) attributed such differences to the genetic make-up of the plant which controls morphological characteristics such as proportion of leaf to stem, and also to different management practices during growth or harvest of the crop. Minson (1990) reported the dry matter content of six species to ranged from 56.1-70.9% , neutral detergent fibre content 13-34% and hemicelluloses 26.5-38.2% on DM basis.

2.3.3Legume and Browse Plants

Browse in the form of trees and shrubs forms an integral part of ruminant production. Feeding browse has become an essential practice especially in the dry season when herbaceous forages are scarce (Bamikole *et al*., 2004) and low in nutritive value (Aregheore, 2001). Their relative importance in ruminant nutrition especially during the dry season cannot be over-emphasized. Improved animal agro-forestry could enhance livestock production in Nigeria through forage production. Large number of browse legumes and multipurpose trees have been tried experimentally and subsequently introduced to ruminant farmers (Mecha and Adegbola, 1980).

Although many of leguminous and browse plants are non – conventional feeds, they are widely used as protein source in ruminant diet. The efficiency of utilizing green forages are determined by the physical characteristics and inherent limitation of the feeds and the knowledge of their digestion in the gastro intestinal tract (Devendra and Burns, 1983). Devendra and Burns (1983) and Sitorus *et al*. (1985) showed that in spite of the high content of crude protein (CP) in

Leucaena leucocephala; it had little effect on diet digestibility. Forage quality is important in getting the high nutrient uptake required for best performance.

Devendra (1983) reported the best N and mineral retention in sheep when leucaena leaves, stems and pods in balanced diet were fed. Browse legumes are shrubs and trees that are of considerable nutritional importance as livestock feed during the dry season of the year. Their leaves are green all year round and many are well known to herdsmen who frequently lop off their branches for stock feeding. Most nomads and smallholders know them and therefore use them for their livestock (Aregheore, 1996; Onwuka *et al*., 1992; Carew *et al*., 1980). The fruits of some of the browse plants form an important feed resource during the dry season. Many browses contain high levels of essential elements such as calcium, sodium and sulphur as well as critical micro-nutrients such as iron and zinc which have been shown to be deficient or borderline for productive purposes in many grass species (Olubajo, 1974).

Browse legumes are found all over the country. Species commonly found in the range include: *Leucaena leucocephala, Gliricidia sepium, Acacia spp. (A. albida, A. nilotica), Ficus elasticoides, Mangifera indica, Musa sp., Spondias mombin, Cajanus cajan, Tamarindus indica,* and *Parkia clappertonian* (Aregheore, 2009) to mention but a few. Leucaena is widely accepted as the best browse legume and has naturalized in some parts of Nigeria (Aregheore, 1996). LeucaenaandGliricidia foliage yields are higher in the wet season (Aregheore, 1996; Balogun and Otchere, 1995). (Ademosun *et al*., 1989) Bamikole *et al*. (2004) evaluated the feeding value of *Ficus religiosa* (FR) and reported that feed intake, weight gain, digestibility and N utilization can be enhanced by feeding *Ficus religiosa* in mixture with Panicum maximum and it can be used in diet mixtures up to 75 % of fed. Yahaya *et al*. (2001) reported that *Acacia sieberiana, F.*

polita and F. sycomorus can sustain sheep on a maintenance diet and could also be used as a supplementary feed during the dry season.

2.3.4Crop residues

During the dry season (November- April) the range and the large quantities of cereal residues from maize, millets and sorghum forms the bulk resources available for feeding ruminant livestock in Nigeria (Lufedaju *et al*., 1992). In some countries, ruminant livestock are maintained mainly on forages and grains derived from arable lands, while in Nigeria and most tropical countries, ruminants receive most of their energy needs from crop-residue and natural pasture land (Ehoche, 2002). The importance of crop residue as feed for ruminants especially during the dry season has been recognised by farmers.

Faced with the constrain of inadequate range forage during the dry season and the high cost of the conventional feed ingredients to feed their livestock (Ademosun *et al*.,1989; Mgheni *et al*., 1993) farmers thus, rely on the available crop residues. Ehoche (2002) reported that large quantities of crop residues are produced annually in the major cattle producing areas of the country. Kossila, (1985) had reported that more than 340 Million tons of fibrous crop residues with great proportion coming from cereal crops. Alhassan (1985) estimated crop residue production from extraction rate of 1kg seed to 8, 4, 4, 2, and 5 kg of millet, sorghum, maize, rice, groundnut and cowpea residue to be 24.6, 17.2, 2.5, 0.2, 1.3 and 3.7 million tons respectively. This is from the major production areas of Sokoto, Kano, Bauchi, Adamawa, Taraba, Kaduna, Benue, Borno states of Nigeria.

In Nigeria level of crop residue availability is ranked among the highest in Africa.(Kossila, 1985) estimated that Fifty Million tons of dry matter (DM) of fibrous crop residues are available to 11 million cattle, 8 million sheep, 22 million goats. Cereal and legume crop residues constitute the major field crop residues for cattle. Cereal crop residues include sorghum, millets and maize stover, and rice, wheat and 'Acha' straws.

CBN (1999) estimated crop residues output for maize, sorghum, millet, rice, cowpea and groundnut production in year 2000 to be 24,914, 35,296, 53,944, 96,820, 11, 305 and 4,780 metric tons, respectively. Legume hays are those from cowpea, groundnut haulms, soybean and lablab (Ehoche, 2002). The amount of fibrous crop residue derived from cereals and other crops considering livestock unit (LU) in metric tons, dry matter metric tons ('000) and tons dry matter per livestock unit of Nigeria are 10,874, 56,260 and 5.17 respectively (Kossila, 1985). Crop residues are grazed intensively from November to February between 8.00am - 6.00pm daily and by March nothing is left in the fields. The amount of crop residue consumed by livestock in Nigeria and the extent of grazing varies considerably. The estimated crop production from which the amount of crop residue can be computed is subject to considerable variation as a result of weather effects and fluctuation in crop to residue ratio (Lufadeju *et al.,* 1992).

Similarly, these crop residues are subjected to trampling, soiling, termite damage, and fire. As a result, less than 50% of the crop residues are actually consumed by livestock (Alhassan *et al.,* 1985; Munthali *et al.,* 2000). In addition to these, the residues have other competitive use in areas they are produced such as being used for housing, roofing, fencing, mat-making, fuel and paper making (Olayiwole, 1976). In spite of this competitive usage if available, crop residues can be properly harnessed and processed; can be used to provide enough roughage for the entire cattle population of Nigeria especially during the dry season (Alhassan, 1985).

2.3.4.1 Quality of crop residues

Cereal (maize, rice, millet, sorghum and wheat) are low in nitrogen but one way of improving their nutritive value is to feed them to animals together with a variety of forage supplements that are potentially valuable to ruminants (Adebowale, 1981). Some of these forages supplements include Siam weed (*Eupatorium odoratum*), cassava leaves (*Manihot esculenta*), Gliricidia leaves (*Gliricidia sepium*), *Leucaena leucocephala* and *Spondias mombin* foliage. The beneficial effects of feeding these forages to ruminant animals are many such as increased metabolisable energy and nitrogen intake, improved palatability, increased available minerals and vitamins, better rumen function and a laxative influence on the alimentary system.

Adebowale (1992) reported the results of a trial in which White Fulani steers were fed *ad libitum* on treated and untreated maize cobs (chopped) with fresh Siam weed (2 kg/head/day). Live-weight improved from a daily loss of 320 g, when animals were fed untreated maize cobs, to a daily gain of about 480 g, when cobs were treated and supplemented with Siam weed. When Gliricidia foliage was supplemented to about 15 percent of the DMI of White Fulani cows on a diet of maize husk, the milk yield increased by about 22.5 percent. However, when maize husk was ensiled with 6 percent urea for ten days, the milk yield increased by 42 percent with Gliricidia foliage and 29 percent without it. When maize husk and bran supplemented with Leucaena foliage were fed to West African Djallonke goats for 12 weeks, animals responded better to maize bran than to maize husks. This confirms that maize bran is better degraded in the rumen than maize husks. However, these two maize residues are either expensive or cumbersome to procure, especially for feeding large animals (Adebowale, 1992).

2.3.5 Agro industrial by-products

Conventional feed resources are in high demand for human consumption. They are therefore not always available for livestock. Where and when available, they are too expensive to justify their inclusion in livestock diets. The use of agro-industrial by-products as feed ingredients has been reported to depend on the cost of the feedstuff, their safety for animal health and alternative uses (Bickel and Deboer, 1988).

The use of these by-products for livestock feeding is justified when the forage supply is inadequate for the animals' needs, either in terms of quantity or quality. Agro-industrial by products in Nigeria vary from primary processing of farm produce wastes to wastes from agro allied industries. Some of these wastes are left unutilized, often causing environmental pollution and hazard. Those that are utilized do not have their full potentials harnessed.

