PERFORMANCE OF ONE-HUMPED CAMEL (*Camelus dromedarius*) FED VARYING LEVELS OF DRIED GAWO LEAVES (*Faidherbia albida*) IN THE NORTHERN GUINEA SAVANNAH OF NIGERIA

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A DISSERTATION SUBMIITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTILA FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ANIMAL SCIENCE

DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF AGRICULTURE, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA.

OCTOBER, 2017

DECLARATION

I declare that the work in this dissertation entitled **"PERFORMANCE OF ONE-HUMPED CAMEL (*Camelus dromedarius*) FED VARYING LEVELS OF DRIED GAWO LEAVES (*Faidherbia albida*) IN THE NORTHERN GUINEA SAVANNAH OF NIGERIA"** has been carried out by me in the department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other institution.

_____

Name of student Signature Date

CERTIFICATION

The dissertation entitled **"PERFORMANCE OF ONE-HUMPED CAMEL (*Camelus dromedarius*) FED VARYING LEVELS OF DRIED GAWO LEAVES (*Faidherbia albida*) IN THE NORTHERN GUINEA SAVANNAH OF NIGERIA"** written by **HARUNA IBRAHIM** meets the regulation governing the award of the Master of Science Degree of the Ahmadu Bello University, and is approved for its contribution to knowledge and literature presentation.

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ABSTRACT

This study was carried out to evaluate the growth performance and nutrient digestibility of dromedary camel fed diets containing varying levels of dried *Faidherbia albida* (*F. Albida*) leaves. Four male camels weighing on average 228.51kg were randomly allocated to 4 diets containing 0, 10, 20 and 30% dried *F. Albida* leaves in a 4x4 Latin Square Design. The results obtained showed that there were significant (P<0.05) effect of diets on the camels. The final weight of camels fed diets containing 20 and 30% levels of inclusion of dried *F. Albida* leaves were at par (255 vs 252kg). However, the total weight gain, average daily weight gain (ADWG) and feed conversion ratio were significantly higher (P<0.05) in camels fed 20% inclusion level of dried *F. albida* leaves compared with other diets. Dry matter intake and nitrogen free extract were significantly higher (P<0.05) in camels fed 20 and 30% levels of inclusion of dried *F. albida* leaves. The crude protein digestibility was higher (P<0.05) in camels fed 20% levels of dried *F. albida* leaves. However, the nitrogen retention of the camels was 22% higher (P<0.05) in the control diet than those fed diet containing 30% inclusion level of dried *F. albida* leaves. Total protein, albumin and creatinine levels were higher (P<0.05) in camels fed 20% inclusion levels of dried *F. albida* leaves. However, glucose and sodium levels were at par (P<0.05) between the control treatment and camels fed 20% dried *F. albida* leaves. Camels fed 30% inclusion level of dried *F. albida* leaves had higher (P<0.05) values of blood parameters except in lymphocytes and basophils. All blood and biochemical parameters are within the normal range. Water retention per day was significantly higher (P<0.05) in camels fed diets containing dried *F. albida* leaves compared to the control. In conclusion, dried *F. albida*

leaves can be included in the diets of camels up to 30% without detrimental effect on growth performance and health of camels in the northern guinea savannah of Nigeria.

CHAPTER ONE

1.0 INTRODUCTION

There has been a trend of growing numbers of camels in the world between 2001 and 2011 (FAO, 2013). This increase might be attributed to changing of environment form the savannah to arid and semi-arid condition, development in camel farming, and an improved ecological image of camel farming and products. The total camelids population in the world in 2013 was estimated at around 25 million animals. This number is probably underestimated because camels are migrant animals. It is difficult to conduct a census for camels such as the wild Australian camel population. The general estimate of the camel world population may probably be around 30 million head (Faye, 2013). About 88% of the camels are found in Africa, while Asia has 12%. The main concentration of dromedary camels in Africa is in the East African countries with 80% of the total camel population raised under various production systems.

The most important countries with a camel population of more than 1 million are Somalia, Sudan, Ethiopia, Niger, Mauritania, Chad, and Kenya. A significant proportion (71% of total world camels) of the world camel population is found in countries defined by FAO as Net Food Importing Developing Countries, Low Income Food Deficit Countries hold 68% of total world camels and Least Developed Countries had 59% of total world camels (Kadim *et. al.*, 2014). Nigeria in particular has about 28,000 camels (NASS, 2011) which are concentrated in the Sahelian region of the North western part of Nigeria (FDCPLS, 1992). The dromedary camels adopted themselves to the ecosystem of dry and hot zone where they are subjected to hash condition in addition to severe fluctuation in the nutritional status, which in turn affect their general performance (Wardeh, 2004). The camel possesses unique

features which make it superior to other domestic animals in the hot and arid desert ecosystem. This is reinforced by the ability of the camel to traverse considerable distance with much less effort than other species. Camel physiology and special features are therefore not only of scientific interest, but are the basic substance for people who live in marginal dry land areas (Wernery, 2006). The dromedary Camels (*Camelus dromedarius*) like any other herbivores animals grazing in the arid rangelands are seasonally challenged with shortage of feeds and water, both in quantity and quality. However, they are known for their ability to survive and produce milk even during critical periods of dry seasons and droughts (Moaeen-ud-Din *et al*., 2004).

Camels are of great socio-economic importance in the lives of pastoral people living in the arid areas of the world (Bahgat, 1991). It's unaccounted for service to the human being under harsh climatic conditions and within highly marginalized ecosystem continues since ancient times (Altaf, 2000). Despites the growing rates of urbanization in several countries, Camels population has not shown a downward trend. This fact itself speaks of the useful role of one-humped camel (Khan *et al*., 1998). Camels have unique capabilities and characteristics, they can be milked, ridden, loaded with baggage, eaten, harnessed to plough and used for other important agricultural operations, traded for goods and exhibited in the Zoo (Iqbal, 1999). Despite the activeness of camels among farm animals, it has remained the most neglected animal in terms of its improvement and scientific researches (Field, 2005). The versatility of camels to survive and perform a great role in the arid and semi-arid regions and its unique physiological system should motivate the researchers to study it more closely to further exploit its potentials. In Kenya, camels have traditionally provided milk, meat and blood for subsistence and have socio-cultural value among the pastoral

communities (Field, 2005). Unlike other ecological zones, camels in the arid areas mainly depend on natural native plants to meet all their nutritional requirements (Simpkin, 1998, Kuria *et al.,* 2004). In Australia, more than 80% of the vegetations in the arid zone are consumed by camels. The animals mostly consume the freshest plant species, ignoring many other potential food plants. They also show distinct preferences for some plant species regardless of their nutritional supply. During the dry periods, leaves from trees and shrubs are the major dietary components. In the wetter periods, they predominantly utilize ground vegetation of which they are mainly forbs. Grasses also serve as some dietary feeds at the beginning of the season when forbs have not yet grown sufficiently (Kuria *et al.,* 2004).

The importance of animal protein especially meat cannot be over emphasized as it contributes to physical and mental development from birth until growth stops. Therefore, it is apparent for every human being to consume sufficient amount of animal protein as insufficient of it can lead to some nutritional diseases and reduced body resistant to diseases. There is need to match the growing population with sufficient amount of protein (Akinimtimi, 2004). However, over the years, Nigerians have been finding it increasingly difficult to meet their demand for animal protein foods. This has resulted in the increasing importation of meat and milk products in recent years. The recommended Per Capita protein intake is estimated at 85.90g, out of which 34.00g should be of animal origin (Abdul Kadir, 1984). However, average Nigerian consumes between 3.25g to 8.60g of animal protein per day as compared to the 34g recommended by FAO (2002). Compared with other developed countries (U.S.A., 64g; Denmark, 57g; United Kingdom, 54g and Germany, 49g) it is obvious that the intake level of Nigerians is grossly inadequate. While solutions to these problems are being sought, it is pertinent to look for other potential sources of animal

protein that will reflect the current interest in the camel as an alternative source of protein and energy. Concomitantly, camels have been used in the countries it is found to substitute for other domestic stock as a source of meat and milk (Akinmutinin, 2004).

1.1 Justification for the Study

- The current trend in camel farming systems as a result of establishment of rain-fed or irrigated agricultural schemes in parts of the camel grazing land have to be taken into consideration. Therefore, to address this challenge, feeding management of camel in new intensive systems and the integration of camel rearing in Nigerian economy needs to be encouraged.
- *Faidherbia albida* which is a multipurpose tree species and is used as feed for livestock in most parts of arid and semi-arid regions of Nigeria. The tree is generally referred to as "Wonder Tree" that displayed excellent survival growth, and produces leaves and pods during dry season when most trees shed their leaves. This quality makes it worthy of investigation as a feed for livestock especially camels.

1.2 Objectives of the study

The main objective of this study was to investigate performance of dromedary camels fed forage based diet in the Northern Guinea Savannah of Nigeria.

Therefore**,** the specific objectives of the study were:

i. To determine the effect of feeding diets containing varying levels of dried *Faidherbia albida* leaves on growth performance of dromedary camels in the Northern Guinea Savannah of Nigeria.

ii. To determine the effect of feeding diets containing varying levels of dried *Faidherbia albida* leaves on apparent nutrient digestibility and nitrogen utilization of dromedary camels in the Northern Guinea Savannah of Nigeria.

iii. To determine the effect of feeding diets containing varying levels of dried *Faidherbia albida* leaves on blood metabolites and haematological parameters of camels in the Northern Guinea Savannah of Nigeria.

1.3 Hypothesis of the study

H_O: Feeding varying levels of dried *Faidherbia albida* leaves with concentrate diet in camels has no effect on growth performance, feed intake, apparent nutrients digestibility, nitrogen utilization, hematological parameters and blood metabolite of dromedary camels

H_A: Feeding varying levels of dried *Faidherbia albida* leaves with concentrate diet in camels has effect on growth performance, feed intake, apparent nutrients digestibility, nitrogen utilization, hematological parameters and blood metabolite of dromedary camels

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The camel (Camelidae)

Camels are in the taxonomic order *Artiodactyla* (even toed ungulates), sub order *Tylopoda* (pad-footed), and Family *Camlidae* (Ji *et al*., 2009). Thus, they are different from the *Ruminantia*, especially Bovinae family. In spite that camels are ruminating animals, they are not ruminants (Bernard, 2015). The family of *Camelidae* comprised of two main types (Large and Small *Camelids*) distributed into three genus: *Camelus, Lama* and *Vicugna* (Ji *et al*., 2009). The small *Camelids* originating from Andin Mountains of South America include: two domestic species (Lama and Alpaca) and two wild species (Guanaco in the genus *Lam*a, and Vicuna in genus *Vicugna*) (Ji *et al*., 2009).

The large camelids are represented by two domesticated species, One-humped camel (*Dromedary*) and Two-humped camel (*Bactrian* camel). The first living in the hot arid lands of North of Africa and Eastern part of Asia, the second in the Cold Steppes and deserts in Central Asia (Ji *et al*., 2009). For few times, a new large camelids was described, it is a wild species living in very remote areas between Mongolia and China, called Tartary camel (*C. Bactrianus ferus*) which was distinguished from the domestic double humped camel (Ji *et al*., 2009). Thus, the *Camelidae* family is characteristic of animals occupying remote areas, arid lands or high mountains. This is linked to the high adaptation of those species to their ecosystem. This explains the interest of this family for maintaining rural activities in the most inhospitable places of the planet (Bernard, 2015).

2.2 World distribution of one-humped camels (Dromedary)

It is difficult to exactly determine the number of one-humped camels in the world, firstly, because it is mainly an animal of nomadic people and pastoralists who are moving frequently, and secondly, because one-humped camels are not usually subjected to obligatory vaccination. So, an exhaustive census for the camels is quite difficult. Officially, the total number of one-humped camels in the world was around 25.89 million heads (FAOSTAT, 2011). This number is probably underestimated, particularly, in the Sahelian countries (Mauritania, Mali, Niger, Chad, Sudan, Ethiopia), when the number of dromedary heads were adjusted after appropriate census (FAOSTAT, 2011). For instance, in Chad, the camel population was readjusted from 800,000 to more than 1.3 million heads after appropriate census by the Ministry of Animal Resources (FAOSTAT, 2011).

However, as the whole, this population represents less than 1% of the total herbivorous domestic population in the world, far away behind the cattle (more than 2 billions), the sheep and goat (more than one billion each) and even behind horse (200 millions) and buffalo (150 million heads) (Gee, 1996). More than 80% of this population lives in Africa with 60% in the Horn of Africa. The most important countries for dromedary economy with a camel population over 1 million are in the order, Somalia, Sudan, Ethiopia, Niger, Mauritania, Chad, Kenya, Mali and Pakistan. The world camel population is increasing regularly with a yearly growth of 3.4%. Since 1961 (date of the first FAO statistics), the world camel population was more than doubled (Schwartz, 2013).

In countries of desert nature (e.g. Mauritania, Saudi Arabia, Gulf countries), the camel farming systems are found all over the country, but only a small space is devoted to camel rearing in sub-arid countries. For instance in India, only the northwestern area (Rajasthan,

Gujarat states) is favorable for camel farming. In Ethiopia, only the lowlands (below 1500m altitude) are regularly occupied by camels. Similar patterns are observed for Bactrian camel. For instance in China and Kazakhstan, the Bactrian camel is present only in the arid part of the country (Gobi desert in China and Moyoum-Koum desert in Kazakhstan) (Faye *et al*., 1995).

