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Original article

Effects of protection system and grazing seasons on goats' nutrition in El Rosa, North Kordofan State, Sudan

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ABSTRACT

The range grazing and distance walked for diet selection and nutritive value were studied in close and open range systems at the flowering and seed setting stages during the September and November 2009 respectively in El-khuwei locality (El Rosa). A completely randomized design was used (CRD). Sampling was done by two stage flowering and seed sating stage under protected and open range systems were selected diets and feed intake locating a 2000 x 2000 m plots. The average weights gains during the flowering and seed setting stage were 23.25 and 26.82kg respectively. Goat preference on bite counts of the different species significantly higher ($P < 0.001$) at flowering stage ranked leflef *Luffa aegyptiaca*, *Aborakhus Andropogon gayanus,* Bano *Ergrostis tremula,* Difra *Echinocloa colonum*, *Huskneet Cenchrus biflorus and Himeira Hymerocardia. Whil* Gadgad *Geigeria alata, Gaw Aristida sp*, Umfraredo *Schoenofeldia gracilis*, Fisiya *Fimbristyls hispidula* and browses *Usher Calotropis procera* least than that. A significant higher ($P < 0.001$) goats selective feed intake, *in vitro* dry matter digestibility dry matter, organic matter and crude protein higher in the protecte range at flowering stage and lowers in the open range at seed setting stage. However; highly ash contents and crude fiber in the open range system during the seed satting stage and least than that. The

distance walked by goats for diet search was significantly longest in the open range system during the seed setting stage. Body weight gain was significantly highest during the flowering stage. It was concluded that at flowering stage higher goats preference on bite counts of the different species and body weight gain. However; feed intake, *in vitro* dry matter digestibility dry matter, organic matter and crude protein in the protecte range. During the seed satting stage were higher ash contents, crude fiber and distance walked by goats for diet search in the open range system.

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1. Introduction

In arid and semi-arid regions the survival of goats is dependent on the presence of water. With dairy goats high milk yield are only possible when there are adequate water supplies. The requirement for water is affected by such environmental factors as the amount of DM eaten, the nature of the feed, physiological condition, temperature of drinking as well as by genotype (NRC, 1981). Sudan has vast areas of forage produced from natural pastures represents 86.6% of national animal feed requirements, and about 14% of the population is involved in livestock production activities on the rangelands (MAW, 2005). And wide range of environmental variations is determined mainly by the amount of annual rainfall which varies from 0-75 mm in the northern desert zone to1300 mm in the Southern humid zone (Harrison and Jackson, 1958). The State area amounts to almost 25 million ha, out of this area; 14.5 million ha are rangeland (AFRICOVER, 2004). The state is considered among the leading regions of Sudan in terms of animal and range resources, where more than 13 million heads of sheep, goats, camels and cattle are present (RPA, 2005). Animal production in the state is mainly practiced under traditional extensive systems, depending on natural rangeland (Cook and Fadlalla, 1987). Cattle dominate the southern part of the State, while sheep, goats and camels are present in larger numbers in the northern and drier part (El-Hag *et al*, 1993). The main objective of this paper was to investigate effects of seasons and protection system on grazing behavior on the various distances walked and digestibility from a diet selection by goats.

2. Materials and methods

2.1. Study area

This study was conducted at El-khuwei locality (El Rosa). It lies between longitudes 28˚:33' to 28˚:30'N and latitudes 12˚:14' to 14˚:12'E, about 105 Km west of El Obeid town, North Kordofan State lies between latitudes 11˚:20' to 16˚:36'N and longitudes 27˚:13' to 32˚:24'E. The close range system was established in 2007 in an area of about 500 ha, El-khuwei locality own large export market of animals (Hammer sheep) in west Sudan (MAWF, 2009). The long term average annual rainfall is about 300-mm, consisting of storms of short duration between July and September with the highest rainfall generally occurring in August. The soil of the site lies within the sand dune area locally known as “Goz” soil. The site is naturally dominated main grasses include namely Huskneet (*Cenchrus biflorus),* Shuleny (*Zornia glochidiata*) and Bigual (*Blepharis linarifolia*). The trees Humied (*Sclerocarya birrea*), *Higlig* (*Balanites)*, Arad (*Acacia etbaica*) and Sider (*Zizuphus spina).* The Shrubs include Kursan (*Boscia senegalensis*), Usher (*Calotropis*), *Mereikh* (*Polygala eriotera*) and Aborakhus (*Andropogon gayanus*) MAWF (2009).

