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IN SACCO DRY MATTER DEGRADABILITY OF SOME NIGERIAN BROWSE PLANTS

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ABSTRACT
One of the major constraints to livestock production is feed which necessitated this study. Twenty (20) browse species of semi-arid origin from the Semi-arid zone (Guinea Savannah vegetational zone) of Nigeria were screened for chemical composition and Rumen Degradation Characteristics (RDC) as a means of evaluating the feed values of the plants under study. The study conducted determined the chemical composition and rumen degradation characteristics of some browse plants and crop residues using the Orskov's exponential equation $P = a + b (1-e^{-ct})$. Three grams (3g) of each sample in triplicate were dispensed into the nylon bags and incubated for 6, 12, 24, 48 and 72 hours in the rumen of two cannulated goats of 20kg and 16kg respectively. The mean NDF, lignin and CP content of browse species were 42.95%, 7.96% and 12.90%, while the mean values for DM, Ash, ADF and EE were 87.40%, 8.66%, 26.20%, and 5.72% respectively. The mean of the rumen degradation characteristics were 37.67%, 45.17%, 52.99%, 62.67% and 71.61% at 6, 12, 24, 48 and 72 hours respectively. Feed that is degraded within 6, 12 and 24 hours may be considered as substantial feed even though based on this study the optimal potential degradation value of browse species was at 48 hours and maximum at 72 hours. The chemical composition shows browse plants to be rich in protein content. Plant that show exceptional degradation was S.virosa with rumen degradation characteristics of 58% and 94% at 6 and 48hours, 48% and 12% NDF and CP respectively. The plants mentioned above were recommended based on their chemical contents and rumen degradation characteristics which presents them to be unique and are commonly found around the area studied.

KEYWORDS: In Sacco, Dry matter degradation, Nigerian Browse plants, Goats, Chemical composition

INTRODUCTION

The semi arid zone is that ecological zone that has experienced persistent low annual rainfall. The range of rainfall received by this zone per year is between 50-600mm. According to Lekan (1991) and Jackson (1982) and Gworgwor *et al* (2006a) stated that, this zone receives less than 250mm of rain in a year. However, there are variations in the amount of rainfall received with these three regions that comprise the semiarid zone (Sahel, Sudan, Savannah and Guinea Savannah). In view of this, it has a long dry season, which may last about nine (9) months especially the Sahel region. Furthermore, the zone has a marked high temperature and consequently, the vegetation is characterized by sparse grass and as reported by Mckell (1980) with shrubs and trees which are most visible on the land surface, among which, the highest percentage is browse species that are mostly found all year round and yet received little or no attention in most scientific research. Surprisingly, in some arid and semi arid zones, livestock has exploited and still exploiting these browse plants as source of their feed supply. In addition, DeMontgolfier-Kouevi and Le Houerou (1980), Mecha and Adegbola (1980) reported that they are still underexploited and undeniably remain the major component of most natural pastures in the zone.

Considering the land surface covered in developing countries situated in the Arid, Semiarid and Montane zones which is about 50% and thus supporting over 250 million domestic ruminant animals (Le Houe'rou, 1980 and Walker, 1980); this is evident enough to say that, most important limiting factor to ruminant livestock production in these areas is the insufficient supply of good quality feeds all year round (Davendra, 1989). The insufficient and less qualitative feed supply may be attributed to some human factors such as rapid industrialization commercialized farming and rapid increase in population, hence, these have affected high quality feed supply to livestock. Moreso, some natural factors are integral part of the semiarid zone such as; low rainfall to support good vegetation for longer range of time, long periods of drought, desertification and indiscriminate bush burning. These have highly limited the fodder production and the size of naturally available grassland (Agishi, 1985; LeHouerou, 1980d).

In order to meet the protein demand of the teaming population, emphasis has to be placed towards increase livestock production. Since the bulk of feeds of the livestock, especially the ruminants come from the forages grasses, shrubs and trees and these grasses and shrubs are only vegetative and available as animal feeds in the rainy season, whereas the trees which serve as browse plants are vegetative and available as feed for the ruminants throughout the year (Baumer 1983).