Inadequate supply and poor quality feeds are the most limiting factors to increase ruminant productivity in tropical Africa (Ademosun, 1994). Since the mid-80s, the use of cereal grains and oil seed cakes such as groundnut and cottonseed cake has been on the decline due to spiral inflation and increased competition from humans whose population has increased tremendously. Conventional feed ingredients still constitute the diets of livestock.

Presently, the high cost of grains due to competing needs have generated interest in sourcing alternative feed resources to match animal production with available and relatively cheap feedstuffs (Jokhtan, 2006). Agro-industrial by product is used as energy or protein sources depending on the nutrient composition. Ruminants were found to exhibit good response in feeding trials involving agro-industrial products. For instance, peels of tuber crops, cereal and legume residues and browse plant have received increased attention.

Cassava, yam and sweet potato peels are fermentable energy sources (Smith, 1993) that might be used in place of molasses or maize bran. Alawa and Umunna (1993) reviewed the utilization of agro-industrial by-products and other farm level residues by ruminants. The authors concluded that inclusion of low quality feedstuff to replace conventional energy source in production rations should not exceed 25-30%, whereas for maintenance rations in ruminants, these levels may be exceeded.

2.4Role of Feed Supplementation in Cattle Production

2.4.1 Energy supplements

Emaciated cattle and buffaloes in the herds of small farmers in developing countries have been usually diagnosed as being energy deficient. While it is evident that these animals, fed largely on poor quality roughages are deficient in nutrients and total energy intake, the low energy intake appears to be due primarily to fermentable N and/or protein deficiency in the diet (Preston and Leng, 1987). The apparent energy deficiency is as a result of an inefficient (fermentable – N) deficient in the rumen which decreases the rate of fermentative digestion and also decreases the ratio of protein to energy in the products of rumen fermentation (microbial cells which is 65% protein and the VFAs) (Singh and Gupta, 1986).

The effect of the low rumen fermentative activities is a reduced feed intake (Orskov, 1982). Increasing energy intake increases milk protein content through increased yields of microbial protein in the rumen. However, providing feed in excess of requirements has little further effect (Sutton, 1990). Stockdale (1994) summarized results from experiments in a wide range of feedstuffs and reported that starch-based supplements, such as cereal grains and compounded concentrates, are the best way to improve milk protein content. This improvement is believed to be due to an increase in the proportion of propionate (glycogenic precursor) produced in the rumen and an increased microbial crude protein synthesis (Beever *et al*., 2001).

An average increase in ME intake of 17.9 MJ metabolisable energy (ME) from concentrates gave a 1 g/kg improvement in milk protein content (Beever *et al*., 2001). When the extra energy was supplied by pastures or maize silage, an average of 29.5 MJ ME was required to improve milk protein content by 1g/l. On clover pastures with a high protein content, milk protein content was not increased by extra feeding. This could have been due to the energy cost of excreting surplus dietary protein, or because metabolisable amino acid supply relative to energy was already at a maximum (NRC, 1989; De Vries and Veerkamp, 2000).

2.4.2 Sources of Energy for Cattle Supplementation

2.4.2.1 Cereal grains

Different sources of cereal grains exhibit different rumen degradability. Grains can be classified as "rapidly and highly rumen degradable" source of energy or "slowly and poorly rumen degradable". For example wheat, barley and oats undergo rapid rumen degradation and are digested more completely than maize and sorghum grains (Nocek and Tamminga, 1991; Martin *et al*., 1999). Overall, starch from all cereal sources is degraded by 50- 94% in the rumen depending on the degree and type of processing (Jouany *et al*., 2000). Martin *et al.* (1999) reported that DMI was reduced by 2.8% for diets fed to beef steers that were supplemented with wheat compared to corn.

The ruminal digestibilities were shown to be 86% and 48% for wheat and corn, respectively. It has been shown that processing increases the digestibility of cereal grains (Tothi*et al*., 2003). Processing can be physical, chemical or a combination of both depending on the nature of the material and the purpose. Maize grains can be fed without processing because the pericarp of maize kernels is not resistant to mastication.

Physical processing may include grinding, cracking and rolling, which all reduce the particle size of grains and increase potential exposure to bacterial and enzymatic action. Other processing methods may involve grinding or cracking in association with heat and moisture, for example steam-flaking, with the aim of achieving different degrees of starch gelatinisation (Jouany *et al*., 2000). However, chemical processing does not always increase rumen digestibility. In fact some chemical treatments (for instance formaldehyde) are used to make grains pass through the rumen so that they are digested and absorbed post ruminally (Smith *et al*., 1988; Sureskhkumar *et al*., 2000; Ehoche, 2002). Processing methods that involve both physical and chemical aspects have proved to be more beneficial by increasing digestibility. The intensity and nature of grain processing and amount of rumen available starch are the most influential factors controlling voluntary DMI and milk yield (Yang *et al.*, 2001).

Processing grains has been shown to aid rumen escape of starch and the post rumen availability (Leng, 1990; Yang *et al.*, 2001). Yang *et al*. (2001) suggested that processing grains,could change the pattern of rumen fermentation because it alters the availability of rumen degradable starch, resulting in a different acetate to propionate ratio and changes in ruminal pH. Yang *et al*. (2001) conducted a factorial experiment to study the effects on DMI and total tract digestibilities of flat vs. coarse rolled barley grains. The total tract digestibility of DM, starch and OM were improved by 5%, 10% and 4.4%, respectively. The 10% increase in starch digestibility was the result of increased ruminal (33%) and post ruminal (15%) digestion of starch.

The more intensive processing to produce flatter barley grains increased both the ruminal and post ruminal digestion of the starch. Tothi *et al.* (2003) compared the effects of expander processing of barley and maize grains with untreated/unexpanded grains and noted a 4.8% increase in DMI for the treated compared to untreated barley, with expander treatment causing an increase in the post ruminal digestibility of starch grains. In another study, DM intake in dairy cows was reduced by 3.3% for dry-rolled barley grains compared to whole barley grains, and 5% for temper-rolled compared to wholebarley grains (Yang *et al.*, 2001). They reported that though, DM intake was reduced, milk yield increased.

2.5Oil Seed Cakes

The oil seed cakes are mainly used as sources of supplementary protein. They include, palm kernel cake, linseed cake, groundnut cake, soybean cake and cotton seed cake. Oil seed cakes constitute the largest sources of supplementary protein in livestock feeds (IDRC and ICAR, 1988). Oil seed cakes are reported to be high in protein, energy and phosphorus (Ehoche, 2002). Among them, cotton seed cake was the most widely used for feeding ruminant animals in Nigeria, in form of undelinted and undecorticated cottonseed cake (CSC) with crude protein (CP) of 26%; but low content of cystine, methionine and lysine (Ikurior and Fetuga, 1988). The decline in production of cotton in Nigeria has seriously affected the availability of CSC in the country. Lufadeju and Olorunju (1986) have reported degradable value of 0.86 for groundnut cake (GNC) with much higher crude protein (45%). Palm kernel meal (PKC) is cheaper than GNC and CSC, but the transportation cost to northern part of the country makes it unaffordable. Moreover, the use of oil seed cakes as ruminant feed is not economical because of their high cost (Ikurior and Fetuga, 1988).

2.6Legume Forages

Legumes have been successfully established by farmers and agro-pastoralists in grassland as "fodder banks" and in cropped areas on fallows (Tarawali and Mohamed-Saleem, 1995) using low input techniques, developed by Research Institutes and Extension Agencies. In the savannas of northern Nigeria where the technology was developed, the productivity of Stylosanthes fodder banks varied from 3000 to 5000 kg/ha and the legume composition from 50 to 70 % (Mohammed-Saleem and Kaufmann, 1982). It is compatible with *Cynodon nlemfuensis*, *Digitaria decumbens* and *Panicum maximum* (Ademosun, 1974). More legumes have been identified for fodder banks in semi-arid regions. These include *Chamaecrista rotundifolia, Centrosema brasilianum, C. pascuorum, S. humilis* and *Aeschynomene histrix* (Tarawali and Ogunbile, 1995). Synge (1981) reported improved production responses in White Fulani cattle due to supplementary feeding under traditional management. Creeping legumes, such as *Calopogonium, Centrosema, Mucuna, and Pueraria*, have attracted much research attention (Agboola and Fayemi 1971; Akobunda, 1993; Tarawali and Ogunbile, 1995). The use of highly productive good quality pasture grasses and legumes resulted in increased productivity in grazing animals in trials in Nigeria (Agishi, 1985)

2.7Significance of Energy-Protein ratio in Ruminant Nutrition

Low productivity in ruminants on forages results from insufficient utilization of the feed because of deficiencies of critical nutrients in the diets. The deficient nutrients are those critical to growth of rumen microbes which ferment or digest the feed or those required to balance the products of digestion that are absorbed to meet requirement (Leng, 1990). Inefficient utilization of nutrient is accompanied by an increase in metabolic heat with a lot of implication for tropicalruminants, impose metabolic stress and high environmental temperature and humidity (Leng, 1989).