Camel was introduced in other countries, either for leisure as in circus or zoological garden, or for rearing in multipurpose activities such as touristic attraction, walking in remote places, beaches, and sometimes for milk production. Some camel farms in Western Europe or in North America were established, but its significance remains quite marginal. Even the dromedary introduction to South-African desert (Kalahari) was poorly developed (Faye *et al*., 1995). The main success of camel introduction out of its original home countries was in Australia, but the major part of the herd is now feral (Faye *et al*., 2002). With a wild camel estimated population approximately 1 million heads, the camel in Australia is regarded mainly as a big environmental problem in the Central desert area of the country rather than a potential source of meat (Saalfeld and Edward, 2010).

2.2.1 Camel Production in Nigeria

Dromedaries in Nigeria are concentrated in the semi-arid northern part of the country. The introduction of the camel into Northern Nigeria can be linked to the caravan trade links between the Sahara and Sokoto, Katsina or Kano and Bilma (Bernus, 1990) and about 60 % of this stock is found in the former Sokoto State (FDCPLS, 1992). The most widely used source of animal power in Nigeria is the oxen harnessed in pairs, which can be used for 5 to 6 working hours per day. The casual use of camels as draught animals was reported by

Musa (1990). Camel is, however, increasingly becoming important in primary land preparation and secondary field operations during the rainy season. Farmers in the Northern states of Nigeria are exploiters of camels rather than producers, since the camels are mainly bred by nomads (Musa, 1990).

Therefore, in Nigeria and indeed in many parts of Africa, camels are increasingly gaining economic importance, especially in the Northern part of Nigeria due to their increasing value as a source of meat, milk, hides and as draught animals (Abdullahi, 2006). The *Camelids* have been known to be capable of withstanding harsh conditions (characteristic of the Sahel region) because of their peculiar morphologic and physiologic features (Bello *et al*., 2008). Camels as drought animals play a pivotal role in the economy of developing countries especially in Sahel part of Northern Nigeria (Raza, 2000). In spite of this importance, camels have rarely received the attention they merits (Umaru, 2002). The available statistics on camel meat production in the world are limited to the number of slaughtered animals, the mean carcass weight upon which meat production is estimated (Faye and FAO, 2015). However, there is no available statistics on the type of camels slaughtered or meat processing. A significant number of camels are slaughtered out of official channels and they are unaccounted for suggesting that camel meat production is probably underestimated (Faye and FAO, 2015). The percentage of slaughtered camels has regularly increased since the year 1960 ranging from 5 to 7%. This increased could be explained by a better organization of the camel meat commodity channels and a decrease of the unofficial slaughtering although unofficial slaughtering in camels is less important than for small ruminants or even for cattle. Indeed, the heavy weight of the camel does not usually encourage killing one animal for few guests contrary to goat or sheep. The

slaughtering rate is obviously higher in male than in female camels. Only local statistics are available for camel meat production (Faye and FAO, 2015).

2.3 Adaptations of dromedary camel to Desert Environment

Adaptation of animal to its environment in general is used often for the process of adjustment to the environmental changes. Adaptations of the camel to the desert environment encompass anatomical, behavioural and physiological changes. It is quite clear that, the camel does not have any special mechanism for survival but relies on mechanisms known to and utilized by other animals. All the desert species have fluctuating body temperature decline in metabolism and utilization of intestinal water. The camel however is able to utilize these mechanisms more effectively when exposed to the direct rays of the sun and for extremely long periods without drinking water (Nielsen, 1979).

Regarding the desert environment, there are several problems facing the desert animals, those are lack of food and water (starvation), sandy or stony ground, thorny plants or trees, hot and windy climate (Fayed, 2008). The performance of the camel is the crucial link between its anatomical structure and ecological adaptations. Most parts of the Arabian Peninsula are characterized by extreme aridity, which is manifested by adverse environmental conditions, leading to fragile ecosystems. They have a higher salt requirement, they eat halophytes (salt tolerant plants), thorny, bitter and toxic plants that are avoided by other herbivores (Barth, 1999). The *camelid* family is well adapted to their respective environments in the harsh and hot deserts. They have developed remarkable features which guarantee their survival in such inhospitable habitats. Under very hot conditions, the dromedary camel (*Camelus dromedarius*) may drink water only in every 8 to

10 days and lose up to 30 % of its body weight through dehydration (Breulmann, 2007).This remarkable attribute results from a very low basal metabolism and exceptional functional anatomical adaptations to defend environmental hazards. The camels are exposed permanently to the heat of the desert sun without shelter. In hot dry areas such as the Empty Quarter of Arabia, the Sahara in Africa or the Death Valley in America, the water loss through sweating (evaporation) is enormous (Boer, 1999). For camel, the question is how to secure water, it does not store water in its body, either in the stomach or in the hump (Farah, 2001).

2.3.1 Anatomical adaptation

Head and neck: The head of the camel is small in comparison to that of other domestic animals. It bears no horns and has small bluntly erected ears to hear the minimal sound vibration from long distance in the desert (Yagil, 1985) and are covered by long hairs even inside with high acoustics power (Ouajd and Kamel, 2009) to filter and warm the air entered the ears in sandy environment (Huh *et al*., 2000). The eyes are large and prominent enable the camel to see in different directions and for long distances. The massive supraorbital fossa or processes give some protection with the long lashes against the sandy environment of the desert in windy day (Breulmann, 2007). Also, the nostrils of the camel are long slit- like appearance having wing, so the camel is the only animal that can close its nostril as protection against sand and winds (Ouajd and Kamel, 2009). Camel has thirty four (34) sharp teeth, the lips are thick to help the camel eat the prickly shrubs growing in the deserts without getting cut (Elkhawad, 1992). The upper lip is split and hairy, extensible and slightly prehensile, it is very sensitive. This modification helps the

camel to select its food (selective feeding) (Ouajd and Kamel, 2009). The camel has a long arched neck helping him to manipulate the high tree plants and to explore the enemy from long distances (Yagil, 1985).

Trunk and tail: Most of the fatty tissues of camel are stored in the hump than being diffused throughout the body. The hump acts as food (fat) storage which will be converted to energy and water in case of starvation in the desert (Fayed, 2008). It is also described as a large store of fat within a mesh of connective tissue but with no water. In the presence of oxygen fat is metabolized to produce energy and water (Ghonimi *et al*., 2014).

Skin and legs: Skin of camel is attached rather tightly to the underlying tissues and has short fine hairs (weber) which helps in thermoregulation (Fayed, 2008). Prepuce of camel is normally directed posteriorally, it is possible that this elevated position keeps the organ from touching the hot sand when the camel squats on the ground and avoiding its contamination with sand (Yagil, 1985). A shaved camel has to sweat 50% more to avoid overheating. It also insulates them from the intense heat that radiates from hot desert sand. Their long legs also help with this by keeping them further away from the sand (Fayed, 2000).

Limbs: The legs are relatively long and slender, an adaptation, perhaps to a long easy gait in sandy environment, and to adaptive cooling, and terminate in large disk -like feet (Fayed, 2008). More than 65% of the camel's total weight is supported by the front limbs (Fayed, 2008). The hooves have a broad, flat leathery pad so that when the camel walks, the pads

spread out and prevent the feet from burying into the hot sand (Mostafa, 2015). The chest is deep and narrow which allows the balance to be shifted easily, so that it is directly over the weight bearing foreleg during locomotion (Yagil, 1985). The camel foot is excellent for movements on sand. It is less suitable for traversing stony desert although some hardening occurs in animals habituated to this kind of country. The presence of the peculiar horny pads on the elbows; stifle and chest prevent more injuries to camel from the stony desert (Yagil, 1985).

2.3.2 Physiological adaptation

Physiological adaptation is defined by biologists as the physiological processes involved in adjustments by the individual to climatic changes and changes in food quality etc. The requirements for survival in hot arid areas are very important. Temperature must be maintained and water must be conserved. The camel losses body heat by sweating more efficiently than other mammals (Nielsen, 1979). The camel (*Camelus dromedarius*) has adapted mechanisms that allow it to withstand prolonged water deprivation (Dahlborn *et al*., 1992), high heat load especially in the absence of readily available water and survive when feed resources are scarce or of poor quality (Dahlborn *et al*., 1992). Heat tolerance is in part due to an animals ability to prevent (or minimise) water loss. For example, the water turnover rate in camels (38 to 76 mL/kg/d) is lower compared with sheep (62 to 127 mL/kg/d) and goats (76–196 mL/kg/d) (Oujad and Kamel, 2009). The camel will respond to hot arid conditions by reducing urine production, concentrating urine, sweating economically, by an increase body temperature and by the 'storage' of CO_2 and glucose in the blood (Oujad and Kamel, 2009). Although other large desert animals (e.g. sheep and

goats) utilised similar coping strategies when faced with high ambient temperatures and reduced water availability, the expression of these coping strategies appears to be greater in the camel (Oujad and Kamel, 2009). It has been reported that camels can survive up to 14 days without water (Elkhawad, 1992), however, six (6) to eight (8) days was suggested by Oujad and Kamel (2009). The differences in the literature are probably a reflection of differences in environmental conditions (Gaughan, 2011). Camels can tolerate water losses of up to 30% (Gaughan, 2011), whereas the maximum for many mammals is approximately 10 to 12% of body weight. Other species such as Australian Merinos can also lose up to 30% of body weight but they would not be expected to survive for more than one to two days of exposure to hot conditions (41^{o}C), whereas the camel will survive for 15 days under the same conditions (Gaughan, 2011).

Rehydration following a period of water deprivation is important for animal survival. A camel may drink more than a third of its body weight **(**Schmidt-Nielsen, 1997**)** as it rehydrates. In other animals rehydration at these levels would lead to over hydration and possible death. The camel is able to do this as large amounts of water can be stored for up to 24 hours in the gut to avoid a rapid dilution of the blood (Wilmer *et al*., 2006). The camels kidneys play a major role in the process of conserving water through increasing the osmolarity of urine. The kidney is characterised by a long loop of Henle, and a well-developed medulla (the ratio medulla/cortica is about 4/1) (Oujad and Kamel, 2009). The kidney has a strong capacity of water reabsorption and a faculty to eliminate very concentrated urine (3200 mOsm); in contrast the Bedouin goat has a urine concentration of 2200 mOsm, and a dehydrated *Bos Taurus* cow has a maximum urine concentration of approximately 1160 mOsm.

The camel can dehydrate without compromising blood viscosity. The camel's blood plays a principal role in adaptive mechanisms to high heat load and dehydration (Oujad and Kamel, 2009; Gaughan, 2011). Blood composition and volume remains relatively constant and haemoglobin function remains normal (Wilmar *et al*., 2006). The erythrocytes of the camel are oval shaped and non-nucleated which resist osmotic variation without rupturing, these cells can swell to twice their initial volume following rehydration (Oujad and Kamel, 2009; Irwin, 2010). Another unique feature of the erythrocytes is their long life span when the camel is dehydrated. The life span of the erythrocytes of hydrated camels is 90 to 120 days (Gaughan, 2011; Oujad and Kamel, 2009). When camels were chronically dehydrated during summer (40^{o}C mean during day, 20^{o}C mean at night) the life span of erythrocytes was extended to 150 days (Gaughan, 2011). Therefore extending the life span of erythrocytes reduces energy and water expenditure (Yagil *et al*., 1974; Oujad and Kamel, 2009).

Exposure to high heat load may result in oxidative stress and cellular damage, and when coupled with dehydration may also lead to hepatic dysfunction. This may increase the plasma concentrations of aspartate amino transferase (AST) and alanine amino transferase (ALT). Katarina *et al*. (1991) reported an increase in AST and ALT in camels exposed to hot (AST = 82.71 ± 1.14; ALT = 10.4 ± 0.31 RF units/mL) and cold conditions (AST = 67.93 ± 8.93; ALT = 9.98 ± 0.17 RF units/mL). These values suggest that the camel may not be immune to heat stress-imposed cellular damage.

When exposed to high heat load animals need to increase evaporative heat loss in order to keep body temperature below a lethal level (Schroter *et al*., 1987). A fully hydrated camel has a diurnal body temperature range of 36 to 38^{o}C. However when dehydrated and exposed to high environmental heat load body temperature may fluctuate by 6 to 7^{o}C, from

approximately 34 to 41^{o}C (Schmidt-Nielsen, 1997). Other animals also allow body temperature to increase but not to the same extent. For example *Bos Taurus* cattle will have a 2 to 4^{o}C variation in body temperature when exposed to hot conditions (Gaughan *et al*., 2010; Mader *et al*., 2010). The increase in body temperature of camels exposed to high heat load, especially following a 2^{o}C reduction below the normal minimum, is advantageous because it allows a considerable amount of heat to be stored during the day and dissipated at night (by radiation) without the expenditure of water (Grigg *et al*., 2009). Furthermore, as body temperature increases the temperature gradient between the camel and the external environment is reduced, and again water use is reduced (Grigg *et al*., 2009). Grigg *et al*. (2009) reported that the heat stored by a 750 kg male camel for each 1^{o}C increase in body temperature was approximately 3.9kJ/kg. Thus a reduction in body temperature from 36^{o}C to 34^{o}C allows for significantly more heat storage.

A key factor in survival during periods of high heat load is the maintenance of brain temperature. Many animals including camels have a carotoid rete at the base of the brain which allows selective cooling of the brain. By cooling the brain the animal is able to tolerate higher temperatures (Elkhawad, 1992). The camel appears to have a gradual increase in respiration rate (approximately 7 to 80 breaths/minute) as body temperature increases from 35 to 41^{o}C (Gaughan *et al*., 2010).

2.3.3 Behavioural adaptation

Under conditions of dehydration and intense heat the camel adopts behavioural mechanisms to conserve energy:

1. The camel sits down in the early morning before the ground has warmed up. It tucks its legs underneath its body so that it absorbs little heat from the ground by conduction.
2. The camel orientates itself towards the sun presenting the least possible body area for the absorption of radiant heat. Any heat absorbed from the ground or the sun would have to be dissipated later in the day.
3. A group of animals may lie down together, thus presenting an even smaller target area for heat accumulation.
4. The camel's metabolic rate increases in the normal way as the temperature rises (Grigg *et al*., 2009).

