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Nutritive Value and Dry Matter Disappearance of Sudanese Acacia Browse Leaves in Goat Nutrition

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ABSTRACT

Browse acacia trees provide feeds of high protein content for livestock in the arid and semiarid regions of Africa. They are important for subsistence livestock production in Sudan. They are a source of high quality protein and minerals for sheep, goats and camels especially in the dry season when the quantity and quality of other feed recourses decline. The nutritive value and digestibility of leaves from five browse trees were analyzed in this study. Browse trees employed in this study are: *Acaciabalbida, Acacia nubica, Acacia sieberiana, Balanites aegyptiaca,* and *Ziziphus-spina- Christi*. Leaves were collected from different areas of the semi arid region of the Sudan. The browse samples were analyzed for their chemical composition, fiber fractions and anti-nutritive components of their leaves, and dry matter disappearance rate. Three fistulated goats were used to determine dry matter disappearance rate (nylon bag technique) at different periods of time. The results showed that the browse species studied have good nutrients contents, especially proteins, and have low and safe levels of anti-nutritional factors, and may therefore form good feed resources for ruminant animal production during dry season. The acacia browse leaves have variable amount of lignin and tannin, which might have contributed to the lower DM digestibility of leaves observed for some species in this present study. However, the results of this study revealed that *A .nubica* may be considered to be an ideal browse acacia tree for this area of Sudan, because of its high protein and energy content, low lignin and tannin, and high DM digestibility. The results of this study should encourage more research and serious efforts on the propagation of high quality trees such as *A. nubica*.

Key words: Acacia tree species, Anti-nutritive factors, Nylon bags technique, Sudan

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INTRODUCTION

Browse shrubs and trees in the tropics have higher protein than grasses (Schoenian, 2009). In Africa, browse trees and shrubs not only provide feed for animals but are often used for other purposes such as source of wood, fruits, or medicine for the local communities and households. The browse shrubs and trees provide an important source of feed for livestock arid and semiarid zones of tropical Africa (Von Kaufmann, 1986). Ruminants in arid and semiarid areas of Africa suffer from shortages of feeds and their poor quality, especially during the dry season (Shelton, 2004). Browse trees and shrubs remain as an important source of better quality feed for sheep, goats, and camels, and their nutrients can provide protein and mineral supplements to improve the productivity of livestock that feed on low quality forages and crop residues (Aganga and Tshwenyane, 2003). As the dry season progresses, feed in dry lands become inadequate in quantity and quality and this leads livestock, such as camels and goats, to depend more on perennial vegetation and browse trees which provide leaves, edible branches and fruits (Abdelgabar, 1986). Browse trees and shrubs can be credited for supporting sustainable subsistence livestock production in arid and semi-arid zones of Africa; since the feeds they provide have high crude protein (CP) and mineral contents. The edible parts (leaves and fruits) of the majority of browse trees and shrubs have more than 10% CP, even in the dry season, when CP% progressively decreases (Backlund and Belskog, 1991). Poor quality feed tends to take longer to digest than high quality feeds, and digestibility of nutrients tend to decrease with increasing the amount of roughage, especially poor quality one (Chessmore, 1979). Lignin is an important anti-nutritional factor that decreases the digestibility of nutrients in fodder crops (Minson, 1990). Lignin is also a limiting factor in the digestion of legumes, but its affect is less pronounced as that of cereal forages (Rittner and Reed, 1992).The objective of this study was to determine the chemical composition, anti-nutritional constituents of leaves from five browse acacia trees (*Acacia albida, Acacia nubica, Acacia sieberiana, Balanites aegyptiaca,* and *Ziziphus spina- Christi*), and dry matter disappearance, using nylon bags technique, after the digestion in the goat rumen for different periods of time.

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MATERIAL AND METHODS

Experimental animals and duration of experiment

Three female goats were used in this experiment, those goats from Nilotic species, all goats were in the same weight (~20 Kg), and age (~2 years), and all are healthy. The animals were housed separately under hygienic conditions in a cleanroom with adequate. Institutional procedure for handling experimental animals was followed. Light and good ventilation .All animals were fed with Berseem (*Medigaco sativa*). The rumen fistula was made by a surgical operation in the left side of the animal, so the diameter of passageway connecting the goat's rumen with the skin is large enough to administrate the samples in the nylon bags. Animals were allowed two weeks to heal and acclimatize before the start of the experiment. The experiment took another two weeks.