In view of the above, emphasis has to be placed on the exploitation of trees, shrubs as browse plants for our livestock to boast their productivities consequently meeting the protein demand of our fast growing population.

According to Robinson (1985) Trees and shrubs, have provided valuable feed to man's herbivorous animals since the time of their domestication. Some tree legumes species have evolved in semi arid regions alongside herbivorous animals and therefore have developed means of protection against browsing or grazing, such as thorns, toxin, fibers and height of trees crowns Brewbaker (1986). Toxins are of two general types, those that deter grazing or feeding and those that poison the animal.

As mentioned earlier forage from browse (trees) is often used as a buffer to overcome feed scarcity or grab that arise from seasonal fluctuation in the supply of other feed sources which die when upper soil layers loose their moisture. During the dry season or in the period of drought, trees provide green forage rich in protein, minerals and vitamins. Browse plants are the basis of diet of ruminants like sheep, goat, cattle and many wild herbivores. Browse plants play a vital role as a complementary source of protein, vitamins and minerals for livestock species during the long dry season found in the arid and semi-arid areas (Bille 1980; Boudet and Toutain 1980; Le Houerou 1980; NAS 1979).

In Northern Nigeria, nomadic Fulani spend five percent of their feeding time on browse plant during the rainy season and 15-20 percent during the dry season while about twenty percent of livestock diet during the dry season in the semi-arid environment of Nigeria is browse. De Leeuw (1975) and Le Houerou (1989b).

Because of the shortage of forage in dry season in the developing world, there has been a growing effort to exploit or identify potentially important feed sources among shrubs, trees and crop residues and possibility of including them in ruminant diets. Therefore, the major problem facing livestock producers in the tropical areas is proper nutrition for their animals during the dry season when pastures, cereal residues are limiting in quantity and quality (Mbahi *et al*., 2006)

Hutagalung, (1981) reported that tropical browse plants have been found to offer promising result in terms of adaptability and acceptability as forage for ruminant livestock to make up the nutrient deficiencies in the dry grass. The report also stated that browse species are able to capture large amount of solar energy in the tropics and in high and low rainfall areas and they produce some yield of biomass.

Economic utilization of browse plants in livestock production depends on the knowledge of browse availability, productivity, acceptability, palatability, digestibility, chemical components and the degree of toxicity found in each potential browse species.

This research attempts to identify some of these browse plants that are available in the semi-arid region especially Girei Local Government Area located in the Guinea Savanna Zone in the semi-arid region of Adamawa State, Nigeria.

MATERIALS AND METHODS

CHEMICAL ANALYSIS

The samples collected were analyzed for dry matter (DM), ash, crude proteins (CP), ether extract (EE) and lignin and AOAC (1980) method was used. Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were analyzed and the methods highlighted by Goering and VanSoest (1987) were used.

The dry matter content for each sample was determined by oven drying of 3g at 105^{o}C for 24 hours; 3g of each sample were taken for ash determination at 550^{o}C complete combustion in a furnace for 3hours.

MANAGEMENT OF THE EXPERIMENTAL ANIMALS

Two (2) Sahel Goats were cannulated for the rumen studies. The host animals were provided with a diet that provided the rumen microbial requirements. Maize bran, some browse, groundnut cake and lush grass pasture were fed in the morning, afternoon and evening. This feeding of the experimental animals helped in stabilizing the rumen environment for optimal microbial requirements and activities on the feed samples degraded. The experiment lasted for two months. Drinking water, minerals and vitamins were made available at all times. The animals were housed in a pen. The cannula environment was cleaned everyday with savlon solution.

PREPARATION OF FEED SAMPLES FOR INCUBATION

At first representative feed sample from the bulk were obtained and dried at 60^{o}C for 24 hours and then passed through a 2mm screen size laboratory hammer mill. At this stage, the nylon bags from the Rowett Research Institute Aberdeen United Kingdom with mesh size of about 45 micro-square (improvised local materials with similar pore size) were used. Bag size may also be big or an improvised bag. For easy identification and precision the bags were numbered with an indelible marker. Also, a 50cm plastic tube of clear polyvinyl chloride (PVC) tubing, four slits evenly distributed were marked on each plastic tube with one end which had a string attached to a tile like material for marking the incubation time (an improvised one was used). The clean dry and labelled nylon bags were weighed and kept sequentially for the set of feed samples, 3g each of the samples were weighed into each of the bags and the weight of the bag plus sample were noted. Nylon bags with feed samples were attached using rubber band to the plastic tubes for incubation in the rumen for different hours.

