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Contribution of Browsing on Livestock Feeding in Abu Zaid Forest-East Nile Locality-Khartoum State

مساهمة الرعي الشجري في تغذية الثروة الحيوانية في غابة ابو زيد– محلية شرق النيل– ولاية الخرطوم

Dissertation Submitted for Partial Fulfillment of the Requirement of the M.Sc. Degree in Range Science

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Dedication

To my mother

To my father

To that man who lighten my life:

My husband

To my children

To those that closed to me my colleagues

For all those I gift the research and simple effort

Majda

Acknowledgment

I would like to convey my deep thanks to my supervisor Dr. Mohammed Ibrahim Abdelsalam for his great assistance and the presented effort which he gave me to light way to continue my success. My great thank to my family in North Darfur State especially my sister Monira. All my thanks extend to my husband for his help and encouragement. I would like to express my sincere gratitude to my colleagues, who assisted me during field work Ahmed Eltiab, Hafsa Ahmed and Safia Ali.

ABSTRACT

The study was conducted in Sharg El Neel locality El Khartoum state in Abu ziad forest. The study aimed to assess the role of browse trees for livestock feeding in the area. The sampling in trees was selected randomly by using Global Positioning System (GPS), was select 10 Feddan which be equivalent 1% of the study area, the samples were distributed along transect of 100m. The study measured the following measurement; Trees density, Browsing level, Diameter at browsing point, Determination of available browsing productivity, Crown area, Stem diameter. Also organic matter of browse was analyzed by using the Near Infrared Spectrometer (NIR) to determine the forage quality. SAS statistical analysis system was used using Duncan's procedure to separate the means. . The study found that the relative density of *Acacia ehrenbergiana* (Salam) was high density it reached about 120 tree/ha, in contrast, *Acacia tortilis subsp tortilis* (Sammar) recorded less density, reaching only 38 tree/ha. The mean diameter of twig at browsing point of *Acacia ehrenbergiana* (Salam) was 1.87 mm, while *Acacia tortilis subsp tortilis* twig diameter at browsing point was 1.6 mm. It was concluded that there was variation of tree height among tree species, *Acacia ehrenbergiana* (Salam) recorded high browsing level (2.68m) compared *Acacia tortilis subsp tortilis* browsing level (1.77m). The study recommended that the *Acacia erenhergiana* and *Acacia tortilis subsp tortilis* were dominant species should be managed sustainably and considered in the management process.

ملخص الدراسة

أجريت هذه الدراسة في غابة ابو زيد محلية شرق النيل ولاية الخرطوم. هدفت الدراسة لتقييم مساهمة الرعي الشجري في تغذية الحيوان بالمنطقة. تم اجراء قياسات الرعى الشجري، وتم تحديد نقطة البداية بطريقة عشوائية. تم اختيار العينات عشوائيا بإستخدام نظام تحديد المواقع العالمي (GPS)، حيث تم اختيار ١٠ فدان تمثل حوالي ١% من منطقة الدراسة، تم توزيع العينات قاطع بطول ١٠٠ متر. حيث تم إجراء القياسات التالية: الكثافة الشجرية النوعية، مستوى الرعي الشجري، القطر عند نقطة القضم، قطر الساق، مساحة التاج، إنتاجية العلف الشجري المتاح وتحليل المادة العضوية للعلف المنتج بجهاز NIR. تم استخدام برنامج SAS الإحصائي بإستخدام طريقة دانكان Duncan procedure لفصل المتوسطات. وجدت الدراسة أن الكثافة النسبية لشجرة السلم (*Acacia ehrenbergiana*) كانت عالية إذ وصلت حوالي ١٢٠ شجرة/هكتار على عكس من شجرة السمر (*Acacia tortilis subsp tortilis*) التي سجلت أقل كثافة بلغت فقط ٣٨ شجرة/هكتار. متوسط قطر القصن عند نقطة القضم لشجرة السلم (*Acacia ehrenbergiana*) بلغ ١.٨٧ ملم بينما بلغ في شجرة السمر ١.٦ ملم. خلصت الدراسة إلى وجود إختلاف في إرتفاع الأشجار بين نوعي الأشجار، حيث سجلت شجرة السلم أعلى مستوى رعي شجري ٢.٦٨ متر بالمقارنة مع مستوى الرعي الشجري لشجرة السمر ١.٧٧ متر. أوصت الدراسة بإدارة شجرتي السلم والسمر السائدتان في المنطقة، كما يجب أن توضع في الإعتبار في عمليات الإدارة.