2.3.4 Ingestive behaviour

Camels are selective feeder not only with regard to plants but also in respect of the parts of the plants they eat. The natural selective feeding habits of the camel are considered the morpho physiological adaptation of the camel's digestive tract (Montes, 2006). The digestive anatomy and physiology of the camel are peculiar in the adaptation to a wide range of food types and in particular, coarse forage, without the necessity of a specialized cellulose fermenting rumen (Montes, 2006). The camel does, however possess adaptive mechanisms to compensate for long periods of poor quality food and water deprivation, for example, there is a slow decrease in weight through fluid loss during exposure to high temperature (41^0C) allowing adjustments of fluid spaces and a stable metabolism (Yousri,1976).

Camels are browsing animals, they feed on thorny plants of the desert. Anatomical adaptation as the mobile and prehensile split upper lip enable them to avoid the injuries of the desert plants, the camel jaw and dental pad enable it to seize and tear branches off trees if required, and with slow lateral movements of the jaw, the thorns of these plants are destructed (Huffman, 2004). Also a small but mobile tongue with numerous hard, dentigerous papillae protruding from the lining of the cheeks and lateral aspect of the tongue assist in the mastication and ingestion of food. Although camels can resist thorns to some extent they are not completely immune to them and on very thorny species feeding is a slow business (Yousri, 1976). The oesophagus has a large potential diameter with much mucus – secreting glands. The areopharyngeal and oesophageal anatomy assist in the movement of hard materials without causing irritation to mucosa (Fayed, 2008).

2.4 Traditional husbandry and management of dromedary camels

Camels are owned by nomads in arid regions. The pastoral land is mainly covered with annual grass, acacias, euphorbias and dwarf bushes. The annual rain fall varies between 100 and 400 mm, the amount of rain varying from year to year and the rains being restricted to widely separated areas (Farah, 2001). This type of pasture permits only extensive types of animal production. Because of its high mobility, its modest fodder requirement and its water regulation perfectly adapted to the environment, the camel is better suited than any other domestic animal to use this type of pasture (Farah, 2001). According to the nomads, camels can survive in times of extreme need for up to 30 days without water. This depends, however, on quality of grazing land and prevailing temperatures (Farah, 2001).

The salt requirement of camels is very high and is six to eight times higher than that of other domestic animals. The salt requirement is only partly satisfied by grazing. When the herdsmen observe that the camels are restless, with reduced appetite, they take this as a sure sign of salt deficiency. The camels are then driven to salty water sources and watered repeatedly. Studies of many nomadic herds in several countries show that female animals constitute 70 to 80% of camel herd. The high number of female animals is needed to satisfy the large milk requirement of the nomad economy. The number of male animals in the herd is reduced in two ways and at two points in the camel's life cycle (Farah, 2001). A percentage of male calves are slaughtered at birth or within few weeks of it. This allows more milk for female calves and for family consumption or sales. Males not slaughtered at birth are allowed to grow until they are about 4 years old. Majority are castrated, fattened, sold and slaughtered for meat (Farah, 2001). Reproduction of the herds is achieved natural selection of suitable male camels especially in pastoral herds. According to the traditional husbandry, the adult male should have the following characteristics:

1. The bull or its father should have had predominately female progeny with good milk performance;
2. It should be fully grown and strong;
3. It should be a good fighter able to overcome other males.

It would be difficult to evaluate to what extent these selection criteria influence the quality of the progeny. In recent years dromedaries from Pakistan have been introduced in some camel farms in Kenya in order to improve milk production through cross breeding. Camels are slow reproducers. A female camel is sexually mature at the age of 4–5 years. Pregnancy is just over 12 months and the calving interval in pastoral production systems is normally 24

months or more. Female camels can remain fertile up to the age of 25 years and a life span of 40 years. It is often reported that they produce 8–10 calves during a lifetime. In pastoral production systems, however, only a small proportion of the breeding females can reach this production performance. A major problem in camel productivity is the high mortality rate of camel calves in the first 3 months. The causes for mortality are mainly poor management practice and infectious diseases (Farah, 2001).

The new-born calf has no natural protection against diseases, as there is no antibody transfer from the mother during foetal development. The calf can obtain immediate immunization soon after birth only through colostrum, which has a very high concentration of antibodies. Therefore, it is vital for the calf to suckle as soon and as much as possible. Unfortunately there is a common belief among many pastoralists that colostrum causes diarrhoea and, consequently, is unsuitable for the new-born calf. This wide spread practice of withholding the colostrum from the new-born calves, depriving them of essential antibodies, is certainly a crucial factor in the frequently reported high calf mortality in pastoral production systems (Farah, 2001).

The milking of camels is a process that varies according to the different pastoral groups. Camels may be milked once or several times a day. In general, it is a normal practice among most nomadic tribes to milk their camels in the early morning before animals are taken out for grazing and at night when they return from grazing. Before milking, the calf is allowed to suckle until the milk is flowing and then the camel can be milked. Without this stimulation, the dam cannot be milked. The milker stands on one leg, puts the milk pot on the upper part of the other leg, and milks with one or two hands. Sometimes, milking may

be done by two persons, each milking two teats. To prevent calves from suckling while at pasture, it is a usual practice to tie up one or more teats with special strings (Farah, 2001).

Camels are kept under the traditional nomadic system in the dry arid zones of the world (HCENR, 2009). Nomadism is a traditional way of life as well as system of rearing animals. For nomadic people in particular, seasonal availability of natural pastures and water is the major reason behind the contentious mobility according to which time and direction of herd's movement is determined. The short distance movement is practiced mainly by agro-pastoralists or in some cases by pastoralists owning small herds (Ishag and Ahmed, 2011). Beside the traditional nomadic system, camels are also reared under semi nomadic production system, which is characterized by less mobility compared to the nomadic one (Eisa and Mustafa, 2011). Camels are also kept under sedentary and semi sedentary production systems that are expressed by high level of settlement associated with some sorts of agricultural activities (Ishag and Ahmed, 2011). During the last decade, camels were also introduced to the newly adopted semi intensive production system. Climatic changes characterized by decrease of mean rainfall with acute long periods of drought reported in the belt of camel rearing (HCENR, 2009) has encouraged the establishment of the new system, in which selected groups of lactating she camels are kept in dairy farm mainly for milk production in the pre-urban area of Khartoum State (Babiker and El-Zubeir, 2014).

2.5 Camels as sources of Meat

Meat is the most important product from the camel. The importance of the camel as a meat-producing animal is increasing due to the amount of high nutritive value meat they produce, besides their ability to survive under harsh environments (Kadim *et al.*, 2008). The total

camelid meat production in 2011 was approximately 338,289 tons. Accordingly, camelid meat contributed approximately 0.18% of total red meat production. Africa produced 62.2% of the world camelid meat followed by 35.8% from Asia while South America contributed only 5.3%. Central Asia contributed 0.38% of the total world camelid meat production. In Africa, the largest contribution came from eastern Africa, followed by northern Africa, and western Africa. In Asia, the largest contribution came from western Asia followed by eastern Asia (FAO, 2013). Although the percentage of slaughtered camelids (number of animals slaughtered) has increased over the last five decades from 5 to 7% (Faye, 2013), the number of slaughtered camelids is much less than those of other red meat species. In spite of the low contribution of camel to the world meat production, it is noticeable that the growth is greater than for cattle, sheep, and horse meat. The total number of camelids slaughtered in 2011 was 2,283,623 head around the world, with Africa contributing 1,086,221 head followed by Asia at 601,883 head. South and Eastern Europe contributed 595,000 and 519 head, respectively. Most African and Asia camel meat generally comes from old animals (more than 10 years) (Kadim *et al*., 2014). Camel meat is also called "Beef". Camel meat tasted like beef, it has relatively the same colour and texture with the cattle meat.

According to the monthly report of the Livestock Service Department of Kano Ministry of Agriculture, on daily basis 50 to 80 camels are slaughtered at Kano main abattoir. This shows how people are consuming camel meat. The figure slaughtered on daily basis are mainly distributed and consumed within Kano metropolitan and its suburb area (Ghude *et al*., 2013). Also, Banerjee (2007) reported that inhabitants of arid and semi-arid zone accept and consumed camel meat. However, UN (2004) reported that camel meat is believed to be medicinal for the simple reason that camel survives well on thorny plants which are

probably believed to contain some quantity of herbal medicine. However, Ghude *et al*. (2010b) reported that a kilo of camel beef is sold at a price of between N1, 000 to N1, 200 against that of cattle beef which cost between N1, 500 to N1, 600 in Kano depending on the season, quality and the availability of the meat.

2.6. Camel Potentials as Milk Producers

It has been shown that camels can be managed intensively like cows, on these farms they would primarily produce milk and meat. In Dubai, United Arab Emirates, one such camel farm already exists where, in 2007, some 600 camels produce about 6000 liters of milk per day (~10 liters milk/day/camel), which is commercially sold in the city of Dubai ("Camelicious") (Marc *et al*., 2007). The Food and Agriculture Organization (FAO) estimated that the global market in camel milk potentially is worth over 10 billion USD. In Dubai, specialized camel milking machinery was developed, which makes the Camel Farm a modern and practical dairy farm. With improved feed, water availability, husbandry and veterinary care, daily yields could rise to 20 liters milk per day/per dromedary (Marc *et al*., 2007).

Camels can produce four times more milk in the desert environment than domestic cattle. Cattle are highly efficient in milk production in temperate climates or when their environment is air-conditioned or where water sprinkling systems are used for cooling the animals to keep their body temperature at 37 ºC. This of course uses an enormous amount of energy and water, causes hygienic problems and is not environmentally sustainable (Marc *et al*., 2007).

In cows, if this is not done, the reservoir for milk-water is lost for body cooling which leads to cessation of lactation or to a very concentrated high fat and low water content in the milk. In contrast, camels can be easily managed in open pens with little shade and need to be neither cooled down nor watered daily (Faye *et al*., 2002). In drought-stricken areas of the world, where continuous drought decimates cattle, sheep and goat populations, only the camel survives and continues to produce milk. In arid and semiarid zones where camels are reared, the milk yield of camels is four times higher than that of indigenous zebu cattle and the daily milk yields have been reported to be between 3 to 40 liters (Marc *et al*., 2007).

One of the remarkable features of dehydrated camels is their ability to continue lactation and to secret milk that is highly diluted with over 90% water content. A 600kg camel for example, has about 200 liters of fluid in the alimentary tract, which is available for milk production, giving 20 liters per day for 10 days (Yagil, 2000). Lactating camels, therefore, will guarantee ample food with the desired content for their offspring and humans alike. Camel milk is a rich source of proteins with potential anti-microbial and protective activity. Components of camel milk differ considerable from those of ruminants (cow, sheep and goat) (Marc *et al*., 2007). The high concentration of niacin and vitamin C, the high water content, especially during the hot summer months, and the low fat content of camel milk are remarkable. Furthermore, the fat of camel milk does not form a layer when kept undisturbed, and it is evenly distributed throughout the milk in small micells. Camel milk does not coagulate easily. It passes the acid stomach unchanged and reaches the intestines for absorption. Because the milk does not curdle, either with acid or with rennet, cheese, especially hard cheese, is difficult to produce. The reason for this is still poorly understood. Milk allergy and lactose intolerance, which are very common in the western world, are

unknown diseases with camel milk. Milk allergy occurs globally in 1 to 7% of all infants, and it is believed that the absence of betalactoglobulin and the different composition of beta-casein in camel milk prevent allergic reactions (Marc *et al*., 2007).

Therefore, camel milk would be an interesting alternative for infant milk products. Lactose intolerance is a different entity. It occurs in people above 5 years as a result of the decrease or absence of an enzyme called lactase in the gastrointestinal tract. Approximately 90 - 95% of black individuals and only 20 - 25% of white individuals throughout the world have partial or complete lactose intolerance. Although, the lactose content in camel milk is as high as in cow milk, camel milk lactose intolerance does not occur. The reason is also not yet known (Wernery, 2006).

Camel milk is healthy and has the following advantages in comparison to cow milk:

1. It has five times higher Vitamin C content than that of cattle
2. Rich in iron.
3. Contains 50 % less fat compared with cattle milk
4. Low cholesterol.
5. Is compatible among people who are lactose intolerant (Marc *et al*., 2007).

2.7 Browse Plants and its Importance to Animals

Browse, or the available parts of the tree or shrub plant such as leaves, twigs, flowers, fruits or pods is an important fodder resource for ruminant livestock in semi-arid rangelands (Oppong *et al*., 2008). This is more pronounced particularly during the dry season or during drought years, when both the quantity and quality of herbaceous cover significantly declines. Not only are the browse species generally higher in some minerals and protein

during these periods, but they also offer a more stable feed reserve when compared to the large biomass variation exhibited by the grass layer (Oppong *et al*., 2008). Despite not gaining inclusion into routine carrying capacity assessments, browse and the role it plays in livestock production has gathered widespread recognition and research impetus over the years (Oppong *et al*., 2008). The use of browse as an available source of quality feed during the dry season is important to maintain seasonal and yearly stability in livestock production thus ensuring sustainable rural livelihoods. It is now generally acknowledged that browse fodder is a potential inexpensive locally-produced protein supplement for ruminants, and can correct nitrogen deficiency in herbaceous vegetation during the dry season (Van, 2006). Recent reviews and studies in various part of the world have shown that browse trees and shrubs play a very significant role, mostly as supplement, in the nutrition of livestock in the arid and semi-arid land of the world (Otsyina and Dzowela, 1995). The most important role of browse has been to provide valuable fodder as supplements to low value fodder in the dry seasons. In Australia for example, stands of *Acacia ameura* sustain the sheep industry in the time of draught. The branches and leaves are lopped to provide feed for livestock (Otsyina and Dzowela, 1995). *Faidherbia albida* (Syn, *Acacia albida*) has been reported to be extremely important in livestock diet in the dry seasons, it provides both leaves and palatable pods, especially, to sheep, goat and camels (Otsyina and Dzowela, 1995).