INCUBATION IN THE RUMEN

The incubation hours were 6, 12, 24, 48, and 72. Plastic tubes with bags attached were pushed slowly into the rumen, which began with the tube, and a small string was attached to a wire loop inserted through the top of the cannula. The cannula top was tightened and the bags were left in the rumen and were withdrawn at 6, 12, 24, 48, and 72. Each sample was incubated in triplicate.

WITHDRAWAL OF BAGS FROM RUMEN, WASHING AND DRYING

The plastic tubes with bags were withdrawn and immediately washed under running tap water for 5 minutes or till the bag was washed until water from the bag became clear. The bags were dried in an oven at 60^{o}C for 48 hours, thus, the dry matter (DM) loss was determined.

WASHING LOSS (SOLUBILITY)

The washing loss was the soluble materials of the feed and was determined after the feed sample of 3g was weighed into the nylon bag and soaked in warm water (40^{o}C) for one hour and washed under tap water for 5 minutes.

STATISTICAL ANALYSIS

The results were subjected to a computerized statistical analysis methods as outlined by the Statistical Package for Social Sciences Version 16. The results of DM disappearance from the nylon bags recording were fitted to the exponential equation of: $P=a+b(1-e^{-ct})$ (McDonald, 1981). The final analysis, feed from nylon bag incubation was defined as A=fraction of feed, B=(a+b)-A, that is, the insoluble but fermentable materials C=the rate constant for the equation above. Thus, the formula below:

$$P = a + b(1-e^{-ct})$$

Where:
a, b, and c are constants and
P is the percentages of material degraded after time t in hours :
a = intercept of the degradation curve,
b = potential degradability,
c = rate of degradation,
t = time in hours.
(Orskov *et al*., 1980; Orskov 1982; Orskov *et al*., 1989; Osuji *et al*, 1993; Aboud *et al*., 2005).

RESULTS AND DISCUSSION

THE CHEMICAL COMPOSITION OF BROWSE SPECIES

The mean values for dry matter (DM), total Ash, Acid detergent fibre (ADF), Neutral Detergent fibre (NDF), lignin, Crude Protein and Ether Extract (EE).

The mean dry matter (MDM) analyzed was 87.43% which is similar to the one reported in North Africa of 91.7%. This variation could be attributed to the different times at which plants were collected, the degree of acidity of the area, differences in species of browse plants, stage of harvest and when analysis is done on fresh or dry basis as reported by Gworgwor *et al*., (2006a).

The mean ash content was 8.66% having a range from 5 to 21%. This value is a little higher than the values of 7.83% reported by Dibal (1991) and slightly lower than the one reported by Gworgwor *et al.,* (2006a) for semi-arid browse plants. However, Le Houerou (1980a) and Gworgwor *et al.,* (2006a) argued that differences in the ash content of browse plants may be attributed to differences in soils, species and the season. The mean Acid Detergent Fibre (ADF) was 26.20% having a range from 28-54%. This value is a little higher than the 22% reported by Norton (1994) for forage tree legumes in the tropic. The hemicellulose content could be what caused the differences in the ADF values. The mean Neutral Detergent Fibre (NDF) was 42.95% and range of 32-60% which is higher than the value reported by Norton (1994) of 20-35%. This is the digestible fraction of the plant cell wall. Stems usually have higher lignin contents than leaves and hence high NDF and this makes them less digestible. The mean value is 7.96% with a range of 2-19% which is in agreement with the one reported by Gworgwor *et al.,* (2006b). Lignification of plant cell walls increases with age of plant. The mean crude protein (CP) is 12.90% having a range from 4-23%. *C.hypopilinum* recorded the least crude protein content of 5.91%, while the highest of 21% and 22% were recorded in *A.africana* and *X.americana* which are slightly lower than the one reported by Gworgwor *et al* (2006a) in *A.africana* with 23%. The variations in the crude protein content for those in the same region may be attributed to different sampling procedures (Le Houerou, 1980c, Gworgwor *et al* 2006b). The mean Ether Extract was 5.72% with a range of 1-10%. The value is higher than the one reported by Dibal (1991) of 3% which also reported that the variation may be due to the location of the study area.