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CHAPTER I

INTRODUCTION

1.1 General:

Rangelands are grassland, shrubland, woodland, wetland, and deserts that are grazed by domestic livestock or wild animal, (FAO, 2007). Range constitutes an important land based resource for several reasons, the most important of which may be their wide distribution. Rangelands ecosystem are a complex set of interactions between soil, water, air, plant, and animal resources; temperature; topography; fire, and humans. Rangeland covered vast area of the globe and is considered a major source of cheap feed for livestock and wildlife habitat, depending upon the management applied, some of the benefits and services that are derived or directly obtained like (water for domestic) livestock products, flood protection, recreation, wood products minerals, and ecological continuity. The rangeland contributes the goods and services of human (Holechek *et al*, 2011). In Sudan rangeland occupies an area of 31.5% million hectares and provides about 70% of the total animal feed requirement for national herds (ELwakeel, 2013 cited by Abdelsalsm *et al*, 2017). The type of vegetation in the Sudan starting from North to South included Desert, Semi-desert, Low rainfall woodland savannah (Low rainfall woodland savannah on clays, Low rainfall woodland savannah on sands, Low rainfall woodland savannah on special areas), High rainfall woodland savannah, Flood plain, Montance vegetation. Rangelands dominate these areas, providing primary products of grasses, legumes and browse from shrubs and scattered trees in some area. (Abusuwar, 2007).

Over the years climate change and variability has impacted negatively on the ability of the local ecosystems to faithfully meet the ever increasing demand for feed resources for their animals. Therefore, the most important role of browse has been to provide valuable fodder when grasses and other herbaceous material is dry and it provides the only source of protein and energy during drought (Lefroy *et al.*, 1992). Browse species also provide fuel and shelter and are used in soil and water conservation. (Orwa *et al.*, 2009). Ecologically the study area classified as semi desert *Acacia tortilis*, desert shrub and semi desert grassland on clay, (Harrison and Jackson

1958). This study was tried to understand the role of browsing trees to fulfill the gab of fodder in semi-arid areas, on East Nile area, Khartoum state.

1.2 Problem Statement:

The browsing is very important to provide forage to livestock, especially on period scarcity of understory during dry season. Due to limited of rainfall and seasonality of understory, the browse trees provide forage during the summer. There were villages led to over grazing and deterioration of rangeland to comprise decrease in vegetation cover in study area.

1.3 Objectives:

1.3.1 General Objective:

To investigate the role of browse trees on providing forage for livestock in East Nile, Khartoum State.

1.3.2 Specific Objective:

1 - To identify the source of browse trees.

2- To determine the available browse forage productivity.

3- To determine the quality of browse forage.

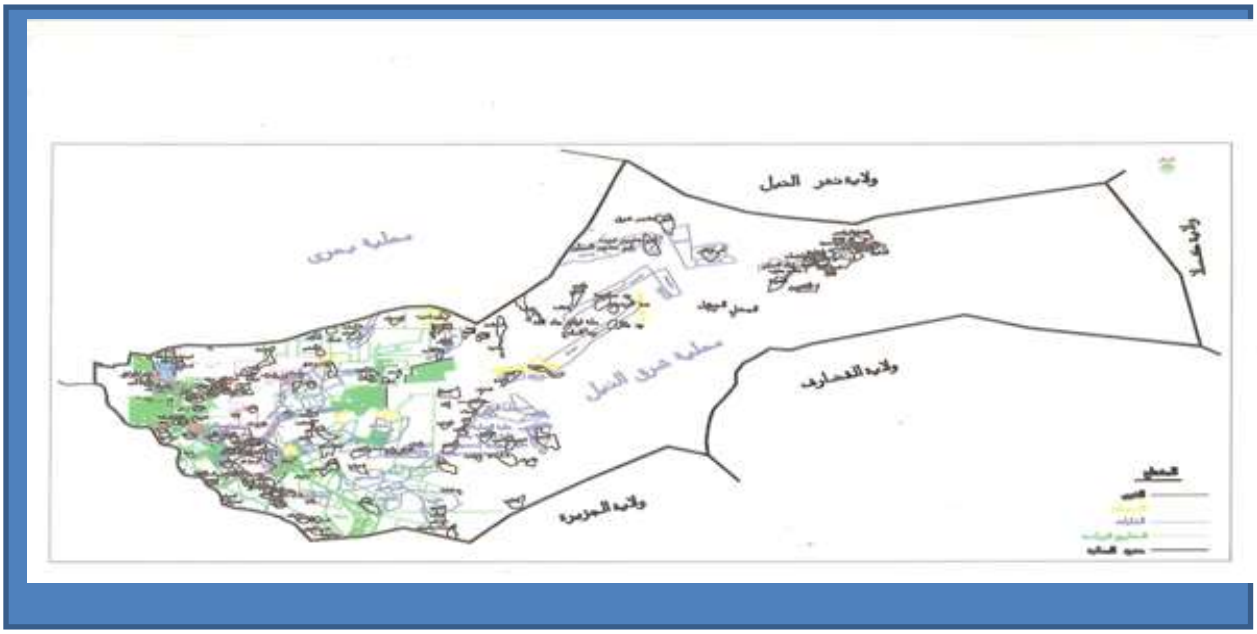
1.4 Research Questions:

- How to determine the available forage browse productivity?
- Why are the important of browse trees?
- What is the contribution of browsing to the availability of forage?
- What is the quality of browse forage?