Collection of feed material

In the present study, leaves were obtained from five acacia trees, growing in different parts of semiarid areas of Sudan. Samples were processed and analyzed for their chemical composition and nutritive value. The samples were carefully cleaned and freed from stones, dirt, or grit; they were then numbered and carefully stored in polythene bags. Their local names, botanical names of the five browse trees used in the study are presented in Table 1.

Table 1. Local and Botanical Names of Acacia trees

Local name	Botanical name
Haraz	*Acacia albida*
Laot	*Acacia nubica*
Kog	*Acacia sieberiana*
Higleg	*Balanites aegyptiaca*
Sidir	*Ziziphus spina- christi*

Nylon bag

The size of the bags was large enough relative to sample used so as to ensure that the ruminal fluid can easily enter the bag and mix with sample. The bag is also small enough to be easily withdrawn through the rumen fistula. The mesh size of these bags allows entry of rumen microbes and exit of fermentation gases on one hand. On the other hand, the losses of solid particles from the bags would be minimum.

Analytical methods

Determination of the chemical composition of the browse plants: The determination of Crude Protein (CP), Crude fiber (CF), Ether Extract (EE, %fat), ash and moisture in the browse leaves were carried out according to the method of analysis of the Association of Official Agricultural Chemist, AOAC (1965). Lignin was determined according to the method of Goering and Van Soest (1970). Quantitative estimation of tannin was carried out using the modified vanillin HCL method described by Price et al. (1987). On the other hand, cellulose and Acid Detergent Fiber (ADF) were digested with acetic acid and sulphuric acid, respectively. The methods used are a modification of Crampton and Maynard (1938).The dry matter disappearance rate in the rumen was determined according to the method of the nylon bag technique of Oroskov et al. (1980).

Preparation of the sample for incubation: Prior to their use, the bags were thoroughly washed under tap water, dried to a constant weight at 105 C° in a hot air oven, and weighed. Four grams of the sample were placed in the bag.

Incubation of the bags in the rumen: In this experiment the fistulated goats were used to determine the dry matter disappearance rate of browse leaves using the nylon bags technique. Four gm of the samples were put in the bags which were inserted into the rumen through the fistula. The nylon bags were identified before incubation by the aid of markers. The bags were incubated for 6, 12, 24, 48 and 72 hrs in the rumen. The nylon bag containing of the browse plant samples were administered directly through the fistula to the rumen. Each sample was replicated 3 times in different three animals and at the end of the incubation period the bags were washed under gently falling stream of tap water, cleaned by rubbing between the finger and the thump until rinsing was clear. The washing time average was 10min/bag, and then the bags were dried for 24hrs at 100C° and weighed. The dry matter losses were determined by calculating the mean of the three replications.

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Statistical analysis

Data were subjected to standard methods of statistical analysis that was performed using windows-based Statistical Package for Social Sciences (SPSS) Version 17.0. Descriptive statistic was used to evaluate the minerals disappearance in trees and shrubs.

RESULTS

In this study, three tables and one figure provide the names of the acacia browse trees, chemical composition, and dry matter disappearance rate of leave samples obtained from the five acacia trees used in the study. Table 2 presents the percentages of moisture, protein, ash, ADF %, lignin, cellulose, and tannin in the browse plants. Table 2 shows that the moisture content of browse species ranges from 7.86% for *A. seiberiana* to19.0% for *B. aegyptiaca.* The CP% ranges from 8.75% to 21%. *Z. spina-christi's* leaves have the lowest CP% while *A. nubica* has the highest CP%. *A. seiberiana, A. albida and B. aegyptiaca* have 13%, 14.87%and 15.75% CP, respectively. The highest fat% was found in the leaves of *B. Aegyptiaca* (6.15%) and rest of the trees have 3.2-4.86% fat in their leaves.

The species that has the lowest CP%, *A. seiberiana*, has also the highest CF% (30%). At the mean time, it was observed that the ash content of the browse samples in the present study were 8.39 –15.0 % (Table2) and that *B. aegyptiaca* leaves has the highest ash%.

Regarding the high amount of lignin content observed in this study (13.40- 79.6%, Table2), *A. nubica* has the lowest lignin content while *A. albida* has the highest. The leaves of the other browse trees were in between. On the other hand, *A. seiberiana* leaves have the highest cellulose content while *A. Nubica* has the lowest. Interestingly**,** *Z. spina-christi* has the highest tannin (3.9%) while *A. nubica* and *B. aegyptiaca* to have around 0.30% tannin.