2.7.1 Limitation of browse plants

2.7.2 Anti-nutritive factors of some browse plants

Anti-Nutritive Factors (ANF) are compounds which are produced by different mechanisms and affect the utilization of nutrients. These are produced by inactivation of some nutrients

and through normal metabolism and affect the utilization of nutrients and digestion of feed. Properties of ANFs also depend on digestive process of animal because sometime ANFs are degraded in rumen and not show any toxic effect on animals (Kumar, 2003). Presence of ANFs limits the use of pods, twigs, leaves and trees for animals as feed material because ANF play significant role in defensive mechanism for reproductive and structure maintenance (Harborne, 1989).

Feeds could be from grasses, legumes; leaves of tress or plant in the form of browse plants (Yahya *et al*., 2000). Browse has been defined as leaves shoots and sprouts including tender twigs and stems of woody plants, which are cropped to a varying extent by domestic animals (Kumar, 2003). It could however, be extended to include the fruits, pods and seeds which provide valuable feed, especially, if the seed is deciduous. Besides the nutrients supplied by these browse plants, they also provide bulk materials. The quality of feeds voluntarily taken to meet the, nutritional requirement depends on palatability, digestibility and nutrient density of the feeds (Yahya *et al*., 2000).

In Northern part of the country, ruminants suffer greatly due to malnutrition, the nutrient available in the grass during the dry season do not meet their maintenance level, which therefore make most animals depend on other source or non-conventional supplementary diet (Devendra, 1989). Therefore, in the tropics browse plants have been found to give significant potential in terms of adoptability, productivity and acceptability for ruminants which balances the difficulties of feed shortages in the dry season (Kumar, 20003). Unfortunately, some browse from tree forages contain secondary compounds which may be toxic when fed adlib (Fall Taure *et al*., 1998). Traditional herdsmen and other pastoral groups habitually cut down branches from various trees species (Acacia, Ziziphus, Ficus,

etc) making them available to livestock during the dry season when no other forage is available (Yahya *et al*., 2000).

One of the constraints to the use of browse species as a livestock feed is the presence of toxic and anti-nutritional constituents. These constituents have different but adverse effects on animal performance including loss of appetite and reductions in dry matter intake and protein digestibility**.** Gidado *et al*. (2013) in their study on anti-nutritional factors and nutrient composition of some selected browse plants reported a mean *tannin* content of the thirty browse plants of 0.20% with the range of 0.114% to 0.695%. The small quantity in *tannin* content of the browse species may likely suggests the nutritional quality of the different species. That is, level of *tannin* which adversely affects digestibility in ruminants is between 2% and 5% **(**Yahya *et al*., 2000**).**

Saponin content of the browse plants varied from 0.150% in *Ficus thoningii* to 6.310% in *Boswellia dalzielia* which were generally high (Gestetner *et al.,* 1996*)*. The tolerable level of saponins in ruminants is 1.5-2% (Onwuka, 1983). The mean alkaloid content of all the browse plants studied was 0.03%. The average *alkaloids* content in the leaves were lower than the average of 0.1 % obtained for other native browse plants as reported by Yahya *et al*. (2000). Among the browse species *Pterocapus erinaceus, Adasonia digitata, Prosopos africana* and *Ficus thoningii: alkaloids* were not detected at all. From the values obtained, it would be concluded that the alkaloid levels of the browse plants studied were low and the plants are therefore safe for feeding, except *Balanites aegyptica* which has a relatively higher values than those revealed by Yahya *et al*. (2000).

2.7.3 Nutritive value of Browse Plants

Even though browse nutritive value varies according to species, generally they remain green even in the dry season just like the perennial legumes; this is because of their adaptation to harsh environment through there deep rooting habit and leathery low transpiration foliage and is therefore able to withstand the adverse climatic condition (Amadu and Otaru, 2004). Most browse species have high protein and low crude fiber contents, which make them suitable as fodder for livestock. The average crude protein of browse in tropical West Africa is 12.5% and this rarely fall below 10% in most browse during dry season. The average crude fiber is 18.5% while the digestibility of browse plants is moderate to high when fed in fresh form. The calcium content is 1.6% while the phosphorus is 0.15% (Amadu and Otaru, 2004).

Several crude protein values have been reported in the literature of *Gmelina arborea* leaves. Ahmed (2000) and Omokanye *et al*. (2001) reported a crude protein value of 26.7%. Leng (1992) reported 34%, Adu *et al.* (1996) recorded 28.6 to 38.4%, Lamidi *et al*. (2009) obtained 14.51% while Taiwo *et al.* (2009) reported 20.39% crude protein. Osakwe and Udeogu (2007) reported crude fiber content of 34.46%, 44.69% nitrogen free extract and 3.59kj/g Gross energy.

2.8 *Faidherbia albida* tree

Faidherbia albida Del. A. Chev. (syn. *Acacia albida*) is widely distributed throughout the dry zones of tropical Africa. Although of the Acacieae tribe, it has many unique botanical and phytochemical features, as well as botanical naming, that justifies its classification as a

separate genus. In western Africa, though not always in eastern, central, or southern Africa, the species has the unique characteristic of shedding its foliage at the start of the rainy season, and of coming into leaf in the dry season. This unexpected "inverted" phenology means that its presence in farmers' fields does not interfere with agriculture, and, indeed, makes it an ideal agro-forestry tree for use in combination with crops. It also provides animal fodder in the dry season. These qualities are traditionally well known in rural West Africa, where generations of small farmers have deliberately encouraged it in a kind of cultivated parkland (Pélissier 1980).

2.8.1 Botanical Characteristics

2.8.2 Morphology and General Features

Under favorable conditions, *F. albida* can attain a very large size; heights of over 30 m and a diameter of 1.5 m. More usually it reaches 15 to 20 m in height and a breast height diameter of up to 1 m. The crown tends to be shaped like an inverted pyramid in young trees, becoming hemispherical with age. The lifespan is generally about 70 to 90 years, although some individuals of over 150 years are reported from Zambia (Pelissier, 1980). The bark of the tree is characteristically dull brown to whitish grey, smooth when young, more fissured and flaky and more cork-like in older specimens. The slash is fibrous, pink to light brown.

2.8.3 Botanical Description

Leaves. The leaves are typical of the Mimosoideae, compound and bipinnate with leaflets borne along the pinnae. They are highly variable: the petiole varies from 0.5 to 3.7 cm long. The rachis is 3-7.5 cm long and carries 2-12 pairs of pinnae, each of which is 2.5-5.5 cm long and carries 6-23 pairs of leaflets. Leaflets are glabrous to pubescent, bluish green, oblongate and occasionally sub-mucronate, overlapping slightly, 2.5 to 12 mm in length and 0.7 to 5 mm in width (CTFT 1989).

Thorns. Thorns occur in pairs at the base of the leaves and are modified, spiny stipules. They are straight and robust, thickened at the base and often (particularly when juvenile) orange or brown at the tip and are 0.2-3.2 cm long. They may be distinguished from those of *Acacia* species with long thorns, such as *A. tortilis* subsp *raddiana*, *A. nilotica*, or *A. seyal*, by their basal thickening.

Flowers. The flowers are borne in dense axillary panicles 3.5-16 cm long, with a peduncle 2-4 cm long. They appear about 2 months after the tree comes into leaf and are sessile or with a pedicel of up to 2 mm. In color they are successively white, cream, and then yellow, and are strongly perfumed. The calyx is 1-1.7 mm long, glabrous to pubescent, consisting of five sepals. The corolla, 3-3.5 mm long, carries five free petals. The stamens, numbering 40 to 50, are 4-6 mm long and their filaments are fused for about 1 mm. There is also partial fusing between the stamens and the bases of the petals, (epipetaly). The anthers are 0.2-0.4 mm in diameter, lacking glands even in the bud. The ovary is lightly stipitate and bears small hairs. Flowering commences towards the seventh year (McGahuey 1985).

Fruits. The fruit is an indehiscent pod varying from bright orange to reddish brown and 7-9 mm thick, 6-35 cm long, and 1.4-6 cm wide. It falls from the tree about 3 months after flowering. The pod surface is convex on one side and becomes concave on the other, and as the fleshy mesocarp lignifies, it tends to roll into a spiral resembling dried apple peel, hence the common name "Apple Ring *Acacia*." There is much variation in pod shape both within and between trees.

Seeds. Each pod contains 10-29 dark brown shiny seeds, separated by thin septa. They are ovoid, 10 x 6 mm in size and are characterized by an elliptic areolus or hilum measuring about 8x5 mm. The seed coat is tough, waterproof, and leathery, and maintains seed viability for many years.

2.9 Taxonomic Classification

2.9.1 Identification and Classification

The first botanical determination of the species under the name *A. albida* Del. was made by Delille in 1813 and was based on a specimen obtained in Egypt. Bentham (1875) recognized the species as belonging to the Mimosoideae subfamily of the Leguminosae in the Gummiferae series which is characterized by possessing spiny stipules.

Classification	Taxonomic name
Family	Leguminosae
Sub-family	Mimosoideae
Tribe	Acacieae
Genus	Acacia
Series	Gummiferae
Species	Acacia albida

2.9.2 Botanical Nomenclature

Because *A. albida (F. albida*) is quite distinct botanically, having no other species closely related to it, its classification has given rise to a number of taxonomic studies. Baillon (1863) concluded that the staminal filaments were indeed joined at the base, but that this feature was not sufficiently important to justify separating the species from the genus *Acacia*. On the other hand, Chevalier (1934), using the same distinctive characteristic as well as other features (which are discussed further below), preferred to exclude the species from the genus *Acacia* and place it in the new monospecific genus *Faidherbia*. This move established the link between the tribes Acacieae and Ingeae, the latter being another tribe of the subfamily Mimosoideae characterized by the stamens being more or less fused into a single ring. This taxonomic classification has since been followed by a large number of authorities quoted in CTFT (1989).

While accepting the distinct nature of the species, some authorities still prefer to keep the name *A. albida* after nonetheless pointing out the differences between this species and other

acacias: "Although different from the other African acacias, *A. albida* has nevertheless many features in common with them. It could ultimately turn out to be preferable to transfer the species to the genus *Faidherbia*" (Ross 1966). Hutchinson and Dalziel (1958) retain the name *A. albida*. However, Brain (1987) points out that the chemical constituents of the species are quite different from those of other acacias, and Robbertse (1974) has shown that the pollen also differs. Some authorities still have reservations about keeping *Faidherbia* separate from the genus *Acacia* but on balance it seems logical to put the species into the genus proposed by Chevalier (1934), which links the tribes Acacieae and Ingeae. This paper therefore uses the specific epithet *F. albida* (Del.) A. Chev.

2.9.3 Distinguishing Characteristics.

The characteristics distinguishing this species from other Gummiferae may be summarized as follows:

- Phenology: deciduous in the wet season, foliated in the dry.
- Cotyledons: cotyledons are sessile, whereas all the other Gummiferae have petiolate cotyledons (Ross 1979).
- Foliage: the primordial leaves are bipinnate, whereas all the other known members of the Gummifera have at least one simple pinnate primordial leaf (Vassal 1979).
- Pollen grains; without ridges, unlike those of other Gummiferae, are of four pores and with an exine like those of the Ingeae.

- Wood anatomy: Layered structure and straight rays (Fahn *et al.,* 1986) differ from those of other African accessions.

2.9.4 Natural Distribution

The main area of natural distribution of *F. albida* is Africa as shown in figure 1. The species occurs right across the African continent from Senegal and Gambia to the Red Sea (Egypt, Sudan, Ethiopia, Somalia, and Kenya). Further south, it is distributed through eastern and central Africa as far as Natal in South Africa, and westwards to Lesotho, Angola, and Namibia, though it is absent from a corridor in the eastern parts of the last two countries. Apart from this area, its distribution corresponds precisely with the Guinean forest zone of Africa.

The natural distribution does not appear always to follow the climatic zone that characterizes the Guinean zone, however, because the species also occurs along watercourses and in other areas where ground-water is present, or where there is residual water in the alluvium of a seasonal water course. In such places, the distribution is discontinuous, and includes sites in the mountain massifs of the Sahara (Air, Tibesti, Ennedi, and Hoggar, for instance). It also occurs along the Nile in Egypt (Brain, 1987). Outside Africa, spontaneous occurrences of the species are found in Yemen, Israel, Jordan, and Lebanon, where the northernmost is 30 km north of Beirut. The species does not occur in Madagascar. Introductions have been made to Ascension Island, the Cape Verde Islands (Wickens 1969), Cy-prus, and Pakistan (Brenan 1983). More recent introductions have been made to other countries, notably Peru and India; in India, it is of interest as occupying an ecological niche similar to that of the indigenous *Prosopis cineraria.*

With a species that has been cultivated so widely and for such a long period, it is now difficult to determine its actual origin. Aubréville (1937) considered that it was originally a riverine tree of eastern and southern Africa, and was introduced into the northern part of its range in West Africa, where it is only found on cultivated or previously cultivated lands. Chevalier (1934) was of the view that it originated in the Sahara before the current desertification, and that it would have become domesticated in the Sudanian zone. Trochain (1969) claimed to have identified a "semi-climax of *F.albida* in the south-western part of Senegal," where the species would have been brought in by nomadic peoples (through the effects of their animals) in particularly hard times. Human influences thus developed "stable tree populations which, on the sandy clay soils, replaced the different natural open forest climax formations of the Sudanian zone, these being *Combretiun glutinosum* on the lighter, sandier soils and *Acacia* seyal on the heavier sandy clays" (Felker 1978). Many foresters also believe that the species is not indigenous to the natural forest areas of West Africa, having been introduced there through pastoral ism and agriculture. Many of the places where it is common today can be identified as old animal compounds, water holes, or common grazing grounds. It is also found in religious forests, where it may have been planted in the past, though there are no records of this.