1.5 Study Area:

1.5.1 Location:

This study was conducted in Sharg El Neel locality El Khartoum state in Abu ziad forest, protected area about 1000 Feddan, which was fenced by state department of agriculture and livestock, administration of range and fodder Which was located in semi-arid zone,(15˚ 15□-16˚ 13˚ N and 32˚ 37□-34˚ 23□ E), the annul precipitation ranges between 75and300 mm. (Annual report 2018).



1.5.2 Soil and Topography:

The eastern part of Khartoum State, where the study was conducted, is a flat plain with frequent undulation. Soil type vary from Nile site along the Nile banks to dark cracking clay plains bisected by depressions and seasonal water courses covered with pale yellowish - white coarse sand and small gravel. (Dawe, 2009).

1.5.3 Vegetation Cover:

Ecologically the study area is classified as semi desert, radiana sayal, (*Acacia tortilis*) sub spp (Samur and Salam).Grasses include *Indigofera hochstetteri, Aristida spp* and *Dacelochtennim aegyptium* (umasabie). (Dawe, 2009).

1.5.4 Climate:

The area is classified as semi-desert zone with hot tropical climate, the rainfall about 75 to 160 mm mainly falling during August and September. The range of temperature between 21.6℃ in winter and 37.70℃ in summer. Due to low rainfall and the short rainy season, agriculture is mainly of the irrigated type. Agricultural schemes are distributed along the banks of the River Nile and its tributaries, 50% of the cultivated areas are in the East Nile locality (Dawe, 2009).

1.5.5 Water resource:

The main sources of water supply is surface water from Blue Nile, the other source are ground water and open ponds (Annual report 2018).

CHAPTER II

LITERATURE REVIEW

2.1 Rangelands:

Rangelands are a broader term than grasslands, including regions where woody vegetation is dominant; moreover, it is a term common in texts looking at land from the viewpoint of livestock production. Rangeland covers vast areas of the global and is considered a major source of cheap feed for livestock and wildlife habitat. The rangeland plays a vital role in providing human with the goods and services, (Holechek, *et al.,* 2011). It considers as renewable natural resources if managed scientifically, they give multiple products according to their energy innovation. Therefore, must be exploited by this energy to maintain them and sustain for future generations. To achieve this situation we need a sound management plan adopts the principle of sustainability and integration of natural resource in a manner, preserve and protect it for the reasons for the different degradation causes .In Sudan rangeland occupies an area of 31.5% million hectares and provides about 70% of the total animal feed requirement for national herd (ELwakeel, 2013 by Abdelsalsm *et al.*, 2017).

2.2 The importance of Rangelands:

Range constitutes an important land based resource for several reasons, the most important of which may be their wide distribution, and supporting indigenous or introduced vegetation that is either grazed or has the potential to be grazed and is managed as a natural ecosystem, and provides significant environmental and agricultural services to people though climate change amelioration, clean water and air, wildlife habitat, recreational use, livestock grazing and many others when they are managed properly,(Abdelsalam *et al.,* 2012).

2.3 Browse:

Browse is a term referring to the tender shoots, twigs, and leaves of shrubs and trees that are eaten by livestock (Chriyaa, 2009). Several studies have shown that browse trees and shrubs play a significant role, mostly as supplements, in the nutrition of livestock in the arid and semi-arid lands of the world (Le Houérou, 1980). Over the years climate change and variability has impacted negatively on the ability of the local ecosystems to faithfully meet the ever increasing demand for feed resources for their animals. Acacia seyal tree is one of the most potential fodder sources for livestock in Sudan. The pods and leaves of Acacia seyal are nutritious and palatable to livestock (Orwa *et al.,* 2009).

Browse production is influenced by many factors such as the climate, soil type, management and history of exploitation by man and animals (Chibinga *et al.,* (2012). Data on browse fodder available and accessible to the ruminants are rare. One of the main reasons is the lack of standardized methodologies to evaluate the production of woody forage and their consumption compared to what can be done in corresponding research on herbaceous pasture (Sanon *et al.,* 2005). Despite the wide use of the indigenous browse species, little has been documented with regard to the Knowledge of browse in term of availability, utilization and other related information under Sudan condition (Abdalla *et al.*, 2017).

2.4 The Importance of Browse Trees:

The importance of browse is universal throughout the tropics, where it serves as a major feed resource, especially in the drier regions and during dry seasons. During these periods, grasses, which are the major feed resource for livestock, dry up and deteriorate both in quality and productivity, (De Leeuw and Brinckman, 1974). Trees are important for two purposes .The first, environmental protection (including soil fertility maintenance), is conservation- oriented. Watersheds, windbreaks, erosion barriers, forest reserves, and planted fallows are all strategies of conservation. The second purposes is produce-oriented and demands that trees be exploited .This, therefor, includes the harvest of trees as timber ,fodder, poles and fuel wood. Unfortunately, the balance between conservation and produce-use objective has favoured the latter at the expense of the former, (Rothenberg, 1980). In

tropical Africa, trees occupy a significant nich in the life of the people. The dominant farming system, shifting cultivation or bush fallow rotation, is based strongly on the conservation and regenerative properties of trees (Nye and Greenland, 1960).). In the tropics, browse plants have been found to be of significant potential in terms of adoptability, productivity and acceptability for ruminants in order to balance the difficulties of feed shortages during the dry season, (Hutagalung, 1981).