Disappearance rate (DM digestibility)

The present findings showed that different browse plants species have different dry matter disappearance rates when incubated in the rumen of goats (Table 2 and Figure 1). With the exception of *A. albida* and *A. seiberiana*, leaves from acacia browse in the present study have shown higher (more than 50%) DM disappearance rate, and a higher DM digestibility. *A. nubica*, which has the highest DM disappearing rate, has also high protein content, low lignin and low tannin. This shows the influence of chemical composition on DM digestibility.

Table 2. The proximate chemical composition of *Acacia albida, Acacia nubica, Acacia sieberiana, Balanites aegyptiaca,* and *Ziziphus spina- christi*

Botanical Name	Moisture %	CP %	EE %	CF %	Ash %	ADF %	Lignin %	Cellulose %	Tannin %
A. albida	11.21	14.87	4.86	15.93	8.39	52.00	79.60	20.00	1.50
A. nubica	9.60	21.00	3.53	18.83	12.59	70.00	13.40	14.50	0.36
A. seiberianae	7.86	13.125	3.20	30.36	11.74	18.40	24.00	32.30	1.90
B. aegyptiaca	19.00	15.75	6.15	17.33	15.00	94.20	17.00	21.20	0.32
Z. spina-christi	8.20	8.75	3.49	17.80	9.40	44.20	31.40	24.20	3.16

Crude Protein (CP), Crude fiber (CF), Ether Extract (EE, %fat), Acid Detergent Fiber (ADF %)

Table 3. Dry matter disappearance rate (%) of acacia tress leaves in goats

Botanical name	Incubation periods in hours					
	6 hrs	12 hrs	24 hrs	48 hrs	72 hrs	Means ± SD
A. albida	10.83	20.83	24.17	39.17	41.67	27.36 ± 12.94
A. nubica	25.75	38.25	49.25	70.00	84.25	53.50 ± 23.66
A. seiberianae	17.50	19.17	27.50	40.00	41.67	29.17 ± 11.32
B. aegyptiaca	22.50	29.17	47.50	64.17	66.67	46.00 ± 19.97
Z.spina-christi	11.67	14.17	38.00	51.67	63.33	35.77 ± 22.72

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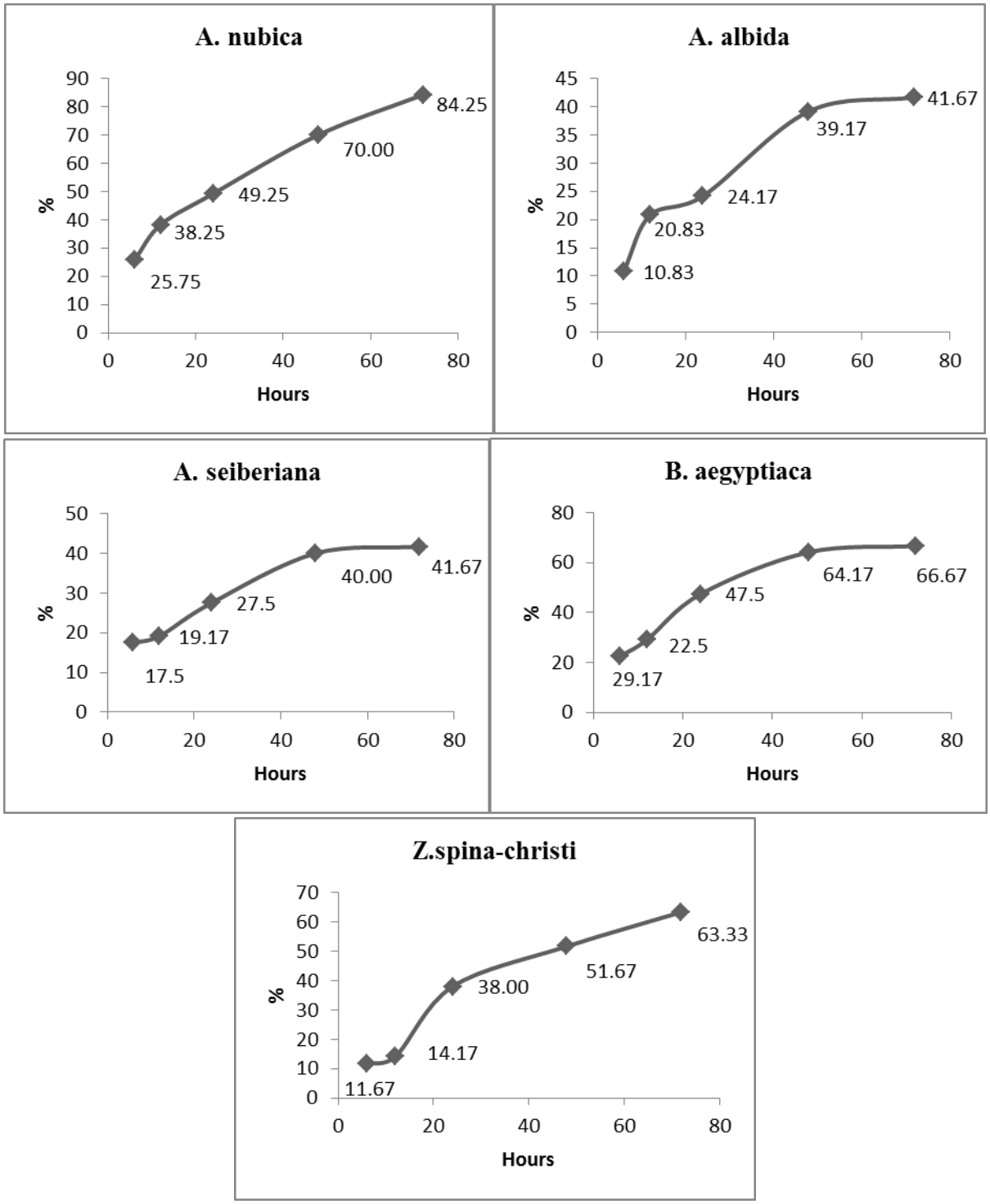