Table 1: Chemical Compositions of some Browse Plants

Sample No	SCIENTIFIC NAME	DM	ASH	CP	EE	ADF	NDF	LIGNIN
1	*Balanites aegyptiaca*	85.86	10.15	14.44	7.63	23.03	49.20	5.16
2	*Ziziphus mauritiana*	87.21	8.14	11.16	7.53	23.11	52.13	6.31
3	*Sterculia setigera*	88.11	9.63	13.78	4.63	21.39	40.73	5.81
4	*Tamarindus indica*	88.62	7.73	16.41	5.63	23.24	43.16	5.54
5	*Terminalia vicennicoides*	87.22	12.63	13.78	5.23	24.61	39.83	6.81
6	*Acacia sieberina*	88.63	9.68	8.63	5.49	26.64	45.81	12.63
7	*Adansonia digitata*	84.73	4.95	19.86	6.14	21.74	51.24	6.24
8	*Annogeissus leiocarpus*	89.04	9.03	11.68	6.49	23.78	49.81	11.84
9	*Annona senegalensis*	87.48	6.49	12.47	3.88	20.63	40.21	5.98
10	*Vitellaria parkia*	87.64	8.26	7.22	3.73	27.29	50.23	11.74
11	*Combretum hypopilinum*	86.83	6.24	5.91	4.29	28.11	49.83	12.98
12	*Ficus platyphylla*	86.24	11.81	16.41	5.83	24.39	53.68	5.73
13	*Ficus polita*	86.66	5.52	13.78	9.83	23.64	48.29	4.88
14	*Ficus sycomorus*	88.11	17.03	11.36	5.68	28.98	40.23	4.29
15	*Ximenia Americana*	87.68	11.11	22.31	5.61	19.28	43.83	5.33
16	*Ziziphus spino-christi*	89.03	8.43	10.50	5.61	23.84	52.11	13.24
17	*Afzelia Africana*	86.47	6.66	21.00	6.83	21.39	52.11	5.46
18	*Parkia clappertoniana*	89.53	5.17	7.22	5.83	23.62	58.42	5.67
19	*Bauhinia rufescens*	88.73	7.28	8.29	4.63	23.84	51.29	10.27
20	*Securinega virosa*	87.84	7.20	11.83	3.89	26.31	48.73	13.24

KEY: DM=dry matter, ASH=ash, CP=crude protein, EE=ether extract, ADF=acid detergent fibre, NDF=neutral detergent fibre,

RUMEN DEGRADATION CHARACTERISTICS

The predicted rumen degradation characteristics values are presented in the appendix. Figures 1- 4 are the graph interpretation of the rumen degradation curves presented in the appendix and percent degradation presented in Table 2.

The peak degradation of *B.aegyptiaca* is 68% and 70% at 48 and 72 hours respectively. Most of the browse species studied shown peak degradation at 48 hours with little variation at 72 hours. *Z.mauritiana, S.setigera, T.indica andT.vicennicoides* had shown more than 50% degradation at 24 hours and about 70 to 80% at 72 hours being the maximum even though *B.aegyptiaca* reached more than 50% at 12 hours as shown in Table 2 and Fig 1.