Browse quality and availability vary greatly from wet season to dry season which invariably affects productivity level of animals. Thus, browse plants constitute one of the cheapest sources of feed for livestock, especially ruminants in the tropics, and are good sources of essential nutrients such as proteins, carbohydrates, vitamins and minerals which are frequently inadequately represented in tropical grass pastures. Ruminants, especially sheep and goats but more likely goats can adapt to a wide variety of browse plants. In many tropical environments, these small ruminants roam free and eat variety of browses, especially during the dry season when green forages particularly grasses are less nutritive as a result of lignification, (Achonwa *et al.*, 2017).

2.5 Importance Source of Browse Trees:

*Acacia tortilis (*Seyal).
*Acacia seyal (*Talih).
*Acacia mellifera (*Kitir).
*Acacia raddiana (*Seyal).
*Acacia senegalensis (*Hashab).
*Grewia yenax (*Gudiam).
*Balanites aegyptiaca (*Heglig).
*Faidherbia albida (*Haraz).
*Ziziphus spina-christi (*Sidir). (Abdalla 2008).

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2.6 Browsing:

Browsing is a type of herbivores in which a herbivore (or, more narrowly defined, a folivore) feeds on leaves, soft shoots, or fruits of high-growing, generally woody plants such as shrubs This is contrasted with grazing, usually associated with animals feeding on grass or other lower vegetation's . Alternatively, grazers are animals eating mainly grass, and browsers are animals, eating mainly non-grasses, which include both woody and herbaceous dicots. In either case, examples of this dichotomy are goats (which are browsers) and sheep (which are grazers) these two closely related ruminants utilize dissimilar food sources. These two closely related ruminants utilize dissimilar food sources (Chapman and Reiss, 1999).

2.7 Over-browsing:

Over browsing occurs when overpopulated or reducing concentrated herbivores exert extreme pressure on plants, reducing the carrying capacity and altering the ecological functions of their habitat. Over-browsing impacts plants at individual, population, and community levels. Over-browsing can lead to the loss of reproductive in a population, and lack of recruitment of young plants. Plants also differ in their palatability to herbivores. At high densities of herbivores, plants that are highly selected as browse may be missing small and large individuals from the population (Augustine and Decalesta, 2003).

2.8 Characteristics of Browse:

With the increasing demand for livestock products as a result of rapid growth in the world economies and shrinking land area, the future hope of feeding the millions of future generations and safeguarding their food security will depend on the better utilization of hither to neglected food and feed resources (Makkar, 2002) . This understanding has over the past few decades rekindled research interest in the use of indigenous browse plants as sources of nutrients for livestock in many tropical environments (Okoli *et al.*, 2014). Although the diversity and nutritional values of these indigenous browse species may be well known to local livestock farmers, animal nutrition is usually limited by their poor intake, high fibre content and, in some cases the presence of toxic factors or metabolic inhibitors such as

cyanogens, alkaloids, saponins and tanins, low digestibility, low nutrient content and subsequent low animal performance. There is therefore the need to properly assay the nutritional, physicochemical and toxicological potentials of novel candidate tropical feedstuffs such before they could be promoted as fodder of commercial value in ruminant animal production or raw materials for monogastric animal feeds formulation (Achonwa *et al.*, 2017).

Indigenous fodder trees and shrubs remain green at critical times of the year (Balehegn *et al.*, 2012) and produce large quantities of year round fodder which are regarded as unconventional feed sources. The year round availability of these unconventional fodders when incorporated to ruminant diets planning help to tackle the effects of poor nutrition which usually manifest as loss of weight and conditions, reduced reproduction capacity, increase mortality rate, poor carcass quality among ruminants reared in many tropical environments (Kubkomawa, 2016).

2.9 Browse Utilization by Ruminant Animals:

Characterized ruminant animals as browsers, intermediate feeders, or grazers. Browsers such as deer and moose are identified as those animals which consume a diet largely consisting of highly digestible forbs (broad leaved weeds and legumes) and browse (leaves from woody plants). Grazers such as cattle and bison consist of ruminant animals which consume a large proportion of grasses for their diet. Intermediate feeders such as elk and goats (and to a lesser degree, sheep) are opportunistic feeders that will shift diet selection among browse, forbs, and grasses according to seasonal palatability and availability. Different classes of ruminants have physical adaptations in several body features including rumen architecture, teeth, mouth, and the tongue to enable them to more effectively process their chosen diet (Sprinkle *et al.*, 2015).