2.9.5 Soil Requirements

In eastern, southern, and central Africa the species is often found growing near sources of water, such as along rivers, on the shores of lakes, and in gullies and ravines. In all these situations, the soils tend to be alluvial or hydromorphic. These seem to be the ideal sites; in Sudan, for instance, the greatest concentrations of the species occur in wide belts along the

sandy alluvia of the drainage basin of the Jebel Marra (Wickens 1969). It is also found on stabilized sand dunes. In western Africa, as we have seen already, the distribution of the species is generally a result of human activity. Here, it prefers deep, lighter sandy or silty soils, though occasionally it is found on lateritic soils with a shallow pan.

2.9.6 Water Requirements

The tree does not conserve moisture but is effective in obtaining water for transpiration, as amply demonstrated by its vegetative vigor in the dry season, in the total absence of rain, when temperatures are high, humidity is low, and evapotranspiration is at a maximum. To achieve this, its root system has a taproot that grows very rapidly and will reach the water table if it is within range; depths of about 40 m have been recorded (Lemaitre 1954). When on its preferred sites, notably in association with water, the species prefers deep sandy soils easily exploited by its root system.

2.9.7 Uses of *Faidherbia albida*

Medicinal plants over the decades have been shown to have a scientific basis for their use in primary health care in the prevention and treatment of various diseases by several scientists. Such therapeutic uses of such plants have been proved to be as a result of the presence of various anti-nutritive factors, also known as bioactives or phytoconstituents, which act individually or synergistically in such plants. Medicinal plants, such as *Faidherbia albida*, also known as *Acacia albida* (Apple ring) is a thorny, deciduous tropical African tree with deep penetrating root. The leaves are bi-pinnate, bluish -green in color with straight whitish thorns, while, the bark is grey, rough and scaly, when old. It possesses pale cream-colored,

long-spiked flowers and has fruits that are twisted, glabrous, and shiny, ranging in color from orange to brown. The fruits are soft and fleshy with narrow wings that extend about three quarters way round the body with a corky and knobby flesh surrounding a hard woody shell (Keay *et al*., 1999). Within the fruits are pod-bearing seeds which are orange-brown in color, twisted in shape, containing almost 10-30 dark, shiny brown ovoid seeds and a tough seed coat; usually eaten by animals (Wood, 1992). Traditionally, the plant is used in the treatment of diarrhea (Muhammad *et al*., 1998), skin diseases and asthma (Gill, 1999). The plant is also useful as an anti-inflammatory, anti-haemorrhagic and ophthalmic agent (Wickens *et al*., 1995). Locally, the seeds of the plant are eaten by humans as foods during famine (Murunda, 1992), while powdered pods and seeds are widely used to poison fish in pools (Timberlake, 1990). Biologically, the plant's usefulness as anti-microbial, antidiarrheric, anti-pyretic, anti-inflammatory, antitrypanosomiasi, anti-diabetic, anti-malarial, anti-fungal and nematicidal agent has been reported Tijani *et al*. (2008). Agriculturally, the plant is a nitrogen fixer and has reportedly been used to improve fertility and hence, increase crop yield of crops planted around it (Vandenbeldt, 1992). Phytochemically, the presence of saponins, tannins, alkaloids, flavonoids, phytates, oxalates, carbohydrates and glycosides has been reported in the plant (Almahy and Nasir, 2011). Extraction and characterization of the seed oil of the plant revealed that it is quite rich in saturated and unsaturated fatty acids, such as myristic, palmitic, stearic, palmitoleic, oleic and linoleic acid (Gunstone, 1968).

CHAPTER THREE

3:0 MATERIALS AND METHODS

3:1 Study area

The study was conducted at the Equine and Camel Research Programme, National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika, Kaduna State, Nigeria. Shika is located in the Northern Guinea Savanna ecological zone and lies between Latitude 10°11'N and Longitude 7°8' E, at an altitude of 650m above sea level (Ovimaps, 2015). The area receives a mean annual rainfall of 1150mm which commences from May and last till October, of which 90% falls between June to September. Following the wet season is a period of dry cool weather called 'harmattan' which marks the onset of the dry season. This extends from mid-October to March. The dry season (October to May) is characterized by very hot weather conditions. At this period, the mean minimum and maximum temperatures range from 12 –28°C during the cold 'harmattan' season and 20 – 36°C in the hot season.

3.2 Sources of *Faidherbia albida* leaves

The fresh leaves of *Faidherbia albida* were obtained from NAPRI rangeland. The fresh leaves was cut and allowed to dry under shade. Branches were cut and twigs were removed before packing into the bags and stored until required for feed formulation.

3.3 Experimental Diets

Four (4) dietary treatments (Table 1) containing maize offal, wheat offal, cotton seed cake, bone meal, salt and premix at varying inclusion levels (0%, 10%, 20% and 30%) of dried *Faidherbia albida* leaves were formulated and used for the experiment.

3.4 Management of Animals and Experimental Design

Four (4) growing male camels with an average body weight of 228.51 kg were purchased from Mai'adua market in Katsina state and used for the study. The animals were dewormed orally with *Sambezole* suspension, sprayed with Amitrix against internal and external parasites, respectively. The animals were placed in a separate pen equipped with water and feeding trough. Animals were then randomly allocated to 4 treatments in a 4x4 Latin Square Design. The animals were fed the experimental diets containing 0, 10, 20 and 30% of dried *Faidherbia albida* leaves at 3% of their body weight on daily basis (Mohamed, 2007). The experiment comprised of four periods and each period lasted for 65 days followed by 7 days of total faecal and urine collection in each period. Animals were fed for 14 days as adaptation period in each phase of the experiment. At the end of the study, the camels were evaluated for growth performance, apparent nutrient digestibility, nitrogen retention, haematological parameters, blood metabolites and water consumption.

Table 3.1: Composition of the experimental diets fed to dromedary camels

Ingredients (%)	**Inclusion levels of dried *F. albida* dry leaves (%)**			
***F. albida* leaves**	**0**	**10**	**20**	**30**
Maize offals	43.86	39.20	35.07	30.63
Wheat offals	43.86	39.20	35.07	30.63
Cotton seed cake	5.53	4.86	3.11	2.00
Bone meal	5	5	5	5
Salt	0.25	0.25	0.25	0.25
Premix	1.5	1.5	1.5	1.5
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis				
Crude protein	14.31	14.43	14.34	14.41
ME: kcal/kg	1912	2028	2135	2214
Crude fiber	16.69	14.91	15.89	14.88
Ether extract	3.32	2.98	3.22	2.08
Ca: P ratio	1.8	1.8	1.8	1.8
Met+ cysteine	0.38	0.43	0.46	0.46

3.4.1 Growth performance

Feed intake was recorded throughout the experimental period and was determined by weighing the amount of feed offered to the animal and the refusal were collected and weighed before morning feeding. Animals were weighed at the beginning and fortnightly during each period of the experiment, using Steelyard Avery (Walk through) weighing scale. Weight gain was computed by subtracting initial weight from final weight. Average daily weight gain (ADWG) was determined by dividing weight gain by the number of days of the feeding trial (Abdel-wahed, 2014). Feed conversion ratio was also calculated on the basis of unit of feed consumed to unit of body weight gain.

3.4.2 Apparent Nutrients Digestibility

After the completion of sixty five (65) days feeding trial, a digestibility trial was conducted with the same animals and experimental diets. The digestibility and N balance was conducted by keeping the animals in their individual pen permitting separate collection of urine and faeces. Both faeces and urine were collected according to the method described by Mahmoud and El-Bana (2013).

3.4.3 Collection and Storage of Faeces and Urine

Faeces and urine from each animal were collected separately each day at the same time just prior to offering water and feeds. The total daily-excreted faeces of each animal was weighed and recorded. The faeces were mixed thoroughly and 10% was daily pooled for the experimental period per animal. Improvised harness bags (as shown in figure 2) was used to ensure total collection of the urine About 100 ml of H_2SO_4 (10%) was added to each urine

collection buckets daily to trap the nitrogen from escape as ammonia from the urine. Twenty (20) percent of the urine-voided daily per animal was sampled and pooled over the collection period. N-content was determined using the method of Kjeldahl by using procedures of A.O.A.C. (2004). The composite faecal samples were ovum dried at (65^0C) to a constant weight. Dried samples were ground through a 1 mm sieve and preserved for chemical analysis. The nutrients digestibility (%) was calculated using the formula reported by McDonald *et al.* (2002).

$$D\ (\%) = \frac{\text{Nutrient intake} - \text{Nutrient in faeces}}{\text{Nutrient intake}} \text{ x } 100$$

Where D (%) = Percentage digestibility.

Nitrogen utilization was calculated using the following formula:

$$NA = \text{Nitrogen intake} - \text{Faecal nitrogen}$$

$$NR = \text{Nitrogen intake} - \text{Faecal nitrogen} + \text{Urinary nitrogen}$$

$$\text{Nitrogen absorbed as percent intake} = \frac{\text{Nitrogen absorbed}}{\text{Nitrogen intake}} \text{ x } 100$$

$$\text{Nitrogen retained as percent intake} = \frac{\text{Nitrogen retained}}{\text{Nitrogen intake}} \text{ x } 100$$

Where NA= Nitrogen absorbed

NR = Nitrogen retained

3.4.4 Blood sample collection and evaluation

Evaluation of blood samples was carried out at the Ahmadu Bello University Teaching Hospital. Ten (10) ml of blood samples were collected from the jugular vein of each camel at the end of each period, with the use of 10ml plastic disposable syringes and placed into two separate sets of Vacutainer tubes; in which 7ml was placed into EDTA (Ethylene Diamine Tetra Acetic Acid) bottle while the remaining 3ml was placed into plain bottle. The anti-coagulated blood was used immediately for the determination of Erythrocyte count, Packed Cell Volume (PCV), Hemoglobin (Hb) concentration and Total Leukocyte count as described by Ewuola and Egbunike (2008).

3.4.5 Serum collection

The plain blood sample was allowed to clot by leaving it undisturbed at room temperature for 30 minutes. Clotted blood was removed by centrifuging at 1,000–2,000 x g for 10 minutes in a refrigerated centrifuge as described by Thavasu (1992). The serum was analyzed spectrophotometrically for sodium, potassium, urea, creatinine, total protein and albumin as described by Mohammed *et al*. (2007). Globulin was calculated by subtracting the concentration of albumin from the concentration of total protein as described by Coles (1974) and reported by Mohammed *et al.* (2007). Blood glucose level was determined by Coles (1974) method, using appropriate test kits.

3.4.6 Water consumption

Water evaporation was calculated by computation method in which a similar volume of water was placed in the experimental pen. The water was measured in the morning to

determine the volume of water evaporated (Shnitnikov, 2010). Water intake was measured for each camel during each day by measuring the volume of water offered and refusal was measured before feeding in the morning (at 8:00hr), taking into account the volume of water evaporated. However, to keep the water fresh throughout the day, it was changed twice daily at morning and afternoon as recommended by Hanan *et al*. (2014).

3.4.7 Laboratory analysis

Experimental diets were subjected to proximate analysis according to the method of A.O.A.C. (2004). The Nitrogen Free Extract (NFE) was calculated as NFE% = {DM – (EE% + CP% + CF% + ASH %). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined according to Goering and Van Soest (1970). Dried *F. albida* leaves were also analyzed for tannin, saponin and alkanoid at Food science laboratory, Institute of Agricultural Research, Samaru.

3.5 Data analysis

The data collected on weight gain, feed intake, nutrients digestibility, and N-retention were subjected to Analysis of Variance Procedure of Steel and Torrie (1980). Significant differences between means were separated using Dunette's Test (Dunette, 1955).

The model for the Experiment is presented below;

$\mathbf{Y_{ijk} = \mu + B_i + S_j + A_k + e_{ijk}}$

Where $\mathbf{Y_{ijk}}$ = Recorded observation

$\boldsymbol{\mu}$ = Overall Means

$\mathbf{B_i}$= Effect of the i^{th} treatment (0, 10, 20 and 30)

$\mathbf{S_j}$=Effect of j^{th} period (Four period)

$\mathbf{A_k}$= Effect of animal (Four animals)

$\mathbf{e_{ijk}}$ = Random error

CHAPTER FOUR

4.0 RESULTS

4.1 Chemical Composition of Experimental Diets

The chemical compositions of the dried *F. albida* leaves and experimental diets (containing 0, 10, 20 and 30% of *F. albida* leaves) used in this experiment are presented in table 4.1.1. The dry matter (DM) and crude protein (CP) content of the diets ranged from 91.16 to 90.82% and 14.69 to 16.19%, respectively. However, the CP content of diet containing 20% dried *F. albida* leaves was higher (16.19%) when compared with the other diets while diet containing 30% *F. albida* leaves has the least (14.69%). The crude fiber content of the diets ranged from 26.86 to 29.67%. Furthermore, the ether extracts (EE) and ash content of the diets ranged from 10.52 to 12.63% and 8.55 to 11.06%, respectively. While the acid detergent fiber (ADF) and neutral detergent fiber (NDF) obtained in the diets ranges from 24.58 to 36.64% and 44.92 to 50.29%, respectively. The nitrogen free extracts were calculated by subtracting the values of CP, CF, EE and Ash from DM and these values ranged from 24.57 to 28.63%. *Faidherbia albida* leaves were also analyzed in which the dry matter and crude protein content were 90.89% and 15.81%, respectively. The crude fiber, ether extract and ash content were found to be 21.57%, 9.91% and 7.84%, respectively whereas the neutral and acid detergent fibers were 66.51 and 59.89%. However, the tannin, saponin and alkaonid content of dried *F. albida* leaves were 2.05, 7.88 and 2.20%, respectively.