Table2 ESTIMATE OF RUMEN DEGRADATION CHARACTERISTICS OF BROWSE PLANTS

		A	B					c
Sample No	Name of Browse plants	Washing loss	6	12	24	48	72	
1	*B. aegyptiaca*	16.9	44.44	56.67	63.33	68.89	70.00	0.079
2	*Z. mauritiana*	17.6	25.56	49.99	62.22	77.78	81.11	0.042
3	*S. setigera*	17.6	37.78	46.67	55.56	60.00	67.78	0.042
4	*T. indica*	17.1	44.44	45.55	64.44	68.89	70.00	0.057
5	*T. vicennicoides*	*18.0*	43.33	45.55	50.00	64.44	72.22	0.038
6	*A. sieberina*	17.8	41.11	42.22	52.22	55.56	60.00	0.039
7	*A. digitata*	16.4	08.89	30.00	31.11	63.33	77.78	0.025
8	*A. leiocarpus*	18.0	46.67	48.89	51.11	64.44	72.22	0.047
9	*A. senegalensis*	17.6	41.11	51.11	56.67	73.33	82.22	0.048
10	*V. parkia*	18.0	33.33	38.89	41.11	43.33	46.67	0.024
11	*C. hypopilinum*	17.4	35.55	36.67	38.89	64.44	76.67	0.028
12	*F. platyphylla*	17.1	37.78	44.44	51.11	55.56	78.89	0.038
13	*F. polita*	16.8	42.22	45.56	50.00	57.78	66.67	0.044
14	*F. sycomorus*	17.7	34.44	47.78	55.56	57.78	71.11	0.040
15	*X. Americana*	18.3	34.44	37.78	44.44	50.00	65.56	0.026
16	*Z. spino-christi*	16.9	31.11	41.11	53.33	67.78	76.67	0.036
17	*A. Africana*	17.0	40.00	43.33	51.11	58.89	70.00	0.036
18	*P. clappertoniana*	17.4	36.67	41.11	45.56	53.33	66.67	0.031
19	*B. rufescens*	18.4	36.67	40.00	50.00	53.33	64.44	0.029
20	*S. virosa*	17.7	57.78	70.00	92.22	94.44	95.56	0.114

KEY: a=intercept of the degradation curve b=potential degradability c=rate of degradation

A.sieberina, A. digitata, A.leiocarpus, A.senegalensis, and V.parkia reached 50% to 60% degradation at 48 hours and more than 70% at 72 hours with some that had shown 50% at 24 hours (*A.sieberina, A.leiocarpus, A.senegalensis*) and *V.parkia* even at 72 hours had not reached 50% degradation which may not fall among recommendable plants for how many days will it stay in the stomach before it releases 50% of its nutrients to the animal?. This plant may need further investigation to be recommended as substantial feed to livestock in terms of degradation.

C.hypopilinum, F.platyphylla, F.polita, F.sycomorus, and X.americana reached their peak degradation of more than 60 to 70% at 72 hours. All reached 50% at 24 hours with an exception of *C.hypopilinum* and *X.americana* of 38% and 44% respectively.

Z.spino-christi, A.africana, P.clappertoniana, B.rufescens and S.virosa all reached 50% degradation at 24 hours except *P.clappertoniana* which was 45% and *S.virosa* that reached more than 50% at 6 hours. All reached peak degradation at 72 hours except *S.virosa* that reached maximum degradation at 48 hours of 94.44% and this property made it a highly acceptable feed for livestock which also has an acceptable level of CP, NDF and lignin.

Highly degradable browse species are *S.virosa, and* are therefore highly recommended as a substantial feed to livestock with acceptable level of lignin, CP and NDF.

Moderately degradable browse species are *B. aegyptiaca, Z.mauritiana, S.setigera, T.indica, T.vicennicoides, A.sieberina, A.leiocarpus, F.polita, F.sycomorus, Z.spino-christi, A.africana, and P.clappertoniana* and are also moderately recommended to livestocks.

Lowly degradable browse species are *A.digitata, V.parkia, C.hypopilinum, X.americana, and B.rufescens*. They form bulk of feed because they are not of good digestibility.

The mean values of degradability observed for 6, 12, 24, 48 and 72hours are given as 37.67%, 45.17%, 52.99%, 62.67% and 71.61% respectively. Peak degradation was observed for each browse plants at 48-72 hours. This peak is for the 20 browse plants.