When the occurrence of grass and forbs declines in a particular pasture, cattle will include a larger portion of browse in the diet, reducing the amount of total forage consumed. The reduction in intake is directly attributable to a lack of physical adaptations to handle a high browse diet. Negative nutritional effects for cattle consuming browse will vary depending

upon the total amount consumed, the stage of plant growth, and the presence or absence of harmful secondary compounds in the browse species (Stuth and Lyons, 1999).

Goats appear to select and more effectively process a browse diet containing more tannin. However, research has shown that goats will avoid diets containing large amounts of tannins. Diets containing large percentages of tannin containing forages (18% mesquite; 10% creosote) caused toxicosis in goats, lower forage intake, and lower forage digestibility. This was not the case for diets containing shrubs with low concentrations (23% fourwing saltbush; 25% winterfat) of tannins (Holechek *et al.*, 1990).

Browse species can generally be characterized for animal preference and palatability according to the amount of secondary plant compounds (such as tannins) they contain. Shrubs like fourwing saltbush and winterfat containing low amounts of harmful secondary compounds and few physical barriers to browsing (such as spines) are highly preferred (Holechek *et al.,* 1990). As mentioned previously, most browse species containing large concentrations of tannins such as creosote, mesquite, and one-seed juniper are largely avoided, although mesquite beans are often sought after and consumed by domestic livestock. One species which has been shown to contain higher amounts of tannins but yet does not appear to appreciably affect forage intake or forage digestibility by goats is mountain mahogany (Sprinkle *et al*., 2015).

2.10 Browse Abundance and Distribution:

Herbs play important roles in livestock nutrition mainly during the wet season, since many of them are annuals, while browses constitute an abundant biomass in farmlands, bush fallows and forests in the humid tropical environment of southeastern Nigeria and are commonly utilized in the wild by small-holder livestock farmers for feeding small ruminants). Over 5000 trees and shrubs have been listed as being suitable for feeding livestock in Africa. (Okoli *et al.,* 2002).

2.11 Browse Management Considerations:

Without proper management, the more desirable browse species can disappear because of these preferences while less desirable or undesirable specie become more. From a livestock perspective, proper management involves controlling browsing livestock numbers and controlling access to browse plants to prevent the rest from browsing. From a wildlife standpoint, proper management involves harvesting animals when wildlife census numbers and browse use signs indicate a danger to the browse resource. Just as with grasses, browse species can be managed to promote and maintain key species, (that is, the preferred plants) that make up a significant part of the production of browse available for animals to eat. This task is accomplished by controlling animal numbers and providing rest from browsing. Manager can use browse indicators to help make management decisions about the browse resource. These indicators include degree of use, hedging, and the presence or absence of seedlings (Robert and Wayne, 2001).

According to Le Houerou, (1980). The healthy management depends on the action taken to maintain the balance between:

-Browse and grass cover.

-Trees, shrubs and under shrubs.

-The various ranges of ages within each specific population, so as to maintain well- balanced and perennial vegetation cover.

To influence the effect of grazing disturbances on range plants, managers can control three factors of grazing or browsing:

- Intensity refers to the amount of grass or browse that is eaten. It the most important factor because it affects the amount of the leaf available for food production as well as the amount of root system in grasses and the production of seed.

- Timing of grazing affects plants more severely at certain stages of their development. The most critical grazing period is usually from flowering to seed protection.

-Frequency refers to how often plants are grazed or browsed. Animals tend to come back to the same plants to graze or browse during a growing season. If a plant is repeatedly defoliated, it can be weakened and may die. (Robert and Wayne, 2001).

2.12 Techniques for Browse Assessment:

According to Rutherford (1979) Different methods and techniques have been developed for measuring browsing utilization, some of them based on calculation of percentage from difference in twig length before and after usage. These are achieved by marking the branches from tip backward to a known length, then remeasuring after utilization from marks upward, to see the different in length, and finally obtain the percentage in length difference (Aldous, 1945). An adjusted practice was used by Smith and Urines (1962), who suggested that there is close approximation between the percentage of twigs length and weight removed.

According to the Abdalla (2008), techniques that use twigs numbers as a basis for utilization estimation without considering weight, are sensitive to utilization levels above 60%. This doesn't give adequate information, because manager normally allows utilization of 50-60% by weight from key plant species, and counting numbers does not detect that sufficiently. An alternative technique developed to minimize the error, from repetitive measurement (before and after), is based on the relationship between length and weight of unbrowsed twigs.

2.13 Method of Determining the Weight of Browse:

The three methods of determining the weight of browse were twigs count, weight estimation, and clip –and weight.

The most widely accepted methods for determining weight of browse are the clip and weight method and weight estimation method (Perchance and Pickford, 1937).however, these two method have been used mainly on vegetation other than hard wood browse (dasmann,1948). The clip and weigh method wields highly accurate result, but its costly and laborious. And since it destroys existing of browse and affect the physiology of plants, this method cannot be used on permanent sample plots (Abdalla, 2008).