Table 4.1: Chemical composition of experimental diets and *F. albida* leaves

Parameters	Inclusion levels of dried *F. albida* dry leaves (%)				*F. albida* leaves
	0	**10**	**20**	**30**	
Dry matter	90.82	91.16	91.23	91.81	90.89
Crude protein	15.63	15.75	16.19	14.69	15.81
Crude fiber	28.16	29.67	26.98	26.86	21.57
Ether extract	12.63	12.03	12.04	10.52	9.91
Ash	8.55	9.14	8.73	11.06	7.84
ADF	24.58	31.59	35.44	36.64	59.89
NDF	44.92	50.29	47.83	50.20	66.51
NFE	25.85	24.57	27.29	28.68	35.76

ADF= Acid detergent fiber, NDF= Neutral detergent fiber, NFE= Nitrogen free extract

4.2 Effect of Diets on Growth Performance of Dromedary Camels

The results of effect of diets on growth performance of dromedary camels are presented in table 4.2. The animal's daily feed intake ranged 6.16kg to 6.57kg, with those on diet containing 20% dried *F. albida* leaves having a significantly (P>0.05) higher daily (6.57kg) feed intake as compared with those on the other diets. There were significant differences (P>0.05) differences in weight gain of animals with those on diet containing 20% dried *F. albida* leaves having a significantly higher weight gain (23.45kg). Better feed conversion ratio (18.21) was recorded in animals on diet containing 20% *F. albida* leaves.

4.3 Effect of diets containing graded levels of *F. albida* leaves on nutrient intake by dromedary camels.

The results of effect of varying levels of dried *F. albida* leaves on nutrient intake of dromedary camels are presented in table 4.3. There were no significant (P<0.05) differences in dry matter and nitrogen free extract intake (6.45, 6.24kg/day and 4.78, 4.14kg/day, respectively) of the animals on diets containing 20 and 30% dried *F albida* leaves. Animals on diet containing 20% dried *F albida* leaves recorded a significantly (P>0.05) higher crude protein when compared with those on the other diets.

Table 4.2: Effect diet containing of varying levels of dried *F. albida* leaves on performance of dromedary camels.

Parameters (kg)	Inclusion levels of dried *F. albida* dry leaves (%)				
	0	**10**	**20**	**30**	**SEM**
Initial weight	227.59	229.88	231.91	235.65	21.97
Daily Feed Intake	6.32[c]	6.16[d]	6.57[a]	6.42[b]	0.03
Final Body Weight	239.33[b]	238.32[b]	255.36[a]	252.66 [a]	4.05
Total Weight Gain	11.74[c]	8.44[d]	23.45[a]	17.01[b]	1.16
ADWG (g/day)	180.62[c]	129.85[d]	360.77[a]	261.69[b]	0.15
Feed Conversion Ratio	35.02[c]	47.44[d]	18.21[a]	24.53[b]	2.11

[a,b,c] Means in the same row with different superscript are significantly different (P<0.05), ADWG= Average daily weight gain, SEM= Standard Error of Mean.

Table 4.3: Effect of varying levels of dried *Faidherbia albida* leaves on nutrient intake of dromedary camels

	Inclusion levels of dried *F. albida* dry leaves (%)				
Parameters (kg/day)	**0**	**10**	**20**	**30**	**SEM**
Dry matter intake	5.62^{bc}	5.16^{c}	6.45^{a}	6.24^{ab}	0.40
Crude protein	1.24^{c}	1.03^{d}	2.27^{a}	1.85^{b}	0.03
Crude fiber	3.02	3.34	2.68	2.60	0.71^{NS}
Ether extract	1.18	0.94	0.93	0.81	0.20^{NS}
Ash	1.09	1.20	1.10	1.24	0.11^{NS}
NFE	3.42^{b}	3.51^{b}	4.78^{a}	4.14^{ab}	0.37

^{a,b,c}: Means in the same row with different superscript are significantly different, NFE=Nitrogen free extract, SEM= Standard Error of Mean NS=not significant

4.4 Apparent nutrient digestibility of dromedary camels

Table 4.4 showed the results of the nutrient digestibility of dromedary camels in the study. There were no significant ($P<0.05$) differences in dry matter (DM) and crude fiber digestibility of the animals on diets containing 0, 20 and 30% dried *F. albida* leaves. However, animals on diet containing 20 and 0% dried *F. albida* leaves recorded the highest (73.88 and 53.95%) crude protein (CP) and Ash digestibility, respectively.

4.5 Nitrogen utilization by dromedary camels

The nitrogen utilization of dromedary camels fed varying levels of dried *F. albida* leaves are presented in table 4.5. Nitrogen intake ranged from 562.45 to 799.85g/kg with animals on control diet having significantly ($P>0.05$) highest (799.85g/kg) nitrogen intake compared to those on the other diets. There were no significant ($P>0.05$) differences in total nitrogen excreted by the animals on diets containing 0 and 20% dried *F, albida* leaves. Animals on the control diet had the highest nitrogen absorbed, retained and nitrogen absorbed as percentage of intake compared with those on the other diets.

Table 4.4: Apparent nutrient digestibility of dromedary camels fed diets containing varying levels of dried *Faidherbia albida* dry leaves:

Parameters (%)	Inclusion levels of dried *F. albida* dry leaves (%)				SEM
	0	**10**	**20**	**30**	
Dry Matter	85.11[a]	81.41[b]	85.12[a]	83.98[a]	0.61
Crude Protein	69.17[c]	71.23[b]	73.88[a]	71.90[b]	0.84
Crude Fibre	60.64[ab]	54.68[b]	66.30[a]	68.87[a]	4.12
Ether Extract	69.19	70.54	70.93	66.00	3.91[NS]
Ash	53.95[a]	33.77[c]	37.13[c]	43.49[b]	4.70
NFE	69.72	65.33	68.83	71.30	3.40

[a, b, c] Means in the same row with different superscript are significantly different, NFE= Nitrogen free extrac,SEM = Standard Error of Mean NS=not significant.

Table 4.5: Nitrogen utilization by dromedary camels fed diets containing varying levels of dried *Faidherbia albida* leaves

Parameters (g/kg)	**Inclusion levels of dried *F. albida* dry leaves (%)**				**SEM**
	0	**10**	**20**	**30**	
Nitrogen intake	799.85[a]	562.45 [d]	738.65[b]	684.91 [c]	12.56
Faecal nitrogen	203.17[b]	166.85 [c]	222.90[a]	191.47 [b]	8.55
Urinary nitrogen	17.43	21.64	17.68	16.85	5.59[NS]
Total nitrogen output	220.60[ab]	188.49[c]	240.58[a]	208.32[bc]	10.19
Nitrogen absorbed	596.68[a]	395.60[c]	515.75[b]	493.44[b]	12.98
Nitrogen retention	579.25[a]	373.96[c]	498.08[b]	476.59[b]	11.72
NR as % intake	71.62[a]	65.27[c]	66.75[b]	69.32[ab]	1.65
NA as % intake	73.93[a]	69.46[c]	69.17[c]	71.89[b]	0.99

Key: a, b, c: Means in the same row with different superscript are significantly different, NR= Nitrogen retained, NA= Nitrogen absorbed, SEM =standard Error of Means NS=not significant

4.6 Blood metabolites of dromedary camels fed diets containing varying levels of dried *Faidherbia albida* leaves

The effect of diets containing varying levels of dried *F. albida* leaves on blood metabolites of dromedary camels are presented in table 4.6. There were no significant ($p>0.05$) differences in blood protein concentration of the animals on diets containing 10, 20 and 30% dried *F. albida* leaves. However, animals on control diet recorded a significantly ($P<0.05$) higher (5.50 mg/dl) ($P>0.05$) globulin content compared to those on other diets. There were no significant ($P<0.05$) differences in glucose level of animals on 0, 20 and 30% dried *F. albida* leaves. Furthermore, there were no significant differences in Triglycerides and urea concentration of the animals across the diets. Animals on diets containing 0 and 20% dried *F. albida* leaves recorded a statistically similar values (113.59 and 110.48mEg/l) for sodium concentration, respectively. Potassium and calcium levels were significantly ($P>0.05$) higher in animals on 0 and 10% dried *F. albida* leaves.

4.7 Blood haematology of dromedary camels fed diets containing varying levels of dried *Faidherbia albida* leaves

Table 4.7 showed the effect of diets containing varying levels of dried *F. albida* leaves on haematological parameters of dromedary camels. The white blood cells (19.19×10^9/L) and packed cells volume (31.79%) were significantly ($P>0.05$) higher in camels on diet containing 30% dried *F. albida* leaves compared with those on the other diets. However, there were no significant ($P<0.05$) difference in white blood cells of the camels fed on 0 and 30% dried *F.* albida leaves. However, the haemoglobin concentration ranged from 10.66g/dl to 11.43g/dl which were statistically similar in camels on diets containing 20 and 30% dried *F.* albida leaves. Animals on 30% dried *F. albida* leaves recorded a significantly ($P>0-.05$) higher (30.37% and 5.84%) percent neutrophils and esinophils, respectively. Percent lymphocyte in the blood ranged from 42.19 to 50.49% whereas percentage monocytes and

basophils ranged from 3.90 to 6.38% and 0.40 to 0.58%, respectively. However, higher (P>0.05) lymphocytes (50.49%), monocytes (6.38%) and basophils (0.58%) were observed in animals on diet 10, 30 and 0% dried *F. albida* leaves, respectively.

4.8 Water consumption and retention of dromedary camels fed diets containing varying levels of dried *Faidherbia albida* leaves

The results for water consumption and retention by dromedary camels in this study are presented in table 4.8. There were no significant (P>0.05) differences in total volume of water (litre/day) consumed by the camels across the diets. Animals on diets containing 20 and 30% dried *F.* albida leaves recorded a significantly higher volumes of water in faeces and urine per day compared to those on the other diets. However, there were also no significant (P>0.05) differences in daily volumes of water retained by the camels across the diets.

Table 4.6: Effect of diets containing varying levels of *F. albida* dry leaves on blood metabolites of dromedary camels

Parameters	Inclusion levels of dried *F. albida* dry leaves (%)				SEM	Ref. Val.
	0	10	20	30		
Total protein (g/dl)	8.45[b]	8.89[a]	9.63[a]	8.97[a]	0.39	4.9 - 10.2
Albumin (g/dl)	2.95[c]	3.55[b]	5.04[a]	3.48[b]	0.14	1.78 - 6.2
Globulin (mg/dl)	5.50[a]	5.29[b]	4.59[c]	5.19[b]	0.72	1.5 - 5.4
Glucose (mg/dl)	36.06[a]	33.55[b]	35.69[a]	36.20[a]	1.07	34 - 119
Creatinine (mg/dl)	0.95[b]	1.04[ab]	1.21[a]	0.99[a]	0.11	0.96 - 1.45
Triglycerides (mg/dl)	27.40	27.58	28.81	30.35	1.55	28 - 45
Urea (mg/dl)	40.22	42.56	42.72	38.78	4.20[NS]	15 - 45
Na (mEq/l)	113.59[a]	105.98[b]	110.48[a]	110.82[a]	2.47	100 - 190
K (mEq/l)	2.55[a]	2.15[b]	2.10[b]	2.20[b]	0.16	2.9 - 6.2
Ca (mg/l)	8.07[b]	9.17[a]	7.80[b]	7.91[b]	0.35	8.0 - 10.3

[a, b, c] Means in the same row with different superscript are significantly different. SEM =standard Error of Means , NS=not significant , Na= Sodium, K= Potassium, Ca= Calcium, SEM= Standard error of mean Ref. Val.= Reference Values. Osman and Al-busadah (2003), Farrooq *et al*. (2015)

Table 4.7: Effect of diets containing varying levels of dried *F. albida* leaves on blood haematology of dromedary camels

Parameters	Inclusion levels of dried *F. albida* dry leaves (%)				SEM	Ref. val.
	0	10	20	30		
WBC ($\times 10^9$/L)	13.01^{c}	9.21^{d}	14.41^{b}	19.19^{a}	0.39	12.1 - 25.3
RBC ($\times 10^9$/L)	7.92^{a}	6.53^{c}	6.98^{b}	7.79^{a}	0.14	5.1 - 9.1
PCV (%)	30.32^{b}	27.73^{d}	28.87^{c}	31.79^{a}	0.11	25 - 32.1
Hb Conc. (g/dl)	10.78^{b}	10.66^{b}	11.43^{a}	10.89^{ab}	0.28	9.2 - 14.1
Neutrophils (%)	29.51^{b}	23.23^{d}	27.67^{c}	30.79^{a}	0.52	22 - 48
Esinophils (%)	4.95^{b}	4.35^{c}	4.57^{c}	5.84^{a}	0.13	3.5 - 6.0
Lymphocytes (%)	44.56^{c}	50.49^{a}	49.28^{b}	42.19^{d}	0.52	41.2 - 56.4
Monocytes (%)	5.20^{b}	4.48^{c}	3.90^{d}	6.38^{a}	0.24	3 - 8
Basophils (%)	0.58^{a}	0.46^{b}	0.40^{b}	0.45^{b}	0.04	0.00 - 2.1