Cattle in the tropics require less feed for maintenance as they do not have to combat cold stress (Leng *et al.,* 1986). The energy spared however must be supplemented with protein to ensure an appropriate protein energy (P:E) ratio in the nutrients absorbed for optimum efficiency of feed utilization. Leng *et al.* (1986) have reported higher amino acid requirement for tropical cattle than in cattle on the same feed in temperate environment. Preston and Leng (1987) described the supplementation as feeding that is meant to increase the ratio of protein (absorbed amino acids) to energy (VFA) available from digestion so that it moves closely corresponding to the animal's requirements (Barje, 2006). Adequate microbial cells and VFA enhance the efficiency of microbial growth and P:E ratio. Thus, a sub-optimal level of any nutrient required for microbial growth results in low protein to energy P/E ratio in the nutrients absorbed (Leng, 1990).

The P:E ratio appears to be the primary factor that controls the efficiency of feed utilization and the partitioning of nutrient into various component of production (Leng, 1990). The relationship of P:E to the efficiency of feed utilization has a very large effect on growth, milk yield and reproductive performance. The levels of production achieved when P:E is increased have been reported to be superior to those predicted from feeding standards based on metabolizable energy of feed (Goday and Chicco, 1990). Application of the basic concept of balanced nutrition is reported to improve animal growth by 2-3 folds and the efficiency of animal growth by as much as 6 fold over estimate of 2-10 folds (Leng *et al.,* 1986).

Leng (1990) showed that growth rate of cattle on forage based diets were below those on grain based diets; they were however, efficient in converting feed to live weight gain. Live weight gain depend mainly on the supply of amino acid and yield in substrates delivered to the tissues up to the genetic limit for protein synthesis, which is scarcely reached for animals consuming pasture (Muia *et al.,* 2002). The supply of amino acids depends on the protein content of the diet and the deposition of protein depends on the efficiency of use of absorbed protein which is known to rely on the availability of non-energy yielding substrates and limiting essential ammo-acids (Poppi and McLennan, 1995).

2.8Mineral and Vitamin Supplements

In addition to carbohydrate, protein and fats, minerals and vitamins are also required in smaller amount for the proper functioning of cattle. Of the forty (40) regularly occurring elements, only fifteen have been found to play metabolic role in cattle (Payne, 1990). They are divided into two groups on the basis of concentration present in the animal body namely macro and micro minerals. The macro elements (those required in large quantities) include; calcium, phosphorus, Potassium, sodium, chlorine, magnesium and sulphur with percentage concentration in the body as; 1.5, 1.0, 0.2, 0.16, 0.11, 0.014 and 0.15, respectively (Payne,1990) while the micro elements (those required in small quantities) are iron, zinc, copper, cobalt, manganese, iodine molybdenum and selenium with the range of; 20-80, 10- 50, 1-5, 0.02-0.1, 0.02-0.05, 0.03-0.06 and 1-4ppm as concentration in animal body respectively (Payne,1990).`

Supplementation of minerals is meant to alleviate deficiency experienced by lactating cows most especially during lactation and growth when demand is critical (ARC, 1980). Tropical forages contain less minerals especially during the dry season, as such grazing cattle in the tropics are often likely to develop mineral deficiency related conditions (Mc Dowell *et al.,* 1983), thus making supplementation very essential. Preston and Leng (1987) reported that there is variability in the mineral contents of pastures which is influenced by many factors including the climate, previous stock history, fertilizer application and soil. Grant (2002) found that milk production by grazing dairy cows was more limited by the supply of ME than by CP. Adamu *et al.* (1993) reported that grazing native pasture during the dry and wet season along with supplementation of nitrogen, energy, common salt and Phosphorus may be beneficial for animals in the northern Savanna zone of Nigeria. Spears (1996) noticed growing interest in the use of mineral when studies revealed their practical roles in improving growth, reproduction and health in ruminants.

Early negative balances are regarded as normal since no ill effects are evident as long as subsequent replenishment of body reserve take place and daily requirements are supplemented on the basis of total production over the lactation (McDonald *et al*., 1995). Twenty six to twenty eight grammes (26-28g) of Ca and 25g of phosphorus/day have proved adequate for cows producing 4540kg of milk/annum over four lactations. McDonald *et al*. (1995) reported that dietary supply of 1.10 to 1.32 of calcium and 1.10g phosphorus per kg of milk is needed (McDonald *et al*., 1995). Although the lactation approach is a satisfactory performance in many cases, considerable trouble may arise if the allowances used are too low. In such cases progressive weakening and breaking of the bones results in serious shortage.

In less severe cases, a premature drying which reduce yield and shortens the productive life of the cows occur. Lactating cows are usually given sodium chloride supplements. The primary need is for sodium rather than chloride (ARC, 1980) which is more plentiful in normal diets. The net requirement for sodium is about 8 mg/kg/day for maintenance plus 0.60g/kg/day for milk (Mc Donald *et al*., 1995). ARC (1984) recommended 28g of NaCl per head/day be provided for lactating cow in addition to that in the food. Ca: P ratio supplementation is 1:1 or 2:1, magnesium (Mg) allowance is 0.125g/kg above 3mg/kgw for maintenance (ARC, 1980).

Available dietary magnesium is very low at about 0.17 (ARC, 1980; 1984). Heifers receiving zinc-methionine complex supplement 78 were said to have had an 8.1% fast weight gain and 7.3% feed conversion efficiency than those not fed the supplement (Spears, 1996). Significant improvement in milk production and reduced somatic cells in milk were reported when lactating cows were supplemented with zinc –methionine complex (Kellogg, 1996).

In the same vein calves fed zinc-methionine gained 10.7% faster, with morbidity rate decreased and required 5-8% less medical treatment per head than those not supplemented. Ward *et al*. (1992) supplemented manganese methionine complex in steers and reported increased ruminal soluble concentrations of manganese. Copper retention was high when copper-lysine complex was fed than copper sulphate (De Bonis and Nockels, 1992). This showed the growing interest in the supplementation of organic trace mineral complex in ruminant diets.

Vitamins are required by the lactating animal to allow proper functioning of the physiological process of milk production and as constituents of the milk itself. Vitamins have important role in the synthesis of milk constituents. For instance, biotin is important in the synthesis of milk fat (Mc Donald *et al*., 1995). Supplementary feeding with vitamin A in excess of levels adequate for reproduction increased the efficiency of the milk by up to 20 times but had no effect on the yield or gross composition of the milk (ARC, 1984). The daily requirement for Vitamin A for lactating cow is 99 iu/kgw or 30mg/kgw (Payne, 1990). Vitamin D value of milk is largely influenced by the extent of cattle exposure to sunlight and large dietary intakes are necessary for small increases in the concentration in the milk (ARC, 1984).

Administration of the vitamin has little effect in ameliorating the negative balances of Ca and P which occur in the early lactation, but very heavy doses 20, 000, 0 iu/d for 3-5 days prepartum and one day postpartum have been claimed to provide some control of milk fever. The daily requirement of the lactating cow is about10 iu/kgw (McDonald *et al.*, 1995). Supplementary dietary intakes of the B vitamin have shown no significance in ruminants because of ruminal synthesis however, they are involved in the complicated enzyme systems responsible for the synthesis of milk (McDonald *et al*., 1995).

2.9 Nutritional Characteristics of Specific Cassava Fractions

2.9.1 Effect of feeding cassava peel meal diets in beef cattle

A comprehensive description of peel polysaccharides was not found, but due to its overall higher fibre content, peels are lower in energy density and digestibility than tubers, thus of less feeding value to ruminants. Fermentation technologies have been developed, however, that result in the conversion of cellulose in cassava peels to soluble carbohydrates (Ofuya and Obilor 1993; Iyayi and Losel 1999) and also add protein content to peels to increase feeding value for poultry. These treatments allowed inclusion of fermented cassava peel as a 100% maize replacement (30% of the diet) that resulted in increased digestibility, growth, and reduced mortality in broilers (Ofuya and Obilor 1993). More recent fermentations have been shown to increase crude protein in peels from <2% to 13 to 26% of DM, while lowering crude fibre values by one-half (Obadina et al. 2006; Adamafio et al. 2010), thus further enhancing potential feeding values.

Nonetheless, digestible energy intakes increased with increasing cassava intake, as did weight gain. ADGs of 0.54 to 0.81 kg have been reported for cattle consuming, respectively, 50 to 60% cassava root byproduct in the concentrate (Umiyasih *et al*.,(2013) cited in Antari *et al*., 2013). In a follow up study, finishing cattle in Thailand were offered diets comprising untreated rice straw (10–20%) and concentrate (80–90%) that contained 40 to 50% cassava powder (34 to 42%

dietary inclusion) and varying levels of rice bran, copra meal, and palm kernel cake, fed *ad libitum* (> 3.5% DMI) for 28 weeks. Total diets contained about 10% CP; animals gained 0.74 to 0.8 kg/day, and performance and carcass traits were not affected by diet treatments, thus demonstrating inclusion rates of up to 40% dried cassava can be profitably fed (Antari *et al.*, 2013). In an attempt to modify the rumen environment to optimize pH and N metabolism, dairy steers were fed a basal diet comprising a high-cassava concentrate (65% cassava chips, 17% SBM, 5% molasses, 2.5% palm kernel meal, 4% coconut oil, 3% urea, and 3% minerals (S, salt, and trace minerals) and local forage (1% and 1.5–1.8% DMI, respectively).