CONCLUSION

Based on the rumen degradation characteristic and chemical composition of the browse species used in this study, it is obvious that most of the plants are of high feeding value and rich in CP content. The mean rumen degradation characteristics at 48 and 72 hours are 56% and 62%DM. this is explained by their level of NDF and lignin content, in most of the plants. Most of the browse reached peak degradation values within 48 hours. In this way, nutrients are made available to animals within a short period of time. Typical high degradation value at 48 hours was that of *S.virosa*, 94.44%. This is obvious, since all of those plants have good potentials for degradation at faster rate which could be due to their level of NDF, lignin and CP content. Those which did reach peak degradation values at such good time as 48 hours mostly had acceptable level of NDF, lignin and CP values and the one with high NDF and lignin with low protein content which attained 50% degradation only after 72 hours *V.parkia.* This plant may not be suitable for feeding this is because it takes as long as72 hours, before a good proportion of the nutrients are made available to the animal. This will affect intake and hence the overall animal performance.

The CP content of most of the browse species was high with a mean of 12.90%. The browse with least CP is *C. hypopilinum* and the ones with highest CP were 21% and 22% in *A.africana* and *Ximenia americana*. While about 12 other browse plants fall within the range of 11-19% CP and about 5 falls within the range of 6-10% CP. The least with 5.91% CP which was observed in *C. hypopilinum*. This finding indicates that most of the plants are rich in CP content, except for possible inhibition by tannins.

RECOMMENDATIONS

Browse species like *S. virosa, S. setigera, A. senegalensis, X. Americana, F. platyphylla, F. polita, F. sycomorus, A. digitata, T. vicennicoides,* and *T. indica* are highly recommended to livestocks as substantial feeds material. These plants have distinguished themselves with high degradation values, high CP content with acceptable level of NDF and lignin content. Besides in all season, they either provide leaves or pods good for ruminant feeding. These plants will serve a great purpose especially during the long dry season in Adamawa State when dry standing grasses have been exhausted or lost their nutritive value. These plants are also available in most natural grazing range in this state. Agro-forestry is highly recommended especially those that shown high RDC this could make them readily available to livestock even when feeds are scarce and or nutrients depleted out of them and in addition, it could be a source of income.

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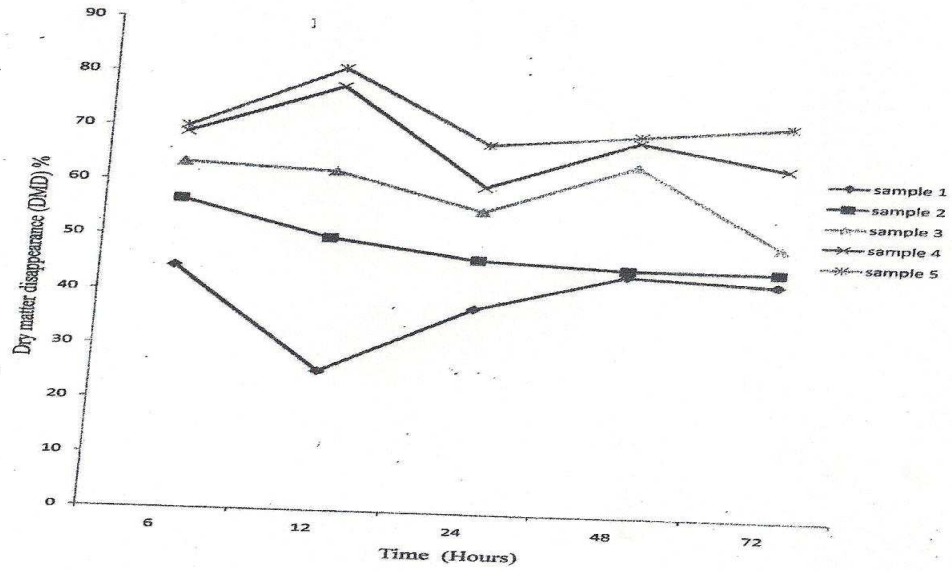

Fig 1: Disappearance of dry matter with time of some browse plants
Key sample: 1 - *Balanites aegyptiaca*
Sample: 2 – *Ziziphus mauritiana*
Sample: 3 – *Sterculia setigera*
Sample : 4 – *Tamarintus indica*
Sample : 5- *Terminalia vicennicoides*