^{a,b,c} Means in the same row with different superscript are significantly different, WBC= White blood cells, RBC= Red blood cells, PCV= Packed cells volume, Hb Conc.= Haemoglobin concentration, SEM= Standard error of mean, Ref. Val.= Reference Value. Osman and Al-busadah (2003), Farrooq *et al*. (2015)

Table 4.8: Effect of diets containing varying levels of dried *F. albida* leaves on water consumption and retention of dromedary camels

Parameters (Liter)	Inclusion levels of dried *F. albida* dry leaves (%)				SEM
	0	10	20	30	
H_20 Consumed/day	7.46[b]	8.56	7.78	7.55	0.76
Vol. of Urine/day	0.45[c]	0.67[b]	0.51[a]	0.62[a]	0.01
Faecal H_20 Content/day	0.59[b]	0.93[ab]	0.82[b]	1.03[a]	0.06
H_20 Retained/day	6.42	6.96	6.45	5.91	0.56

[a, b, c:] Means in the same row with different superscript are significantly different. SEM =standard Error of Means Vol. = Volume, H_20= Water

CHAPTER FIVE

5.0 DISCUSSION

5.1 Composition of experimental diets

The chemical compositions of the experimental diets are presented in Table 4.1. The dry matter (DM) content of the diets ranged 90.82 to 91.81% with diet containing 30% level of dried *F. albida* leaves having the highest (91.81%) as compared to the other diets. This may be attributed to the high level of dried *F. albida* leaves in the diet. However, the DM values in this study were similar to the values (90-90% DM) reported by Chaudhary *et al.* (2008) in their study on feeding different dietary energy in dromedary camels. The crude protein (CP) content of diet containing 20% dried *F.* albida leaves was higher (16.19%) than the other diets. This is probably due to inclusion levels of wheat offals and or cotton seed cake. While diet containing 30% level of dried *F. albida* leaves had the least (14.69%) crude protein content, this may be associated with the low levels of cotton seed cake. The crude fibers (CF) content of the diets ranged from 26.67 to 29.67% and the highest CF content was obtained in diet containing 10% dried *F. albida* leaves which may be attributed to level of maize offals in the diets. Mahmoud and EL-Bana (2013) reported 15.5% ether extract content in their experimental diet fed to dromedary camels which was higher than the values (10.52 to 12.63%) recorded in this study. The Ash content in the experimental diets of the present study ranged from 8.55 to 11.06%. However, Adel and EL-Metwaly (2012) in their study on dromedary camels, reported ash content (experimental diets) of 10.00 to 13.67% which were slightly higher than the values reported in this study. The higher ash content of the diets in the present study is in agreement with higher minerals requirement of camel (Adel and EL-Metwaly, 2012). The acid detergent fiber and neutral detergent fiber ranged

from 24.58 to 36.64% and 44.92 to 50.29%, respectively. Nitrogen free extracts (NFE) content in the diets ranged from 24.57% to 28.68% and these values were lower than the values (29.27%, 33.76%, 42.39% and 31.37%) reported by Abdel-Wahed (2014). However, the differences may be attributed to differences in feed ingredients.

5.2 Effect of diets containing varying levels of dried *F. albida* leaves on performance of dromedary camels

The effect of diets containing varying levels of dried *F. albida* leaves on performance of dromedary camels were presented in table 4.2. There were significant differences (P>0.05) in daily feed intakes of the camels across the diets with those on diet containing 20% dried *F. albida* leaves having a significantly (P<0.05) higher (6.57kg) daily feed intake. This may be attributed to the level of dried *F. albida* leaves in the diet. Furthermore, as the level of dried *F. albida* leaves increased to 30%, daily feed intake of the camels decreased which may be attributed to the storage condition of the leaves. El-waziry *et al.* (2012) in their study on carcass characteristic and meat quality of four breed (Majaheem, Wodoh, Suffr and Sho'l) of camels recorded a lower daily feed intake of 4.73kg, 4.68kg, 5.24kg and 4.53kg, respectively when compared with the values obtained in this study. Differences in daily feed intake may be associated with the types of diets and or age of the animals. There were significant (P>0.05) differences in average daily weight gain of the camels across the diets with those on diet containing 20% levels of dried *F. albida* leaves having a significantly (P<0.05) higher (360.77g/day) daily weight gain. However, Adel and EL-Metwaly (2012) in their study on growth performance of dromedary camels recorded daily weight gains of 690, 940g/day, which were higher than the values obtained in this study. However, the lower daily weight gain obtained in this study may be attributed to the restriction of the camels to

single diet because dromedary camels diets consists mostly of foliage, dry grasses and desert vegetation (mostly thorny plant) (Sambraus, 2000). El-Waziry *et al.* (2012) also reported that camels are normally raised under extensive systems depending mainly on rangeland grazing rather than feedlot. There were significant differences in feed conversion ratio (FCR) of the camels across the diets with camels on diets containing 20% dried *F. albida* leaves having a significantly ($p<0.05$) higher (18.21) FCR as compared to those on the other diet. This may be attributed to better utilization of the diet by the camels.

5.3 Effect of varying levels of dried *F. albida* leaves on nutrient intake of dromedary camels

Table 4.4 showed the nutrient intake of camels fed diets containing varying levels of dried *F. albida* leaves. The daily dry matter intakes by dromedary camels ranged from 5.16kg to 6.45kg. Dry matter intake was significantly ($P>0.05$) higher in treatment. The higher (6.45kg) dry matter intake of the camels on diet containing 20 and 30% dried *F. albida* leaves may be attributed to the high level of dried *F. albida* leaves in the diets. However, the values obtained in this study agreed with the report of Kempton *et al.* (2012) that camels have a lower dry matter intake than cattle or horses. The authors reported that, camels typically consume only 2.5% of their body weight as dry matter compared with 3 to 4% body weight for horses and cattle. Contrarily, the camels on 0 and 10% dried *F.* albida leaves consumed lower (2.35 and 2.17% DM as percentage body weight) than the recommended 2.5%. This may be attributed to health status of the camels during the experimental period. The daily crude protein intakes of the camels ranged from 1.03kg to 2.27kg. However, crude protein intake was significantly ($p<0.05$) higher in diet containing 20% dried *F.* albida leaves compared to those on the other diets. Chaudhary *et al.* (2008)

also reported a crude protein intake of 1.30kg, 1.34kg and 1.37kg/day in their study on dromedary camels fed diets containing different energy levels. These values were slightly similar to the values obtained in this study. Daily crude fiber, ether extracts and ash intakes of the camels recorded in this study ranged from 2.60 to 3.34kg, 0.81 to 1.18kg and 1.09 to 1.24kg, respectively. There were no significant ($p>0.05$) differences in crude fiber, ether extracts and ash intake of the camels across the diet. The nitrogen free extract intake were significantly ($p<0.05$) higher in camels fed 20 and 30% levels of dried *F. albida* leaves which may be associated with the high level of the dried leaves in the diets.

5.4 Apparent nutrient digestibility of dromedary camels fed diets containing varying levels of dried *Faidherbia albida* leaves

Data concerning nutrients digestibility of dromedary camel's on diets containing varying levels of dried *F. albida* leaves are presented in Table 4.4. The results indicated that there were no significant ($P>0.05$) differences in dry matter (DM) digestibility of the camels on diet containing 0. 20 and 30% *F. albida* dry leaves. However, Abdel-Wahed (2014) in a study on effects of type of roughage and level of concentrate supplements on feed digestion and utilization in growing female dromedary camels recorded an average DMD of 76.66%. Similarly, Emmanuel *et al.* (2015), Adel and El-Metwaly (2012) reported a DMD of 57.53% and 73.94%, respectively. All these values were lower compared to the values obtained in the present study. Therefore, the high dry matter digestibility recorded in this study might be attributed to the levels of dried *F. albida* leaves in the diets or it could be linked to the provision of diet reach in protein which might have boosted microbial digestion (Moges *et al*., 2016). Crude protein digestibility (CPD) was significantly ($P<0.05$) higher in camels on diet containing 20% level of dried *F. albida* leaves compared to those on those on the other

diets. This may be attributed to high level of crude protein in the diet. Average CPD of 70.10 and 69.17%, were reported by Adel and El-Metwaly (2012) and Abdel-Wahed (2014), respectively. These values were all slightly similar to the values obtained in this study. However, the higher CPD recorded in this study may be attributed to the level of dried *F. albida* leaves in the diets. There were significant ($p<0.05$) differences in crude fiber digestibility of the camels across the diets with those on diet containing 20 and 30% dried *F. albida* leaves having a significantly higher CFD as compared to those on the other diets. However, diets containing 20 and 30% dried *F. albida* leaves had the least crude fiber content but recorded the highest CFD of 66.30% and 68.87%, respectively. These suggest that 27% CF is the most acceptable level for efficient utilization of the fiber in the diet. Furthermore, the higher CFD recorded in camels on diets containing 20 and 30% dried *F. albida* leaves agreed with the report of Wilson (1998) who stated that camel perform better when consumed feed which is low in fiber such as the leaves of browse plants.

5.5 Nitrogen utilization of dromedary camels fed diets containing varying levels of dried *Faidherbia albida* leaves

Nitrogen utilization of dromedary camels offered diets containing varying levels of dried *F. albida* leaves are presented in Table 4.5. Data for nitrogen intake by camels ranged from 562.45 to 799.85g/kg. There were significant ($P<0.05$) difference in nitrogen intake across the diets with camels on control diet having the highest ($p<0.05$) (799.85g/kg) nitrogen intake followed by those on 20 (738.65g/kg) and 30% (684.91g/kg) levels of dried *F. albida* leaves. The differences in nitrogen intake may be associated to the high level of cotton seed cake and wheat offals in the diet. Camels on control diet recorded a significant ($P<0.05$) higher nitrogen absorbed, nitrogen retained, nitrogen retained as percentage intake and

nitrogen absorbed as percentage intake compared to those on the other diets. This may be attributed to high level of cotton seed cake and or higher levels of maize and wheat offals in the control diet.

5.6 Effect of diets containing varying levels of dried *F. albida* leaves on blood metabolites of dromedary camels

Results on the effect of diets containing varying levels of dried *F. albida* leave on blood metabolites of camels are presented in Table 4.6. There were no significant ($p>0.05$) differences in blood proteins and globulin concentration of the camels on diets containing 10, 20 and 30% dried *F. albida* leaves. These may be associated with the levels of dried *F. albida* leaves in the diets. Adel and El-Metwaly (2012) in their study on dromedary camels reported an average total protein of 9.22g/dl which were slightly similar to the values obtained in this study. However, the values for total protein recorded in this study were within the normal reference values reported by Osman and Al-Busadah (2003) and Farooq *et al*. (2011). The higher (5.50mg/dl) globulin concentration recorded by camels on the control diet may be associated with the high level of cotton seed cake and wheat offals in the diet. Animals on 20% level of dried *F. albida* leaves recorded a significantly ($p<0.05$) having (5.04g/dl) albumin compared with those on the other diets. However, the values for albumin obtained in this study were within the reference values reported by Farooq *et al*. (2011). Camels on diets containing 0, 20 and 30% dried *F. albida* leaves had the highest ($p<0.05$) glucose levels and are within the reference values. The creatinine content in the camel's blood ranged from 0.95 to 1.21mg/dl. However, there were significant ($p<0.05$) differences in creatinine levels in the blood with camels on diet containing 20% level of dried *F.* a*lbida* leaves having a significantly ($p<0.05$) higher (1.21mg/dl) creatinine level.

The values for creatinine obtained in this study were similar to the values (0.97, 1.08 and 1.09mg/dl) reported by Adel and EL-Metwaly (2012). However, the values obtained in this study were within the ranged reported by Osman and Al-Busadah (2003). The triglycerides level obtained in this study ranged from 27.40 to 30.35(mg/dl) and there were no significant ($p>0.05$) differences observed across the diets. The urea and sodium levels in the blood ranged from 38.78mg/dl to 42.56mg/dl and 105.28mEq/l to 113.59mEq/l with no significant ($p>0.05$) differences in urea concentration of the camels blood across the diets. The values for blood urea obtained in this study agree with the report of Eggun (1970) who stated that the blood urea content increased with the protein content in the diet. The values for potassium and calcium levels in the blood range from 2.15mEq/l to 2.55mEq/l to 7.91mg/l to 9.17mg/l, respectively. Babeker *et al.* (2013) reported potassium levels of 2.04 mEq/l, 2.25mEq/l, 7.19mEq/l and 4.70mEq/l. However, the potassium levels recorded in the present study were within the ranged provided by Bogin (2000). Camels on diet containing 10% dried *F. albida* leaves had a significantly ($p<0.05$) higher (9.17mg/l) calcium level as compare to those on the other diets. The calcium levels reported in this study were within the normal range of 8.0- 10.3mg/dl Osman and Al-Busadah (2003).