They were offered a feed block containing 30% cassava hay or rice bran, at 0.5% DMI, with malate added at 500 or 1000 g (Sittisak *et al*., 2009). Native cattle in Cambodia were fed 0, 0.25, 0.5, 0.75, or 1% of BW in dried cassava foliage as a supplement to untreated ad libitum rice straw, with a rumen supplement fed at 0.25% BW (comprising urea, salt and minerals) in an on-farm trial (Sath *et al*., 2008). Over 3 months, cattle weight gain doubled (201 to 402 g/day) with increasing intake of dried cassava foliage (90% intake of leaves, 45% of petioles), and feed conversion improved with added nitrogen from the cassava hay.

2.10 Anti-nutritional Factors and Plant Secondary Metabolites in Cassava

Anti-nutrients are potentially harmful and pose a genuine concern for human and animal health as they prevent digestion and absorption of nutrients. They may be toxic and can reduce the nutritional value of a plant by causing a deficiency in essential nutrients or preventing thorough digestion when consumed (Prathibha *et al*., 1995; Francis *et al*., 2001). Alkaloids, flavonoids, tannins, cardiac glycosides, anthraquinone, phlobatinnins, saponins and anthrocyanosides have been reported in aqueous and ethanolic extracts of raw cassava tubers, peels and leaves (Ebuehi *et al*., 2005), as have oxalates, nitrate, and phytates. Dunstan *et al*. (1996) also reported the occurrence of phaseolunatin in cassava (*M. aipi* and *M. utilissima*). The most commonly known anti-nutritional factors in cassava roots and tubers are cyanogenic glycosides (Montgomery 1980), which must be inactivated/removed through processing before they are suitable for livestock or aquaculture nutrition (Falaye 1992; Ebuehi *et al*., 2005; Agbor-Egbe and Mbome, 2006). Cyanide inhibits several enzyme systems including metalloenzymes (Enneking and Wink, 2000) through cytochrome oxidase, depresses growth through interference with certain essential amino acids, and impacts utilization of associated nutrients (Tewe and Egbunike, 1988).

2.10.1Effect of feeding cassava peel meal diets in Small herbivores

All parts of the cassava plant are successfully utilized in feeding small ruminants, as well as rabbits, particularly by the smallholder farmer. Cassava sievate included at up to 18–20% in rabbit grower diets (replacing the corresponding amount of maize grain) resulted, for all inclusion rates, in growth performance similar to or slightly better than that obtained with the maize-based control diet (Ngodigha *et al*., 1995; Ekwe *et al*., 2011). A higher inclusion level (40%) reduced growth rate by 9% in comparison with the maize-based control diet, but the unit cost of feed to weight gain remained in favour of sievate utilization (Ngodigha *et al*., 1995).

A production of goat concentrate was developed in North Vietnam containing 25% dried cassava foliage, 25% dried *flemingia (Flemingia macrophylla*) foliage, 11% rice bran, 11% cassava root meal and 28% molasses (Van *et al.,* 2001). Dried cassava peels, with poultry litter as the N source, replaced maize in goat diets at 0, 50, or 100% substitution in a trial conducted by Akinsoyinu (1992) as a supplement to grass (*Cynodon nlemfluensis).* No effect on DMI (5.5% of BW) was noted across diet treatments, but digestibility parameters were reduced with increasing inclusion rates. Theresults support the value of cassava peels as a dry season feed resource. Although fresh (Onwuka 1992) and dried (Lakpini *et al.*, 1997; Ukanwoko *et al.*, 2009, Asaolu *et al.*, 2012) materials have been utilized successfully as roughage in various feeding trials with various protein supplement sources (cottonseed or groundnut cake, SBM, brewer's grains, urea-molasses blocks, local browses/shrubs), ensiled cassava peels have also shown excellent promise as a practical feed ingredient for small ruminants.

Not only does ensiling minimize cyanogenic compounds in the peels, but recent studies with goats confirm the efficacy of cassava peels as a high starch additive to improve fermentation and moisture-holding capacity in grass silages (Olorunnisomo *et al*., 2012). After wilting elephant grass (*Pennisetum purpureum*) and cassava peels for 6 hours, various silage blends were tested with the addition of 10, 30, or 50% wet cassava peels to the mixtures. Following a 21-day fermentation, silages were fed to goats *ad libitum*, along with concentrate at 0.5% DMI; higher inclusion rates of peels increased fermentation characteristics, palatability, animal intakes, and plasma glucose, and clearly could be fed without problem at 50% inclusion. Okoruwa *et al*. (2012) conducted a trial with growing West African Dwarf sheep, replacing 70% of guinea grass diets with dried cassava peels and rice husk in differing ratios (60:10 and 55:15). DMD was not affected by the dietary treatments, and metabolizable energy $BW^{0.75}$ was highest on the 55:15 diet, suggesting that blends of cassava peels and rice husks may successfully replace guinea grass in diets. Other studies by (Asaolu and Odeyinka 2006), with sheep fed cassava peels demonstrated increased gains with ensiling vs. feeding dry peels (59 vs. 81 g/day) and linear improvements in weight gains (45 to 107 to 225 g/day) with addition of cottonseed cake as a protein supplement to a grass (*Pennisetum spp*) and dry cassava peel diet (Formunyan and Meffeja, 1987).In another study, Fomunyan and Meffeja (1987) fed sheep on three levels of dried cassava peel (0, 35, 70 percents of diet) in combination with *Pennisetum purpureum* at 70, 35, and 0 percents of diet, respectively.

In another study comparing the rumen degradability of several crop residues in cattle, sheep and goats, Smith *et al.* (1988) reported high dry matter losses for cassava peel in the three ruminant species, with a mean value of 83% in 48 hours. These high rumen degradability values suggested that cassava peel could serve as a useful energy feed in ruminant diets. Devendra (1977) reported a 40 percent mortality in weaned kids fed fresh leaves of a bitter variety containing 180-240 mg/kg of cyanide. There is evidence that ruminants can use a variety of sulfur donors including elemental sulfur to detoxify cyanide of dietary origin.

Thus, Blakley and Coop (1949) have indicated that HCN was rapidly detoxified in the rumen and liver by reactions using sulfide ions or cystine, concluding that approximately 1.2g of sulfur was required to detoxify 1.0g of HCN. Observations by other workers (Wheeler *et al.*, 1975) showed that the supply of sulfur licks to ruminants effectively protected them against chronic cyanide toxicity. Therefore, HCN toxicity should not constitute a constraint to the feeding of cassava products and by-products to ruminants, as simple processing techniques such as sun-drying, ensiling and fermentation combined with the provision of adequate dietary sulfur effectively protect the animals from HCN toxicity.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Site Description

The study was conducted at the Experimental Unit of Beef Research Programme, National Animal Production Research Institute (NAPRI) Shika, Zaria. Shika is geographically located between latitude 11^{o}12‟N and 7^{0} 33‟E, at an altitude of 640m above sea level (Garmin Receiver, 2015). Annual rainfall is about 1100-1200mm while, mean temperature is 24.4^{o}C (14.5-39.5^{o}C) with lower temperature occurring during the early dry season (November-January) while the higher temperatures are experienced during the late dry season (February- April) (IAR/BSADP,2015).

3.2 Source of Cassava Peel and Processing

Fifty bags ofcassava peel weighing 50kg each, for this trial was sourced from open market in Ungwan Romi New Extension, Kaduna, Kaduna State.The peels were sorted and foreign materials were removed. The peel was then spread on a concrete floor to dry for five days in December with continuous turning for uniform dryness. The dry peels were then crushed and stored in bags until when it was required for the feed formulation.

3.3 Growth Trial

A growth trial was conducted for 91 days using sixteen (16) growing Bunaji bull calves with an average weight of 95 kg within the age range of 6 month to 1 year. The experimental bulls were obtained from the Beef Research Programme of the National Animal Production Research Institute, Shika, Zaria. The experimental bulls after balancing for weight were randomly allotted the four dietary treatments in aCompletely Randomized Design (CRD), with four animals per treatment.Prior to the commencement of the experiment, the animals were dipped in acaricide Steladone (Novartis Inc. Basle,Switzerland) against ectoparasites and then dewormed using Albendazole® 2500mg boli (Eagle Chemicals Co.Limited. Chungchongnamdo, Korea) at the rate of 5mg/Kg body weight. The bulls were allotted to four dietary treatments in a Completely Randomized Design (CRD) with each treatment consisting of four animals to evaluate the effect of Cassava peel on the growth performance ofgrowing Bunaji bull calves.