Figure 1. Dry matter disappearance rate for acacia browse leaves over time (6-72 hours)

DISCUSSION

The value of a feed for an animal depends on the feed intake, nutritional content, dry matter digestibility as well as the availability of the nutrients to animal after absorption (Seoane et al., 1981).When feed DM digestibility decreased to less than 50%, the feed did not meet cattle's requirements for nutrients (Leng et al., 1992). Therefore, it is important to analyze the nutrients contents, DM digestibility, and presence of anti nutritional factors in order to determine the worth of a feed for the ruminant animal.

The findings of the present study showed that the moisture content of browse species ranges between 7.86 to –19.0% which is lower than that reported by Le Houeru (1980). Moisture content is affected by rainfall, temperature, and age of the plant. On the other hand, the present findings showed that acacia trees examined in this study had relatively high level of crude protein (8.75 –21.0%) which lies within the range obtained by Walker (1980). Some browse species showed in the present study high level of crude protein, including *A. nubica*, that has21.0 CP% (Table2), which is in agreement with Dougall et al (1964). It seems that the protein content reported in this study would be adequate to meet

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goats requirements, however, not all of the protein will be digested since browse tree forages has been reported to have a true digestibility of proteins of approximately 60-70 % (Wilson, 1977). Lower protein digestibility could be due to the presence of tannin that decreases protein digestion by rumen microbes (Gartner and Hunwood, 1967).When tannin complexes with proteins, it tends to decrease the proteins digestibility (Kumar and Singh 1984). On the other hand, forages that has less than 8% CP can adversely affect growth and function of rumen microbes (Van Soest, 1982). None of the browse acacia species in the present study has CP% of less than 8%.

Browse plants in the present study are high in EE% (Table 2). This is in agreement with Mecha and Adegobla (1980), who reported that high energy content is expected if the edible browse has high content of true fat. Van Soest (1982) contended that the most important factor that makes feed valuable for maintenance of body functions is its metabolizable energy content, especially in dry season because of reduced intake of low quality pasture (Walker, 1957).Wilson and Harrington (1980) reported that when the digestibility of the grass decreases with age, the metabolizable energy levels of the feed declines. In contrast to grass, browse plants seem to be able to provide more than the energy needed for maintenance of livestock (Toutain, 1980). This is not surprising since browse plants have almost twice the energy that is found in the dry grass (Le Houerou, 1980)