5.7 Effect of diets containing varying levels of dried *Faidherbia albida* leaves on blood haematology of dromedary camels

Table 4.8 showed the effect of diets containing varying levels of dried *F. albida* leaves on haematological parameters of dromedary camels. The white blood cells (WBC) ranged 13.01×10^9/L to 19.19×10^9/L with camels on diet containing 30% level of dried *F. albida* leaves having a significantly ($p<0.05$) higher (19.19×10^9/L) WBC when compared with camels on the other diets. The values of WBC obtained in this study are within the ranged

values of 11.97 $\times 10^9$/L and 11.54 x 10×10^9/L reported by Ahmad *et al*. (2004) and Alsaad (2009), respectively. The values recorded in this study were within the ranged (12.1-25.3$\times 10^9$/L) reported by AL-Busadah and Abdel-Gadir (2004). The values of red blood cells (RBC) and packed cell volume (PCV) recorded in this study ranged from 6.53$\times 10^9$/L to 7.92$\times 10^9$/L and 27.73% to 31.79%, respectively. However, there were significant ($p<0.05$) differences in RBC and PCV of the camels across the diets. Camels on diets containing 0 and 30% levels of dried *F. albida* leaves had a statistically similar values of RBC in the blood while camels on 30% level of dried *F. albida* leaves recorded the highest ($p<0.05$) PCV as compared to those on the other diets. These values for RBC obtained in this study are in line with the findings of Ahmad *et al.* (2004) who reported mean red blood cells of 6.93$\times 10^9$/L. Relatively similar values of 7.40$\times 10^9$/L and 7.92 $\times 10^9$/L of RBC have been reported by Al-Sultan (2008) and Alsaad (2009), respectively. Hence, the variation in red blood cells of the camels in this study may be associated with the levels of dried *F. albida* leaves and or health status of the animals (Al-Sultan, 2008). However, the RBC values were within the ranged reported by AL-Busadah and Abdel-Gadir (2004). The increase in PCV of camels on diet 10, 20 and 30% were attributed to the increase in dried *F. albida* leaves in the diets. The PCV values recorded in the present study were also within the ranged provided by Osman and Al-Busadah (2003).

The values of haemoglobin concentrations obtained in the present study ranged from 10.66 g/dl to 11.43 g/dl with camels on diets containing 20 and 30% levels of dried *F. albida* leaves having a significantly higher (11.38g/dl and (10.89g/dl)) haemoglobin concentration as compared to those on the other diets The values for haemoglobin concentration of the camels across the diets were within the ranged (9.2- 14.4g/dl) provided by Farooq *et al*.

(2011). The percentage neutrophils obtained in this study ranged from 23.33 to 30.79%. However, there were significant ($P<0.05$) differences in percentage neutrophils of the camels. The values of percentage neutrophils obtained in this study were within the range (22- 48%) provided by Bogin (2000) in his study on camelids.

The percentage esinophils and lymphocytes obtained in this study ranged 4.35% to 5.84% and 42.19% to 50.49%. There were significant ($p<0.05$) differences in percentage esinophils and lymphocytes of the camels across the diets with camels on diet containing 30% and 10% having a significantly ($p<0.05$) higher percentage esinophils (5.84%) and lymphocytes (50.49%), respectively. However, the percentage esinophils obtained in the present study were similar to the mean values (4.42%, 3.92% and 4.97%) of esinophils documented by Aichouni *et al.* (2010). The values obtained for percentage esinophils in this study were within the ranged (3.5-6.0%) reported by Bogin (2000). Mohammed (2012) in his study on some haematologic values and serum biochemical parameters of dromedary camels reported percentage lymphocytes of 40.00%, 45.00%, 50.00% and 54.00%. The variation in percentage lymphocytes may be associated with the levels of dried *F. albida* leaves. The percentage monocytes and basophiles recorded in this study ranged from 3.90% to 6.38% and 0.40 to 0.58%. There were significant ($p<0.05$) differences in both percentage monocytes and basophiles (%) across the diets with animals on diets containing 30% and 0% levels of dried *F. Albida* leaves having the highest ($p<0.05$) (6.38% and 0.58%) percentage monocytes and basophiles, respectively. Differences in percentage basophils may be attributed to differences in diets and or levels of dried *F. albida* leaves in the diets.

5.8 Effect of diets containing varying levels of dried *F. albida* leaves on water consumption and retention of dromedary camels

The water consumption and retention by dromedary camels fed diets containing varying levels of dried *F. albida* leaves are presented in Table 4.8. There were no significant differences in daily water consumed and retained by the camels across the diets. However, the volume of urine voided were significantly ($p<0.05$) higher in camels on diets containing 20 and 30% dried *F. albida* leaves. Camels on 10 and 30% levels of dried *F. albida* leaves recorded significantly higher faecal moisture compared to those on the other diets.

CHAPETR SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

This study was carried out to evaluate the growth performance and nutrient digestibility of dromedary camel fed diets containing varying levels of dried *Faidherbia albida* (*F. Albida*) leaves. Four male camels weighing on average 228.51kg were randomly allocated to 4 diets containing 0, 10, 20 and 30% dried *F. Albida* leaves in a 4x4 Latin Square Design. The experiment comprises of four periods and each period lasted for 65 days. The animals were weighed at the beginning and fortnightly using Steelyard Avery weighing scale. At the end of each period, digestibility and nitrogen balance was conducted. Blood sample was collected from each animal at the end of each period through the jugular vein of using disposable plastic syringes. Water consumption and retention by the camels were measured. The result showed that dried *F. albida* leaves added to camels diets at 20% inclusion level recorded the best in dry matter intake, average daily weight gain and feed conversion ratio. No health hazard on the camels as evident from the results of haematology and blood chemistry profiles. The metabolism trial showed that the diets were highly digestible and resulted in relatively higher nitrogen retention by the camels.

6.2 CONCLUSION

It could be concluded that;

- Dried *Faidherbia albida* leaves added to the camels diets at 20% inclusion level gave the best dry matter intake, average daily weight gain and feed conversion ratio.
- It could be concluded that up to 30% drie*d Faidherbia albida* leaves in camels feed has no health hazard on the camels as evident from the result of haematology and blood chemistry profiles.
- The results indicated that despite camel's selectivity and unique adaptation to arid and semi-arid condition, they could be confine and raise under the Northern Guinea Savannah of Nigeria.

6.5 RECOMMENDATION

From the results of this study, it is therefore recommended that camel's famers should;

- Incorporate dried *F. albida* leaves in camels feed at 20% inclusion level.
- Further research should be conducted on the use of other browse plants and or *F. albida pods* as feed for camels.
- Camel farmers, stock owners and research institute should harness the potential of *F. Albida* tree as a feed resource for camels through massive planting of the tree.

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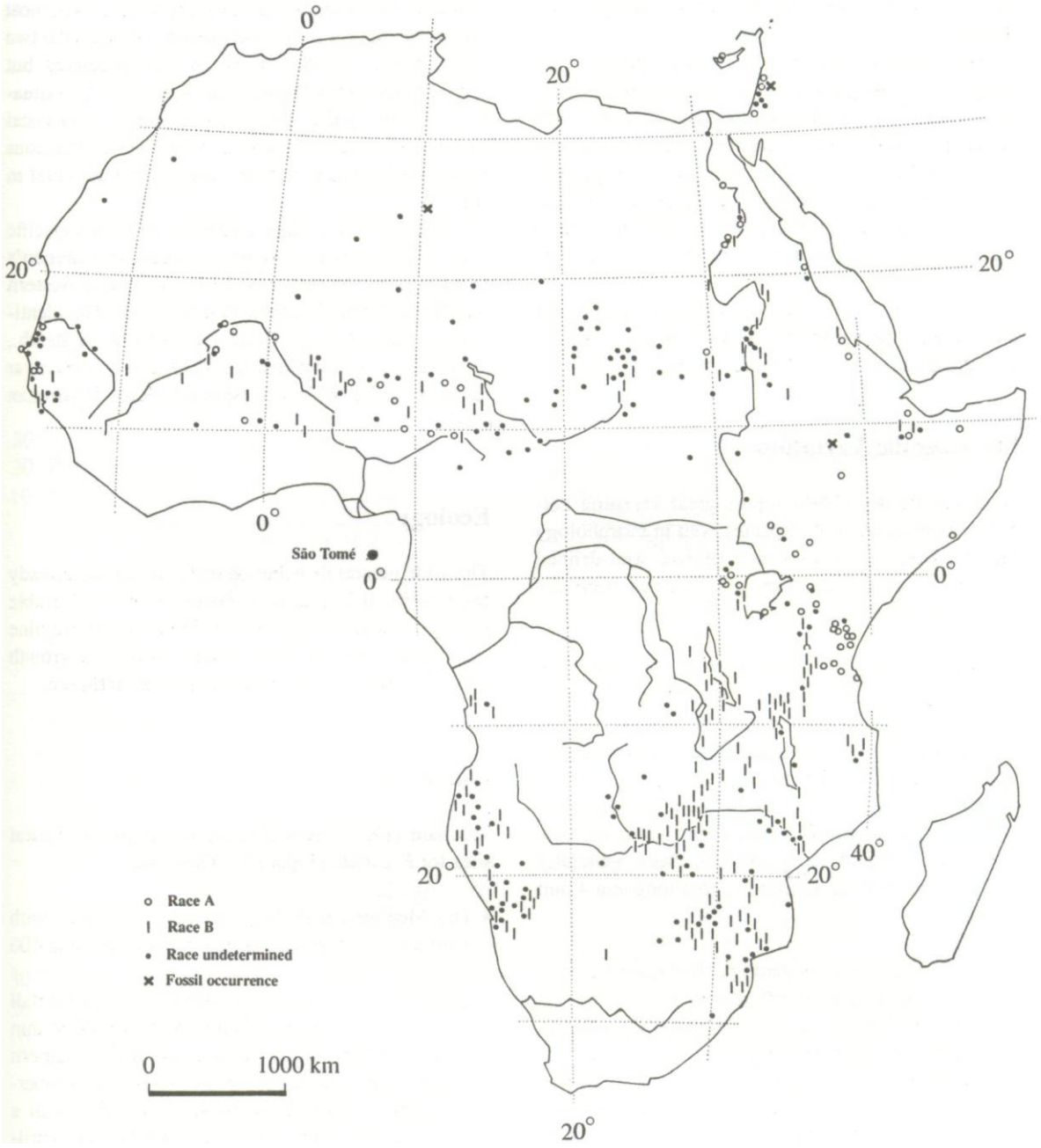


Figure 1: Distribution map of *Faidherbia albida.* (Source CTFT, 1989)



Figure 2: Preparation for urine collection

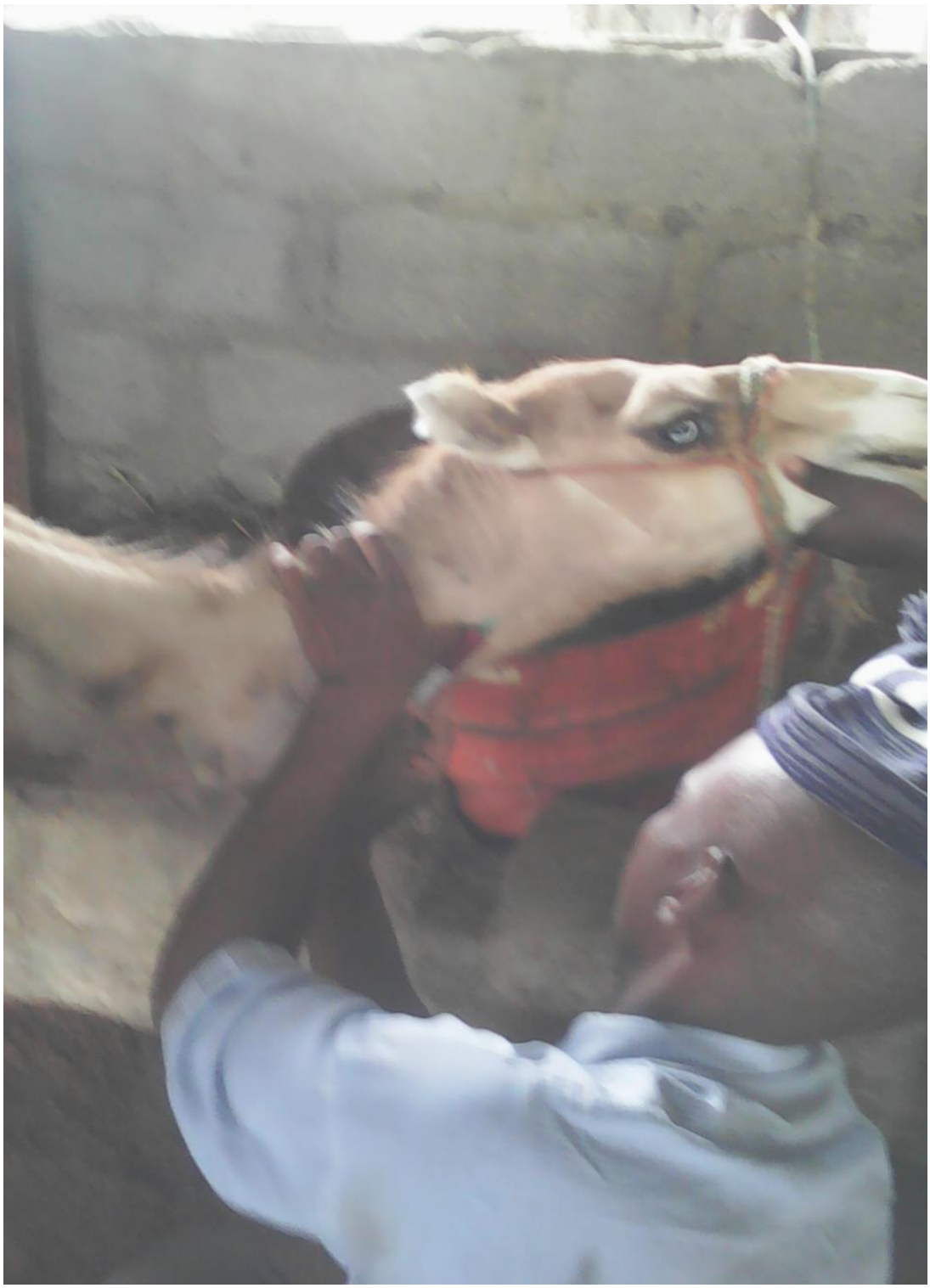


Figure 3: Preparation for blood collection