3.3.1 Experimental Diets

Four (4) isonitrogenous and isocaloric concentrate diets with 16% crude protein level were formulated, which consisted of the following ingredients (maize offal, rice offal,cotton seedcake, bone meal, common salt) and the main test ingredient (dried cassava peel meal), which was included at 0, 10, 20, and 30 percent inclusion levels and each inclusion level serves astreatment diet (Table 3.1) while *Digitaria smutsii* was given separately and*ad libitum*

3.3.2 Management of Experimental Animals

The experimental bulls were housed in individual feeding pens and were adjusted for 14 days. During the adjustment period concentrates and Wooly Finger grass (*Digitaria smutsii*) fedat 1.0% of their body weight and water was offered *ad libitum.*After adjustment period the bulls were fed experimental diets at 1.5% of their body weight and wooly Finger was fed *ad libitum*, in two split at 8:00 and 4:00pm and in addition, the animals were given salt lick. Before the commencement of the experiment, all animals were weight fortnightly and feed offered were also adjusted according to the new body weight and fed their respective diets and water offered *ad libitum*. The feeding trials lasted for 90 days.

Table 3.1.Ingredient composition of experimental concentrate diet

Ingredients (%)	Inclusion level of CPM%			
	0	**10**	**20**	**30**
Maize offal	32.25	32.25	32.25	32.25
Cotton seed cake	36.00	36.00	36.00	36.00
CPM	0.00	10.00	20.00	30.00
Rice offal	30.00	20.00	10.00	10.00
Bone meal	1.00	1.00	1.00	1.00
Common salt	0.50	0.50	0.50	0.50
Premix cattle	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Analyses				
ME(kcal/kg)	3129	3129	3129	3129
Dry matter (%)	91.3	90.5	89.7	89.0
Crude Protein (%)	16.0	16.0	16.0	16.0
Ether Extract (%)	3.08	2.73	2.38	2.02
Crude fibre (%)	21.15	21.45	21.75	21.81
Cost/Kg(₦)	49.30	47.80	46.30	44.10

3.3.3 Parameters Measured

Parameters measured include: Final body weight, weight gain, voluntary feed intake, Total volatile fatty acid (TVFA) and total feed intake. Feed cost per kilogram gain was calculated. The live weight of the animals was obtained by weighing the bulls with a Standard cattle scale (Avery) at the beginning of the experiment and then fortnightly before every morning feeding. The initial weight of the bulls was considered as their weight after adjustment period and the final weight was their weight at the end of the experiment.

3.3.4 Voluntary feed intake

Feed was offered and the leftover of the previous days feed was collected and weighed every morning. The quantity of feed offered to each animal was adjusted every two weeks in relation to changes in their body weight throughout the period of the experiment.

3.4 Rumen Fluid Sampling

Rumen fluid samples were collected from the bulls at the end of the feeding trial at 0hr, 3hrs, 6hrs and 9hrs after feeding for determination of volatile fatty acids and rumen ammonia nitrogen (NH_3-N). About 50mls of the rumen fluid was drawn from all the bulls in each treatment using a suction tube. The tube which is about 150cm with a metallic strainer attached to the end was passed through a pipe placed in the mouth of the bulls into the rumen and a suction pump which was used to draw out the rumen fluid was attached to the other end of the tube. The rumen fluid collectedwas immediately strain through double layers of cheese cloth into plastic bottles containing equal quantity of 0.1N H_2SO_4 to trap ammoniaand the temperature of the rumen fluid recorded with a digital thermometer. The samples were taken to the laboratory for analysis. Total volatile fatty acid was determined as described by AOAC (2000).Rumen ammonia concentration was determined by steam distillation into boric acid and back titrated with 0.01N hydrochloric acid (HCl), according to the procedure described by Whitehead *et al.,* (1976).

3.5 Haematological Studies

The end of the digestibility trial, 10mls of blood samples was collected through jugular vein puncture using disposable syringe and sterile 19G needle from four animals. 5ml of blood was put in tubes containing ethylene diaminetetraacetic acid (EDTA) as anticoagulant for determination of packed cell volume, serum biochemical indices (blood glucose, total protein and urea nitrogen), were analyzed using haematology analyzer (sysmex, kx Japan) by Dacie and Lewis (1991). Total protein was determined using refractometer at the clinical pathology laboratory, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria. The plasma urea nitrogen was analyzed by the diacetylmonoxime method using a commercial kit (Stanbio- urea nitrogen kit procedure number 580, Stanbio laboratories) as reported by Kiran and Mutsvangwa (2007).

3.6 Digestibility Study

At the end of the growth study, four bulls were randomly selected from each treatment and housed in metabolic crates for total faecal and urine collectionas described by (Osuji *et al.*, 1993). The animals were allowed for 14 days to adjust to the condition of the metabolic crates before the commencement of the samples collection which lasted for 7 days. The animals were fed 1.5% of their body weight as concentrate and Wooly Finger grass *ad libitum.* Daily faeces voided were weighed and 10% of each day collection was sub sampled and oven dried at 60^oC for dry matter determination. This waslater bulked and taken to the laboratory for proximate analysis, neutral detergent fibre, acid detergent fibre and acid detergent lignin. Daily urine output was collected in a plastic container containing 100mls 0.1N H_2SO_4 placed under metabolic crates. 10% of daily urine was taken from each bull and stored in the refrigerator.

At the end of the 7 day collection period, 10% of the urine taken from each bull was sub sampled and stored in the refrigerator pending nitrogen determination (Osuji *et al.,* 1993).

3.7 Chemical analysis

Dry matter content of cassava peel meal, experimental diets,*Digitaria smutsii* and faecal samples was determined by drying at 60^{o}C. Nitrogen content of the feed samples and urine were determined using Micro Kjedahl Procedure AOAC (2005). The samples were ashed by charring in muffle furnace at 500^{o}C for about 3 hours. Ether extract and crude fibre of the samples were also analyzed according to (AOAC, 2000) procedure. The acid detergent fibre (ADF) and neutral detergent fibre (NDF) of the feed samples and faeces were analyzed according to the Procedure of Van Soest (1991).

3.8 Cost benefit Analysis

The current market price of the various feed ingredients was used to compare the total cost of feed consumed within the growth period and feed cost per kilogram weight gain. This was carried out to determine the profitability or otherwise of raising Bunaji bulls with cassava peel meal diet inclusion. Net benefit was calculated by subtracting the total cost of feed from value of gain.

3.9 Data analysis

The data generated from this study were analyzed using General Linear Model procedure of SAS (2002) and significant differences among treatment means with the control were compared using

Dunnet test of the SAS package. Repeated measures analysis was also used to analyze the rumen fluid samples taken over time.

The Model used is as follows:

$Y_{ij} = \mu + T_i + E_{ij}$

Where Y_{ij}= j^{th} observation of i^{th} graded level of cassava inclusion.

μ=overall mean

T_i = effect of i^{th} graded level of cassava inclusion on performance

E_{ij} = random error

CHAPTER FOUR

4.0RESULT

4.1Chemical compositions of *Digitaria smutsii*, Driedcassava peel and experimental diets

Chemical composition of *Digitaria smutsii*, cassava peel and concentrate diets containing graded levels of cassava peelmeal are shown inTable 4.1The result of chemical composition of experimental diet showed that 30% inclusion of cassava peel had the highest crude protein contents of 15.19%, crude fibre (21.49%) and NDF contents of 36.58% . Ether extract (13.72%) and ADF (27.09%) concentration were highest at 20% inclusion. *Digitaria smutsii* had higher values for dry matter (96.47%), ether extract (12.52%), NDF (41.10%) and hemicellulose (14.08) while the results of chemical composition (%)of *Digitaria smutsii* and cassava peel meal showedthat cassava peel meal has 89.60% DM, while the crude protein is 5.95%, crude fibre contentin CPM is 15.20%. The basal diet (*D. smutsii hay*) has 96.47% dry matter, CP of 2.13% and 12.57 and 14.25% ether extract and crude fibre respectively.