40

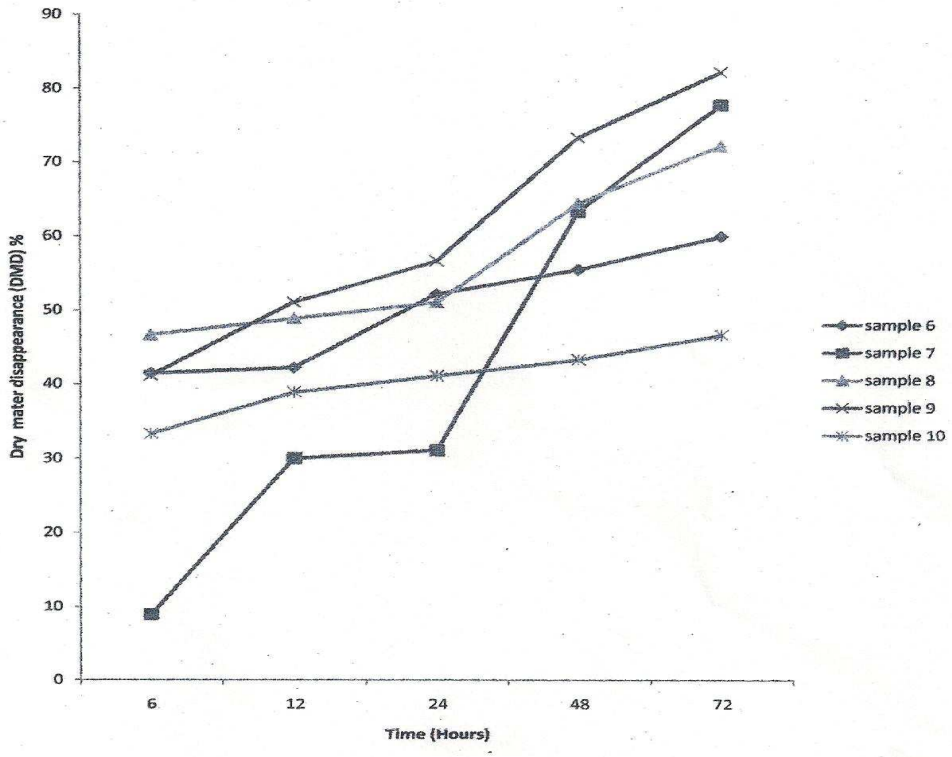

Fig 2. Disappearance of dry matter with time of some browse plants

Key: sample 6- *Acacia sieberina*

Sample 7- *Adansonia digitata*

Sample 8- *Annogeissus leiocarpus*

Sample 9- *Annona senehalensis*

Sample 10-*Vitellaria parkia*

41

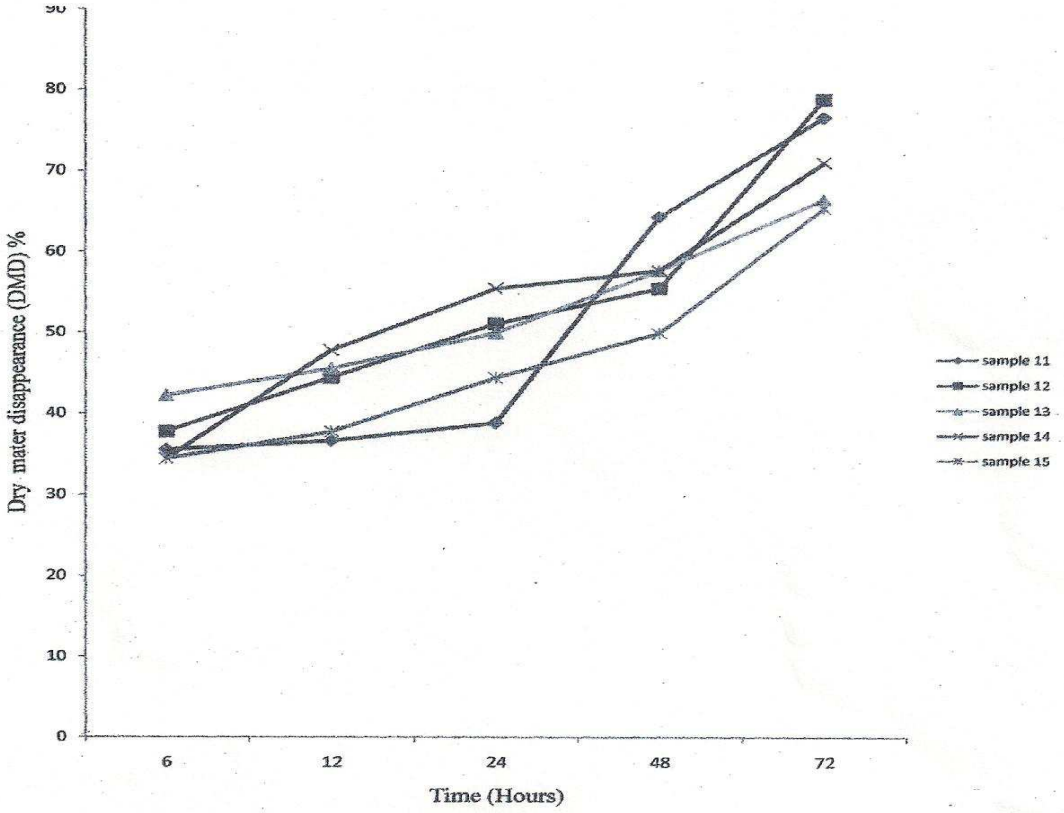

Fig 3. Disappearance of dry matter with time of some browse plants

Key : sample 11- *Combretum hypopillinum*