The weight estimation method is desirable for extensive browse inventories, fast and does not involve destructive plot sampling. However, estimate derived by this method cannot be analyzed statically. The twig-count method described here is as accurate as the clip and weigh and as fast as weigh-estimation method. It is also nondestructive, and since result are counts, not estimates, they can be analyzed statically. In it is present form, it converts account of twigs to weigh of browse by use of weigh per twig individual species (Abdalla, 2008).

CHAPTER III

MATERIALS AND METHODS

3.1 Study Concept:

The main idea of this study to know the contribution of the browsing for livestock feeding used tool of browsing measurement.

3.2 Sampling Procedure:

The measurement was taken in Abu zaid forest located in East Nile, Khartoum State. The sampling in trees measurement was selected randomly by using GPS (Global Positioning System). Random sampling is considered effective only if the population to be sampled is homogenous, was select 10 Feddan which be equivalent 1% of the study area, was use transect(100m), compasse and vierner.

3.3 Browsing Measurements:

3.3.1 Trees density:

The base line transects of 1000m was established to determine total trees density and species density using near individual method. Two trees was selected along the line transect with 20 meter interval, then recorded species name and distance in specific sheet. The following formulas were used to determine the density:

$\bar{D} = \frac{\Sigma D}{n}$ (Equation 1).

$d = \frac{10000}{D^{-2}}$ (Equation 2).

Relative density = $\frac{number\ of\ species\ distances}{all\ distance\ number}\ X\ total\ tree\ density$ (Equation 3).

Where:

$\bar{D}$ = the mean distance.

D = distances.

n= number of samples.

d= total tree density (tree/ha).

3.3.2 Browsing level (BL):

According to the dominant animal browsing species and previse browse, to determine height level to animal reach.

3.3.3 Diameter at browsing point (DBP):

The diameter of twig at browsing point was determined by using vierner to measure the twigs that were consumed by browsing animal at past browsing season.

3.3.4 Determination of browsing productivity:

It was use diameter at browsing point (DBP). the height and browsing level (BL),twig weight count methods were apply to determine available browse in the site .Three twigs from each of the three randomly selected trees in the circular samples within the three plots was cut at the prescribe DBP (2.5mm) then will dry on oven from 48 hours on75 degree and weight to get the average weight/branch (Abdalla, 2008).

$$\text{Productivity} = \frac{\textit{Twig weight}}{\textit{Number of twigs in individual tree}} \times \text{Trees density}$$

3.3.5 Crown area:

Crown area was estimated to give an indication of the extent of tree cover .Three trees were selected for any specie. Then tape measurement was taken along two directions and took the means to calculate the average crown area.

3.3.6 Stem diameter:

The stem diameter was measured to give the dimension of stem. Three trees were selected for any species.

3.4 Determination of Organic Matter of Browse:

Firstly all twigs were grinded and 100 g of the sample was taken to determine organic components by using (NIR) device to determine the organic matter component such as CF, CP, ASH, ADF and NDF.

3.5 Data Analysis:

The results were analyzed by the SAS statistical analysis system, using Duncan's procedure to separate the means, and determined organic components by using Near Infrared (NIR) device.

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Trees Density at Abu Zaid Area:

Tree density is a good indicator for understanding the dominance of vegetation cover in various plant ecosystems. Results in Table (4.1) showed that the relative density of *Acacia ehrenbergiana* (Salam) was high density it reached about 120 trees/ha. In contrast, *Acacia tortilis subsp tortilis* (Sammar) recorded less density, reaching only 38 tree/ha. As for the total trees density in Abu Zaid area, it amounted only 158 trees/ha. This result indicated that tree density almost low in the area. This could be attributed of seasonality fire and increase human demands, this leads to increase the pressure on trees and shrubs in the area caused over exploitation by human and over-browsing by animals. This may explain the low available browse as result of low tree density in the area. This result agree with (Abdalla *et al.,* 2015) stated that there was a positive relationship between browse availability and tree density.

Table (4.1) Relative trees density in Abu Zaid area

Species	Tree density (tree/ha
Acacia tortilis subsp tortilis (Sammar)	38
Acacia ehrenbergiana (Salam)	120
Total density	158

4.2 Browsing Characteristics of Tree Species:

4.2.1 Browsing Level:

Results represent in table (4.2) revealed that there are high significant differences between the species of Acacia (0.002) in terms of browsing level. *Acacia ehrenbergiana* (Salam) recorded high browsing level (2.68m) compared *Acacia tortilis* browsing level (1.77m). This result

explains the variation of tree height among different species. This result also explains the difference of the livestock that utilized the browsing tress last browsing season. Also this result reflects the variation of trees height among these two species, where *Acacia ehrenbergiana* (Salam) is taller than *Acacia tortilis subsp tortilis* (Sammar). Abdalla *et al.,* (2015) reported that there was a positive relationship between biomass yield and trees height.