The leaves of the acacia browse trees in the present study had CF% hat ranges from 15.93% for *A. albida* to 30.36 % for *A. seiberiana* (Table 2), which is similar to the range reported by Dougall et al. (1964). High protein and low fiber content of acacia browse would provide high nutritive value feeds for browsing sheep and goat, especially during the dry season when the nutritive value of grasses in arid areas of the tropics declines due to decreasing levels of protein and increasing level of crude fiber (Van Soest, 1982). On the other hand, concerning the high level of ADF% observed in this study (18.4- 94.2%, Table 2) which is higher than the values of 27.20- 50.10% reported for twigs. This variation may be due to the differences between ADF% in leaves and twigs (Elginaid, 1997). The high lignin content observed in the present study was higher than the values obtained by Khazaal et al. (1993) who found that the concentrations of fiber and lignin increase as forages advance to maturity. Lignin provides strength to the cell wall as plant grows and growing plant. Because lignin is resistant to microbial degradation in the rumen, it is expected to result in decreased DM digestibility.

The results for the ash% of the leaves of acacia browse trees observed in present study (8.39 –15.0 %, Table2) is slightly higher than the range reported by Dougall et al. (1964), and higher than the range (3.10- 9.70%) reported by Elginaid (1997). On other hand, tannin levels presented in Table 2, range between 0.32% for *B. aegyptiaca*to3.16% for *Z. spina-christi's* leaves which are within the range 0.18- 9.51%, reported by McKey et al. (1978). As mentioned above, of the browse species investigated in the present study, *Z. spina-christi* showed a high level of tannin in their leaves, which is lower than the 5.84% level reported by Reed et al. (1990).Although it is generally accepted that increased tannin in the feed depresses DM digestibility and availability of nutrients for the ruminant animal, Barry and Manley (1984) suggested that in ruminants, directly condensed tannins (2-3%) have been shown to impart beneficial effects because they reduce the wasteful protein degradation in the rumen by the formation of protein-tannins complex.

Browse leaves digestibility

Wilson and Harrington (1980) argued that lignin content decreases digestibility of DM of browse plants, and that the decreased DM digestibility could be due to the fact that lignin may prevent the degradation of the browse feed leaves cell wall (Richard, 1976). Other factors may have contributed to the low DM digestibility, such as presence of some phenolic compounds (Danny, 1982), and the impact of high tropical temperature on the leaves' chemical composition (Van Soet, 1982). Since browse acacia trees investigated in the present study were grown in semi tropical areas, where the temperature is so high, it is expected that as the leaves mature, the cell wall composition changes and that may have resulted in decreased feed intake and digestibility (Figroid et al., 1972). Further, the size of feed the particles in the present study lies in the range of 0.6 and 1.0 mm, and are incubated in the nylon bags. This may have resulted, in the absence of mastication, addition of saliva, and ruminal mixing in decreasing particles degradation and digestibility as suggested by Weakley et al. (1983).

The present findings showed that different browse plants species have different dry matter disappearance rate when incubated in the rumen of goat. This may be due to the variation of the chemical composition and the nutritive values from one browse plant species to another (Le Houerou, 1980). And it also may be due to the effect of the animal and days of the incubation as Meherz and Oroskov (1977) suggested that variation in situ DM disappearance rate of was largely influenced by the animal factor than by variation among days. Figroid et al. (1972) observed differences in DM disappearance rates of barley and sorghum. It, therefore, could be concluded that lignin and tannin, and their levels in different plant species are important factors that significantly depress degradation of cell wall (Hartly et al., 1989). Another factor that might have contributed to decreased DM digestibility is interactions between the bag surface and fibrous mat in the rumen, and that would affect the disappearance rates of fiber from the bags (Weakely et al., 1983).

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CONCLUSION

Acacia browse leaves investigated in this study have, with the exception of one species, high protein content, which provides good nutrition for sheep, goats and camels especially during the dry season. Feeds in the arid and semi arid areas of the tropics, including Sudan, decrease in quality and quantity during the dry season. Protein nutrition is crucial for maintenance and growth. The acacia browse leaves have variable amount of lignin and tannin, which might have contributed to the lower DM digestibility of leaves observed for some species in this study. However, the results of this study revealed that *A. nubica* may be considered to be an ideal browse acacia tree for this area in Sudan, because of its high protein and energy content, low lignin and tannin, and high DM digestibility. The results of this study should encourage more research and serious efforts on the propagation of high quality trees such as *A. nubica*.

Competing Interest

The authors declare that there are not significant personnel, professional or financial competing interest that might have influenced the presentation of the results of the study described in this manuscript.

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