Table 4.1 Chemical composition (%) of the experimental diets (dry matter basis)

Parameters	0	10	20	30	*Digitaria smutsii*	Cassava peels meal
Dry matter	95.73	95.41	95.39	94.86	96.47	89.60
CP	13.50	13.50	13.56	13.50	2.13	5.90
EE	11.18	8.19	13.72	11.92	12.57	2.51
CF	19.17	17.96	12.86	21.49	14.25	15.20
NDF	35.20	35.13	34.04	36.58	41.10	10.44
ADF	28.70	29.07	29.20	27.09	27.02	13.24
Hemicellulose	6.50	6.06	4.84	9.49	14.08	37.00

CP = Crude protein ; EE = Ether extract; CF = Crude fibre; NDF= Nitrogen Detergent Fibre; ADF= Acid Detergent Fibre

Table 4.2 Growth performance of groving Bunaji bull calves fed concentrate diets containing different inclusion levels of cassava peel meal

Parameters	Inclusion level of CPM				SEM
	0	10	20	30	
Initial weight (kg)	95.00	97.00	95.00	95.00	5.49
Final weight (kg)	103.01[c]	110.00[b]	111.75[a]	106.50[c]	2.67*
Total weight gain (kg)	8.01[d]	13.00[b]	16.75[a]	11.50[c]	1.01*
Average daily gain (g)	89.0[d]	144.44[b]	186.11[a]	127.77[c]	11.22*
Total conc intake (kg)	83.70	85.50	99.00	83.70	10.22
Daily con. Intake (kg)	0.93	0.95	1.10	0.93	0.77
Total hay intake (kg)	166.50[b]	195.30[a]	188.10[a]	162.00[b]	9.88*
Daily hay intake (kg)	1.85[b]	2.17[a]	2.09[a]	1.80[b]	0.09*
Total feed intake (kg)	250.2[b]	280.8[a]	287.1[a]	245.7[b]	10.22*
Daily feed intake (kg)	2.78[b]	3.12[a]	3.19[a]	2.73[b]	0.09*
FCR	31.23	21.60	17.14	21.36	

[a,b,c,d]Means within the same row bearing different superscripts differ significantly (P<0.05) SEM=Standard error of means, FCR-Feed conversion ratio

4.2Growth performance of growing Bunaji bull calves fed concentrate diets containing cassava peel at different inclusion levels.

The results of growth performance of Bunaji bull calves fed concentrate diets containing cassava peels at different inclusion levels were presented in Table 4.2. There were significant($P<0.05$) differencein all the parameters measured and calculated expect total concentrate intake and daily concentrate intake. Final weight was significantly ($P<0.05$) higher at different inclusion level of cassava peel meal (106.50-111.75kg) than the bull calves at 0% (103.01kg). Total weight gain was significantly ($P<0.05$) higher at 20% inclusion level of cassava peel meal while the least total weight gain was observed at 0% inclusion level. The inclusion of cassava peel meal significantly ($P<0.05$) influenced total hay intake with the highest values observed at 10% (195.30kg) and 20% (188.10kg) while the least recorded at 0% (166.50kg) and at 30% (162.00kg).

Table 4.3: Nutrient digestibility and urine nitrogen of growing Bunaji bull calves fed concentrate diets containing cassava peel meal at different inclusion levels

Parameters	0	10	20	30	SEM
Nutrient Digestibility (%)					
Dry matter	96.97	96.57	96.66	96.67	15.11
Crude Protein	59.02	56.81	67.84	58.79	3.39
Ash	17.07[b]	17.83[b]	18.41[ab]	21.24[a]	1.20
Ether Extract	8.66[b]	8.32[b]	10.85[a]	11.90[a]	1.01
Crude Fibre	20.99	23.17	23.87	21.41	2.67
Hemicellulose	9.02	12.71	9.55	10.25	3.25
Acid Detergent Fibre	39.68	40.27	42.25	42.48	5.01
Neutral Detergent Fibre	51.33	52.98	52.58	52.73	10.60
Nitrogen Balance (g/day)					
Urine Nitrogen	0.52	0.41	0.83	0.87	0.70
Nitrogen Intake	74.90	72.65	73.45	69.80	5.56
Fecal N_2	27.16	26.65	25.92	25.00	3.14
N_2Balance	47.22	45.59	46.70	43.93	4.09

[abc]Means within the same row bearing different superscripts differ significantly ($P<0.05$).

4.3Nutrient digestibility and urine nitrogen balance of growing Bunaji bull calves fed concentrate diets containing cassava peel meal.

The result of nutrient digestibility and urine nitrogen balance study are present in Table 4.3. The digestibility of ash was significantly (P<0.05) higher in bull calves fed concentrate diets containing cassava peel meal at 20 and 30% inclusion level while the least ash digestibility was observed at 0% inclusion level. Inclusion of cassava peel meal was significantly (P<0.05) higher in ether extract digestibility at 20 and % levels as compared to 0% inclusion level. There was no significant (P>0.05) difference in DM, CP, Hemicellulose, ADF and NDF.The digestibility of CP was numerically highest (67.84%) at 20% level of cassava peel meal inclusion.

All the parameters measured for nitrogen balance were not significant (P>0.05) however, as cassava peel meal increased, there were increase in urinary nitrogen which was higher at 30% inclusion level. Nitrogen intake was numerically higher in growing Bunaji bull calves fed 0% diet compared to those on cassava peel meal based diets.

Table 4.4 Haematological parameters of growing Bunaji bull calves fed concentrate diets containing cassava peel meal at different inclusion levels

Parameters	Inclusion level of CPM				SEM	Ref. values
	0	10	20	30		
Packed cell volume (%)	32.33	36.33	32.00	32.00	4.88	24- 46
Haemoglobin (g/dL)	10.73	12.07	10.63	10.63	2.27	8- 15
Red blood cell ($\times 10^6$µl)	4.85	6.03	5.40	6.00	2.09	5.0-10.0
White blood cell($\times 10^6$µl)	9.13^a	8.83^b	7.50^b	10.47^a	1.26	4.0-12.0
Neutrophil (%)	17.50^a	15.00^b	19.67^a	16.00^b	1.50	15-33
Lymphocytes (%)	80.67	84.00	79.67	82.33	7.11	45-86
Monocytes (%)	2.00	3.00	2.00	2.50	1.90	0-8

[abc]Means within the same row bearing different superscripts differ significantly ($P<0.05$) SEM=Standard error of means, Latimer, K.S, Duncan and Prasse's Veterinary Laboratory. Clinical pathology, 5 ed., Wiley-Blackwell, 2011; and Welss, D.J, Wardrop, K.J, Schalm's Veterinary Hematology, 6[th] Ed, Wiley-Blackwell, 2010

4.4Haematological parameters of growing Bunaji bull calves fed concentrate diets containing cassava peel meal at different inclusion levels.

The result of haematological parameters of growing Bunaji bull calves fed concentrate diets containing cassava peel meal at different inclusion levels is presented in Table 4.4. White blood cell differs significantly ($p<0.05$) across dietary treatments, however, it fell within the normal range for health animal.PCV, haemoglobin, red blood cell, lymphocytes and monocytes were all similar ($P>0.05$) across dietary treatments.

Table 4.5. Biochemical parameters of growing Bunaji bulls fed concentrate diets containing cassava peals at different inclusion levels

Parameters	0	10	20	30	SEM	Ref Values
Glucose (mg/dl)	53.67[b]	61.00[a]	56.67[b]	42.67[c]	1.98	40-100
Total Protein (g/dL)	5.27	5.33	5.93	5.60	1.74	-
BUN (mg/dl)	1.10	1.63	2.03	2.03	1.04	3.6-8.9
Creatinine (mg/dl)	76.00[a]	77.00[a]	65.00[b]	54.33[c]	4.32	44-194

[abc]Means within the same row bearing different superscripts differ significantly (P<0.05). Latimer, K.S, Duncan and Prasse's Veterinary Laboratory. Medicine: Clinical pathology, 5th Ed., Wiley-Blackell, 2011; and Kaneko, J.J, Harvey, J.W, Bruss, M.L, Clinical Biochemistry of Domestic Animals, 6th Ed., Academic Press, 2008.

4.5Biochemical parameters of growingBunaji bull calves fed concentrate diets containing cassava peelmeal at different inclusion levels.

Table 4.5 shows the biochemical parameters of growing Bunaji bull calves fed concentrate diets containing cassava peel meal at different inclusion levels. Glucose and creatinine differs significantly ($p<0.05$) across dietary treatments. Bunaji bull calves fed 10% cassava inclusion had the highest concentration of glucose. Creatinine level decreases significantly ($P<0.05$) as the level of cassava peel increase in the diet. There was no significant different ($P>0.05$) in creatinine level between the bull calves on control diet and those on diet containing 10% cassava peel.

Table 4:6. Main effect of time of sampling on rumen metabolites of growing Bunaji bull calves fed different inclusion of cassava peel meal

Parameters	Sampling time post feeding (hr)				SEM
	0	3	6	9	
Temperature ^{0}C	39.1^{a}	39.75^{a}	39.05^{a}	38.5^{b}	0.26*
NH_3 (mg/100ml)	12.26	10.69	11.31	9.86	3.19
TVFA (Mmol/L)	29.75^{c}	34.17^{b}	39.42^{b}	46.83^{a}	4.06

^{abc}Means within the same row bearing different superscripts differ significantly (P<0.05). SEM=Standard error of means

4.6Effect of time of sampling on rumen metabolites in growing Bunaji bull calves fed different inclusion levels of cassava peel meal

Table 4.6shows effect of time of time of sampling on rumen metabolite in Bunaji bull calve fed different inclusion levels of cassava peel meal. Cassava peel meal had higher temperature at 0hr, 3hrs and 6hrs sampling time. NH_3 was also higher at 0hr, 3hrs and 6hrs sampling time.VFA differs significantly ($P<0.05$) across different treatments and was higher at 3hrs, 6hrs and 9hrs sampling time.