Sample 12- *Ficus platyphylla*

Sample 13- *Ficus polita*

Sample 14- *ficus sycomorus*

Sample 15- *Ximenia americana*

42

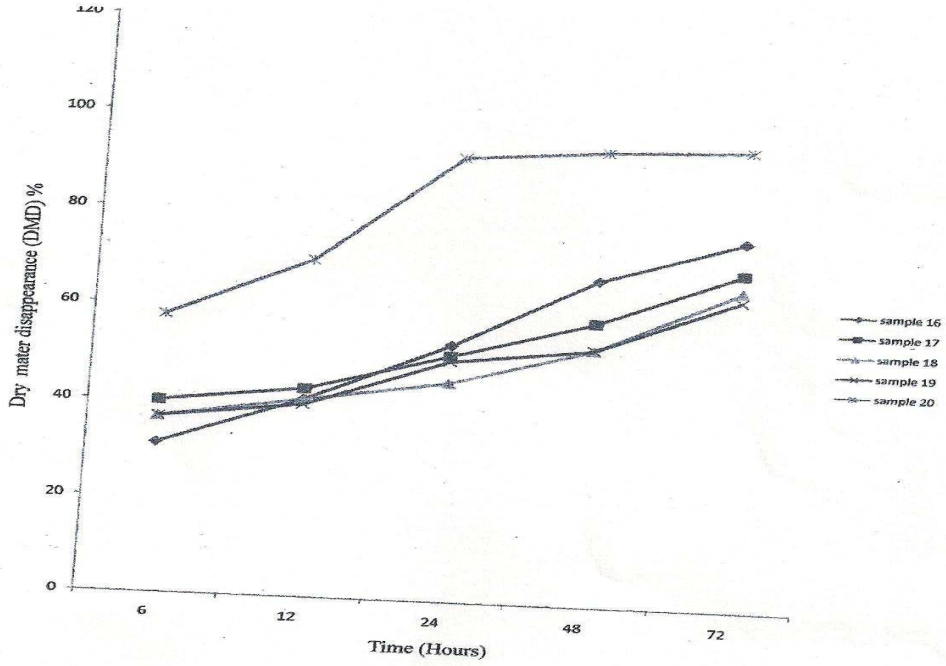

Fig 4. Disappearance of dry matter with time of some browse plants

Key: sample16- Ziziphus spino –christi
Sample 17- *Afzelia Africana*
Sample 18- *Parkia clappertoinana*
Sample 19- *Bauhinia rufescens*
Sample 20- *Securinega virosa*

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