Table (4.2) Browsing level of selected tree species

Species	Means of Browsing Level (BL)
Acacia tortilis subsp tortilis (Sammar)	1.77b
Acacia ehrenbergiana (Salam)	2.68a
Pr >F	0.002**

** Means there are high significant differences.

Means with the same letter are not significantly different at alpha 0.05.

4.2.2 Twig Diameter:

According the results shown in table (4.3) there are no significant difference between the means of twig diameter at browsing point among the two species. The mean diameter of twig at browsing point of *Acacia ehrenbergiana* (Salam) was 1.87 mm, while *Acacia tortilis subsp tortilis* twig diameter at browsing point was 1.6 mm. Twig thickness affects the dry matter yield of fodder trees, when twig diameter increased the twig weight increasing.

Table (4.3) the diameter at browsing point of selected trees at Abu Zaid area

Species	Means Diameter at Browsing Point (DBP)
Acacia tortilis subsp tortilis (Sammar)	1.6a
Acacia ehrenbergiana (Salam)	1.87a
Pr >F	0.07Ns

Ns means there are not significant differences.

Means with the same letter are not significantly different at alpha 0.05.

4.2.3 Number and Weight of Twigs of Selected Tree Species:

Through the result presented in the table (4.4), there are no significant differences between tree species in terms of twig number and twig weight, (Pr 0.2 and 0.07) respectively. The twigs number of *Acacia tortilis* recorded 555 twigs per tree with compared to 311 twigs per tree in *Acacia ehrenbergiana* (Salam). On the other hand the averages weigh of twig 8.75 and 3.62 g of *Acacia ehrenbergiana* (Salam) and *Acacia tortilis* (Sammar) respectively. The increased weight of *Acacia ehrenbergiana* (Salam) tree reflects positively on the fodder production of this tree. The number and weight of twigs are considered good characteristics related to the fodder productivity of browse trees, as they have a strong relationship with the fodder production.

Table (4.4) Average of Twig Number and Twig Weight:

Species	Means	
	Twig N	Twig W
Acacia tortilis (Sammar)	555 a	3.62a
Acacia ehrenbergiana (Salam)	311 a	8.75a
Pr >F	0.2 Ns	0.07Ns

Ns means there are not significant differences.

Means with the same letter are not significantly different at alpha 0.05.

4.2.4 Stem Diameter and Crown Area of Tree Species at Abu Zaid Area:

The results presented in table (4.5) confirm that there are no significant differences between the two tree species, in terms of stem diameter and crown area, (Pr 0.12 and 0.14). The stem diameter reached about 8.75 and 8.1 cm for *Acacia ehrenbergiana* (Salam) and *Acacia tortilis* (Sammar) respectively. With regard to the crown area, it reached about 14.17m² in *Acacia tortilis* (Sammar), while it only less than 3m² of *Acacia ehrenbergiana* (Salam) trees. The crown area is closely related to the available browse of fodder trees. Abdalla *et al.,* (2017) found that there were strong positive correlations between browse biomass productivity and crown area and it consider the main parameter to predict browse productivity. The stem diameter is an important characteristic of fodder trees, which reflects the trees ability to resist

browsing stress and twig removal resulting from browsing process. It is observed that the average stem diameter of the two species in the Abu Zaid area is relatively thin, and therefore the ability of trees to resist browsing utilization will be weak.

Table (4.5) Stem diameter and crown area of tree species at Abu Zaid area

Species	Means	
	Steam Diameter (cm)	Crown Area (m^2)
Acacia tortilis (Sammar)	8.1a	14.17a
Acacia ehrenbergiana (Salam)	8.75a	2.95a
Pr >F	0.12Ns	0.14 Ns

Ns means there are not significant differences.

Means with the same letter are not significantly different at alpha 0.05.

4.3 Browsing Productivity:

The results in Table (4.6) reveals that available browse of *Acacia tortilis subsp tortilis* (1.9 kg/tree) and (72.2 kg/ha) while the *Acacia ehrenbergiana* the available browse was 2.5 kg/tree. The total production of fodder for *Acacia ehrenbergiana* was reached about 300 kg/ha this productivity higher than the total productivity of *Acacia tortilie subspp tortilis* it just reached only 72.2 kg/ha. The total browse productivity of Abu Zaid area was 372.2 kg/ha (0.37 tone/ha). This result indicate approximately low yield, the lower browse productivity in the area might be due to fire and excessive browsing by animal when understory were disappear. These results agree with (Abdelsalam *et al*., 2017).

Table (4.6) Browse productivity of tree species at Abu Zaid area.