Table 4:7 Main effect of levels of cassava peel meal inclusion on rumen metabolites of growing Bunaji bull calves

Parameters	**Inclusion level of CPM**				**SEM**
	0	**10**	**20**	**30**	
Temperature ^{0}C	39.08[a]	39.06[a]	39.03[a]	38.63[b]	0.21*
NH_3-N(mg/100ml)	10.86	10.91	11.44	10.93	2.27
TVFA (Mmol/L)	32.67[b]	41.58[a]	34.08[b]	31.83[b]	2.88*

[abc]Means within the same row bearing different superscripts differ significantly (P<0.05). SEM=Standard error of means

4.7Effect of levels of cassava peel meal inclusion on rumen metabolites in growing Bunaji bull calves.

Theresult of effect of levels of cassava peel meal inclusion on rumen metabolites of Bunaji bull calves is presented in Table 4.7. Temperature was significantly($P<0.05$) higher at 0%, 10 and 20% inclusion level of cassava peel meal while at 30% level of inclusion.NH_3 was not significant ($P>0.05$), but was numerically highest at 20% inclusion of cassava peel meal after feeding. VFA differs significantly ($P<0.05$) across different treatments. However, it was higher at 10% inclusion level of cassava peel meal compared to other treatments.

Table 4.8: Interaction effect between time and levels of inclusion on rumen metabolites of growing Bunaji bull calves

Hours	Treatment	NH_3	VFA
0	0	12.00	28.00^c
0	10	12.09	31.00^c
0	20	13.02	28.33^c
0	30	11.92	31.67^c
3	0	12.26	39.67^b
3	10	9.67	38.67^b
3	20	11.11	30.00^c
3	30	9.72	28.33^c
6	0	8.12	26.00^c
6	10	12.17	31.67^c
6	20	13.02	28.33^c
6	30	11.92	31.67^c
9	0	11.07	37.00^b
9	10	9.70	65.00^a
9	20	8.62	49.67^b
9	30	10.14	35.67^b
	SEM	**5.07**	**7.72**

4.8Effect of interaction between time of sampling and levels of cassava peel meal inclusion on rumen metabolites in growing Bunaji bull calves.

The result of interaction between time of sampling and levelsof cassavapeel meal inclusion on rumen metabolites in growing Bunaji bull calves is presented in Table 4.8. VFA (28.00-65.00) differs significantly ($P<0.05$) across different level of cassavainclusion but NH_3(8.12-13.02)were similar although not significant ($P>0.05$) across treatments. VFA at 10% inclusion of cassava diet in 9 hours of fermentation significantly ($p<0.05$) has the highest value (65.00) than other dietary interactions.

Table 4.9. Cost benefit analysis of feeding Cassava peel meal in concentrate to growing Bunaji bull calves.

Parameters	Inclusion level of CPM%			
	0	**10**	**20**	**30**
Cost per Kg of feed (₦)	49.30	47.80	46.30	44.10
Total weight gain (Kg)	8.01	13.00	16.75	11.50
ADWG (Kg)	83.70	144.44	186.11	127.77
Value of gain (₦)	50.220	86,664.00	111,666.00	76662.00
Conc. Intake (Kg)	83.70	85.50	99.00	83.70
D. Smuthii intake (Kg)	166.50	195.30	188.10	162.00
Total feed intake (Kg)	250.20	280.08	287.10	245.70
Cost of conc consumed (₦)	4126.41	4086.90	4583.70	3691.17
Cost of *D. Smuthii* consumed (₦)	6103.89	7159.70	6895.750	5938.92
TCFC (₦)	10230.30	11246.60	11479.45	9630.09
Cost per Kg gain	1277.19	865.12	685.34	837.40
Net benefit	39989.70	75417.40	100186.60	67031.91
RIF	3.91	6.71	8.73	6.96

CPM=Cassava peel meal, ADWG=Average daily weight gain, TCFC =Total of feed consumed, Value of gain= weight gain X cost of live weight (N600/Kg life weight), Net benefit= value of gain-Total cost of feed consumed, RIF=Return to investment on feed (Net benefit/Cost of feed consumed), Cost *D. smuthii*=₦ 36.66/Kg. Cost/kg gain= Total cost of feed consumed/Total weight gain

4.9.Cost benefits analysis of growing Bunaji bull calves raised on diets containing cassava peel meal.

Table 4.9 shows the cost benefit analysis of Bunaji bull calves raised on diets containing cassava peel meal. There were significant differences (P< 0.05) among most of the parameters evaluated. The value of gain ranged from ₦50,220 - ₦76,662 at 0, 10, 20 and 30% inclusion levels of cassava peel meal; the total cost of feed ranged from ₦9,630.09 to ₦11,479.45 at 0, 10, 20 and 30% inclusion levels of cassava peel meal. The cost/kg gain values ranged from ₦837.40 to ₦1277.19 with 20% inclusion having the lowest and 0 % inclusion having the highest cost/kg gain. The Net benefit ranged from ₦39,989.70 to ₦100,186.60 at 0, 10, 20 and 30% inclusion level of cassava peel meal. Return to investment were 3.91, 6.71, 8.73 and 6.96 for 0, 10, 20 and 30 % inclusion level of cassava peel meal respectively.

CHAPTER FIVE

5.0 DISCUSSION

5.1.1 Chemical composition of experimental diet

The dry matter content of cassava peel obtained from this study is higher than the value (84.20%) obtained by Uchegbu *et al.* (2011) but comparable to the values of 92%, 91.8%, and 89.56% obtained by Church and Pond (1998), Anigbogu (2003) and Ironkwe and Bamgbose (2012), respectively. The difference in the nutrient composition of the cassava agrees with the report of some other workers could be as a result of variation from source and method of processing as established by Oluokun and Olalokun (1995).

The crude protein content of 13.50% for 30% inclusion of cassava used in the study is higher to 7.4 to 8.8 % (Ahmed and Pollot 1977; Ndlovu and Hove, 1995) or 8.6-9.1% (Etela and Dung, 2011). It was however comparable to the values of 14.7% (Murthy *et al*., 2004); 13.5 % (Nouala *etal*., 2006) and 12.8 % (Asaolu *et al.*, 2010). The crude protein content of the concentrate diets ranged from 10.50 and 14.06% indicating that the diets were not isonitrogenous. The mean crude protein concentrations in the four concentrate diets were all higher than the minimum of 8% necessary to provide the minimum ammonia levels required by rumen microorganisms to support optimum activity (Annison and Bryden 1998; Norton 2003). The range ofcrude protein is similar to the values (9-25%) reported by Kwari *et al.* (1999), Oluponna *et al.* (2002) however, the values reported in this study is similar to the values (18-20%) obtained by Bello (1984).

The Crude fibre (CF) value for 30% of cassava inclusion obtained in this study was lower than the values of 39.5 % reported by Ahmed and Pollot (1977). The observed variations in cassava peel in this study could have been due to non-uniformity in their harvesting and collection methods from one source to another since the cassava used in this study, was purchased from the opened market. The Crude fibre is however higher than the value 8.11% reported by Ironkwe and Bamgbose (2012) and 13.12% reported by Uchegbu and Udedibie (1998).The NDF value in present study is higher than 21.64% reported by (Lamidi *et al.*, 2008) but lower than 55.15% (Idowu, 2011), 33% (Olorunmisomo *et al.*, 2006) and 53.92% (Madziga *et al.*, 2013). In general, the differences observed in the proximate composition of these by-product was in the line with the views of Oyediji (2001) who reported that, the protein, fibre and energy of these by-products differ within themselves according to source and variety as well as processing methods.

5.2 Growth performance of growing Bunaji bull calves fed varying levels of cassava peel meal

The treatments with 10%, 20% and 30% inclusion of cassava had a higher final weight than the control diets could be attributed to the higher feed intake observed in those treatments compared to the control. Higher values obtained could probably be due to differences in experimental diets. Insufficient energy level in diet of high protein level has been associated with wastage of protein and increase energy cost of eliminating excess urea from the body (Huber, 1994).

Growth rate in ruminants is highly correlated to energy and protein intake; with energy intake being the major limiting factor affecting tissues deposition (Leng, 1990). The significant improvement in average daily weight changes of bulls fed 20% level of cassava diets compared to those fed other diets could be due to the enhanced total feed intake in the bulls. Although it has been reported that high consumption of feed does not produce better live weight gain (Alhassan,1985).

5.3 Nutrient digestibility and nitrogen retention of growing Bunaji bull calves fed concentrate diets containing cassava peel meal at different inclusion levels

There were no significant (P>0.05) difference in most of the digestibility parameters except in digestible Ash where inclusion of cassava peel meal at 20% was higher than other treatments and ether extract was also higher at 20% inclusion level of cassava peel meal.

Nutrient digestibility in animals is the classical and direct method for estimating feed digestion by ruminants; hence studies on digestibility of ruminant feeds are very important as they allow for the estimation of nutrients actually available for ruminant nutrition (Yahim *et al*., 2016)

Animals on 20% CPM inclusion had highest digestibility values for CP, ASH, EE, CF and Hemicellulose except DM, ADF and NDF. This might have resulted to the higher weight gain obtained at 20% inclusion of CPM when compared to other CPM inclusion levels (0%, 10% and 30%).

ADF (42.28%) is higher compared to range (20.28-22.84%) obtained by Lamidi (2005). The NDF value 52.98% in present study is higher than the 21.64% reported by Lamidi *et al.,* (2008) but lower than 55.15% (Idowu, 2011), 33% (Olorunmisomo *et al.*, 2006) and 53.92% ((Madziga *et al.,* 2013).

5.3.1 Nitrogen Balance

The result showed an increase in urinary nitrogen as the level of cassava increased in the diets. The observed result on urinary nitrogen output does agree with the findings of Al-Asfoor, (2010) who reported that the nitrogen concentration of faeces strongly depends on the N concentration of the diet. All the animals had positive nitrogen balance irrespective of the level of CPM in their diet. This is an indication that the nitrogen was well metabolized and utilized by the bulls (Abdu *et al.,* 2012). This is also an indication that there was no detrimental effect on feeding cassava up to 30% inclusion level.

5.4. Haematological parametersof growing Bunaji bulls fed concentrate diets containing cassava peals at different inclusion levels

The significant improvement in the White blood cell of Bunaji bulls fed diets with varying levels of cassava underscored the importance of plane of nutrition on the blood metabolite profiles. Alabi (2005) reported that protein deficiency is responsible for clinical anaemia accruing from decreased White blood cells. Packed cell volumes values were moderately lower than the range of 39.79 to 41.42% reported by Moloney *et al.* (1994) for healthy cattle. However, the values of packed cell volume and Haemoglobin in this study were within the normal ranges in cattle (Coles, 1974and Olaloku and Oyenuga, 1975). This suggests that cassava peel might not possessany detrimental factor to ruminants. However, these were similar to the values observed in sheep fed pigeon pea hay (Jokthan, 2006) and when Pigeon pea was supplemented to Yankasa sheep and in Friesian x Bunaji heifers fed diets with varying levels of cottonseed cake (Barje, 2006).

5.5 Biochemical parametersof Bunaji bull calves fed concentrate diets containing cassava peelmeal at different inclusion levels

The concentration of serum glucose in this study were higher than glucose concentration reported by Jonas and Vilma (2007) when fermented silage was fed to daily cows, but higher to 2.82-3.33 Mmol/L reported by Finangwai *et al.* (2010) when urea treated maize stover were fed to Friesian x Bunaji bulls. However, they were higher than the normal range of 3.0- 8.3 Mmol/L reported by Woodman and Evans (1974).

The total protein levels were lower to the normal range of 60-82g/L (Singh and Gupta, 1986). The high total protein concentration recorded in animal fed 20% cassava could have been caused by the significantly higher ruminant NH_3-N and higher serum blood urea - N observed in this study. Bakshi *et al*. (1997) reported that diets high in protein content are always responsible for higher serum ammonia nitrogen.

Singh and Gupta (1986) observed that higher rumen TVFA concentration resulted into increased serum glucose concentration which was attributed to the higher molar proportion of propionic acid of TVFA. Thus, the highest level of serum glucose at 10% level of cassava peel meal inclusion in the diet is a reflection of TVFA concentration in rumen of bulls on that diet.

The creatinine concentration of between in this study was lower than the minimum normal value of 90-126 Mmol/L (Woodman and Evans, 1974). BUN was lower than the normal range of 2.5-6.5 Mmol/L (Woodsman and Evans, 1974; Moloney *et al*., 1994).

5.6 Effect of time of sampling on rumen metabolites in Bunaji bull calves fed cassava diets different inclusion level

The significant differences in total volatile fatty acid (TVFA) concentration in rumen across treatment were in line with the report of Orskov (1982). He stated that TVFA is the main source of energy to ruminants feeding solely on roughages, thus their concentration gave an indication of the energy value.

5.6.1The TVFA values range for effects of levels of cassava peel meal on rumen metabolites

Rumen metabolites in this studyat 0hr before and after feeding 3hrs, 6hrs and 9hrs were above 19.57 – 36.57 Mmol/L reported by Jokthan (2006) when pigeon pea forage was supplemented in sheep diet. Although these values were lower than 96.1 – 111.9 Mmol/L reported by Jonas and Vilma (2007) when dairy cows were fed fermented legume silages. The highest TVFA was observed at 10% CPM inclusion level while the lowest was observed at 30% CPM inclusion. The result showed increase in the level of total volatile fatty acid to 9hrs post feeding could possibly be due to increased digestibility of the feed material (Orskov and Ryle, 1990), since volatile fatty acids are products of degradation of feed in the rumen.

5.6.2 Rumen ammonia nitrogen (NH_3N)

The rumen ammonia nitrogen (NH3 – N) concentrations in this study were slightly lower than 19.24 – 23.27 mg/100 ml reported by Finangwai *et al.* (2010) when Urea treated maize stover was fed to Friesian Bunaji bulls. The values of NH3 – N in this study werelower than 21.5 mg/100 ml reported by Naik and Sengar (1999) 19 – 25 mg/1 00 ml observed by Mehrez *et al.* (1977) as adequate for forage digestion. Satter and Slyster (1974) have reported 50 mg/100 ml as the optimum NH3 – N concentration for microbial growth. Powel *et al.* (1981) have reported that between 3.6 – 17 mg/100 ml NH3 – N concentration promoted microbial protein production. Ammonia -Nitrogen is an important factor in determining the utilization of nitrogen in the rumen (Jokthan, 2006). The non-significant difference in NH3 – N concentration across treatments showed that cassava inclusion in diet was beneficial to rumen protein synthesis. Similarly, the non-significant difference across the sampling time is an indication that there was a stable rumen environment needed for efficient rumen fermentation. Orskov (1982) noted that the requirement for rumen degraded protein is considerably less with straw than for concentrate due to low digestibility of highly fibrous crop residues.

5.7 Cost benefit Analysis of growing Bunaji bull calves fed containing cassava peel meal at different inclusion levels

Feed account for 70- 80% of the total cost of fattening bulls (Powell, 1975, Olayiwole *et al*1981) and since feed cost was the input monitored during the study; the economic returns were based on this. The calculations of other cost such as capital required for pens, depreciation and purchase of stock and labour were considered.

Feed cost (concentrate) in Naira per kg declined with increase cassava peel meals ranged from ₦4,126.41/kg to ₦3,691.17/kg at 0, 10, 20 and 30% cassava peel meal inclusion level. The feed cost to gain ratio was higher in the control (₦1,277.19/kg live weight gain) and lowest at 20% CPM inclusion level (₦685.34/kg live weight gain) which implies that the 20% inclusion was economically better than the control. The Net benefit was generally higher in the diets with inclusion of CPM compared to the control (0 % inclusion) but the highest was recorded in diet with 20 % inclusion level. These results were in agreement with the work of Ogundola (1984) who observed reduced cost of feed in the diet of growing Bunaji bull as the quantity of agro by-products increased.

CHAPTERSIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The inclusion of cassava peel meal resulted in a significant influence to the growth performance in growing Bunaji bull calves. The cassava peel meal contained 89.60% dry matter, 5.90% crude protein, 2.51% ether extract, 15.20% crude fibre, 10.445 neutral detergent fibre, 13.24% acid detergent fibre and 37.00% hemicellulose.

The 20% inclusion of the cassava peel meal in the diets resulted in a live weight gain of 52.18%. This was a better performance than diets without cassava peel meal and the inclusion bought about a net benefit of 60.08%. The inclusion of20% level of cassava peel meal did not have adverse effect on the animals, nor was there a negative reaction to the calves' health. It is important to note that based on this research, an inclusion of up to 30% level of the cassava peel meal will not have any adverse effect on the animals.

Ultimately, the weight gain and net benefit recorded at optimum level in the growing Bunaji bull calves was with a 20% inclusion of cassava peel meal in the diets.

6.2 Conclusion

Inclusion of cassava peel meal in concentrate diets of growing Bunaji bull calves at 20% influencedgrowth performance and live weight gain by 52.18% when compared to diet without cassava peel meal inclusion. The inclusion of cassava peel meal at 20% level resulted in net benefit of 60.08% when compared to diet without cassava peel meal inclusion.

Inclusion of cassava peel meal up to 30% level does not have any adverse effect on the calves. From the study, 20% inclusion level of cassava peel meal in concentrate diets is most appropriate for obtaining optimum weight gain and net benefit.Therefore, cassava peel meal can be incorporated in the diets ofgrowing Bunaji bull calves up to 30% inclusion level.

6.3 Recommendations

From the results of this study, the following recommendations were made:

Farmers in Nigeria could include cassava peel meal up to 30% in the diets of growing Bunaji bull calves for improved performance.

Research can be carried out to see how unfavourable olfactory properties of cassava peel meal can be eliminated by processing and treatment.

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