Species	Available Browse	
	Browse Productivity kg/tree	Browse Productivity kg/ha
Acacia tortilis (Sammar)	1.9	72.2
Acacia ehrenbergiana (Salam)	2.5	300
Total	4.4	372.2

4.4 Nutritive Value of Browse:

The results of organic matter shown in table (4.7) explain that the *Acacia* tree had a good nutritive value of browse in terms of Ash, Fat and crude protein. *Acacia ehrenbergiana* (Salam) recorded high values of Ash and CP (12.39 and 17.02%) compared to 10.98 and 15.07% respectively of *Acacia tortilis* (Samar) browse. While *Acacia tortilis* (Sammar) surpassed the *Acacia ehrenbergiana* (Salam) in the percentage of Fat, which reached 5.17% while the *Acacia ehrenbergiana* (Salam) just reached about 2.9%. Generally, this result clearly demonstrates the high nutritive value of browsing trees, especially the higher component of crude protein and minerals (Ash), and thus makes them a good source of animal feeding in critical periods.

Table (4.7) Organic Matter of Selected Species Browse:

Organic component	*Acacia* (Salam)	*Acacia tortilis* (Sammar)
Ash	12.39	10.98
Fat	2.9	5.17
Fiber	26.87	26.26
Moisture	5.14	5.48
Protein	17.02	15.07

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 Conclusion:

The study concluded that:

- The main dominant species in Abu Zaid area was *Acacia ehrenbergiana* (Salam) according to their relative density as they reached about 120 trees/ha, While the relative density of *Acacia tortilis subsp tortilis* (Sammar) only reaching only 38 trees/ha. As for the total trees density in Abu Zaid area, it amounted only 158 trees/ha.

- There was variation of tree height among tree species, *Acacia ehrenbergiana* (Salam) recorded high browsing level (2.68m) compared *Acacia tortilis subsp tortilis* browsing level (1.77m).

- The available browse productivity of *acacia ehrenbergiana* was higher than *Acacia tortilis subsp tortilis* reached 300 kg/ha where *Acacia tortilie subspp tortilis* it just reached only 72.2 kg/ha.

- Acacia trees had good nutritive value of browse. *Acacia ehrenbergiana* records high value of Ash and crude protein to reach (12,39and 17, 02%), while *Acacia tortilis* surpassed the *Acacia ehernbergiana* in percentage of Fat, which reach 5.17%.

5.2 Recommendations:

The study recommended that**:**

1. *Acacia erenhergiana* and *Acacia tortilis* were dominant species should be managed sustainably and considered in the management process.
2. Sound management to ensure sustainable trees cover to providing available browse for the livestock, and avoidance seasonality fire.
3. Planting various fodder trees species to increase the diversity of trees in study area.
4. More study needs for browsing in the study area.

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Interviewed with Abu ziad on 22/2/2020.

Visited study area on the end of January.

Appendices

Appendix 1 ANOVA tables:

Table 1 Average of Diameter at browse point (DBP)

Source	DF	Anova SS	Mean Square	F Value	Pr >F
Spp	1	0.1066	0.10666	1.31	0.37 Ns
Rep	2	0.1033	0.0516	0.63	0.61 Ns

Ns means there are not significant differences.

Table 2 Average of browse level (BL)

Source	DF	Anova SS	Mean Square	F Value	Pr >F
Spp	1	1.25	1.25	414.72	0.002**
Rep	2	0.05	0.026	8.76	0.1Ns

** Means there are high significant differences.

Ns means there are not significant differences.

Table 3 Averages of the twig numbers

Source	DF	Anova SS	Mean Square	F Value	Pr >F
Spp	1	89304.0	89304.4	3.55	0.2 Ns
Rep	2	32133.3	16066.66	0.64	0.6Ns

Ns means there are not significant differences.

Table 4 Averages the stem diameter

Source	DF	Anova SS	Mean Square	F Value	Pr >F
Spp	1	27.26	27.26	6.54	0.12Ns
Rep	2	11.77	5.88	1.41	0.41Ns

Ns means there are not significant differences.

Table 5 Averages the twig weight

Source	DF	Anova SS	Mean Square	F Value	Pr >F
Spp	1	39.975	39.475	11.9	0.07Ns
Rep	2	4.566	2.28	0.07	0.59Ns

Ns means there are not significant differences.

Table 6 Average of Crown Area (CA)

Source	DF	Anova SS	Mean Square	F Value	Pr >F
Spp	1	188.83	188.83	5.29	0.14 Ns
Rep	2	85.38	42.69	1.20	0.42 Ns

Ns means there are not significant differences.

Appendix 2 Measurement Formats:

Format (1): Trees density

Forest Name: Abu Zaid Forest Name of Place: Umdawenban

Distance / Tree Name	1	2	3	4	5	6	7	8	9

Format (2): Twig number and Crown diameter

Forest Name: Abu Zaid Forest Name of Place: Umdawenban

Tree Name	Twig Number	Crown Diameter	
		Crown area	Stem diameter

Format (3): DBP and BL

Forest Name: Abu Zaid Forest Name of Place: Umdawenban

Tree Name	Diameter at Browse Point (CM)	Browse Level(M)

Appendix (3): Plates:

Plate (1): Camels browse the tree

Plate (2): measuring the twig diameter

Plate (3): measuring trees distance