2.2. Sampling and experimental animals

Sampling was done on two stages flowering and seed sating under protected and open range systems in selected locations (2 km^2 each). Within each stage twenty goats randomly selected, their average weights gains were 23.25 and 26.82kg, respectively (Fadlalla and Cook, 1985).

2.3. Nutritional value of range quality

2.3.1. Feed or diet selection

The parameters measured diet botanical composition was estimated using the bite-count techniques, (Fadlalla and Cook 1985). The parameters measured included diet botanical composition and voluntary intake of dry matter. Within each seasons flowering and seed sating twenty goats was kept for this study. The first goat was followed for five times, and then the second one followed for another five minutes and so on for all goats. The procedure was repeated tine times, thus each goats followed for one hour in the first day, was also followed by observer for three days and 600 bites, and species of plant ingested and bite were recorded.

2.3.2. Voluntary feed intake and *in vitro* dry matter digestibility

The total fecal collection and *in vitro* dry matter digestibility techniques were used to measure voluntary intake. In this technique, the total faces produced by grazing goat were collected into appropriately designed collection bags attached to animals. Collection bags attached to goats were emptied at least twice a day and weighted. *In vitro* DM and *In vitro* dry matter digestibility determined (Tilly and Terry, 1963). The sample for flowering and seed setting stages under protected and open range systems was obtained by observing plant species and plant parts selected by goats during grazing and then collecting similar material for analysis by Tilley and Terry (1963). I*n vitro* dry matter digestibility *INVDMD* was calculated according to the following formula:

$$INVDMD\% = \{\text{Sample DM} - (\underline{\text{Residue sample-Mean.resid DM inoc.blank}})\}*100$$
$$\text{Sample DM}$$

The voluntary intake of DM was determined according to Fadalla and Cook, (1985).from the following formula:

$$\text{Dry matter intake (DM)} = \underline{\text{Total fecal output /24 hr}} *100$$
$$100 - \text{DM digestibility (}\textit{in vitro}\text{)}$$

2.4. Measuring parameters

2.4.1. Average distance walked

Distance from the goats search to voluntary feed intake. The first goat was followed for five minutes, and then the second one followed for another five minutes and so on for all goats. The procedure were repeated distance walked at five minutes of bite count by matter, thus each goat followed for one hour in the first day, ware also followed by observer for the total of distance walked under four days under protected and open range systems during the flowering and seed satting stages. However measured distance refers to the distance grazing area as measured by meter per hour according to Fadlalla and Cook (1985).

2.4.2. Average body weight gains

Two stages flowering and seed satting were measuring body weight gains (2 km^2 each). Within each season twenty goats was kept for this study. The procedure was repeated initial and final body weight of goats before and after grazing. The weight between initial and final equal weight change gram/day were recorded at three weeks on two stages Fadlalla and Cook (1985). Weight and body condition, for instance, provide a measure of the nutritional response, integrated over weeks or months (Lambourne *et al*, 1983).

2.5. Laboratory analyses

Dry-matter weight (DM) is determined by drying the feed in the oven at 105°C for 12-15 hours and weighing. Organic matter (OM), crude protein (CP) was determined by (AOAC, 1980). Crude fiber (CF) was determined by (Van Soest, 1982). *In vitro* dry matter digestibility (*INVDMD*) was determined (Tilley and Terry, 1963).

2.6. Statistical analysis

Completely Randomized Design (CRD) was used in this experiment. Data were subjected to analysis of variance and means were estimated. Chi Square test was used to compare diet selection (Steel and Torrie, 1960). SPSS (Statistical Package for Social Sciences) computer software was used for the statistical analysis.

3. Results and discussion

3.1. Bite Counts

Table 1 shows the season on bite counts of the different species by goat preference, north Kordofan Stats. Goat *at the flowering stage* was preference highly (P < 0.0001) on bite counts of the different species ranked leflef, *Aborakhus,* Bano, Difra, *Huskneet,* Agoor, *Himeira. Whil* Gadgad, *Gaw,* Frareda, Fisua and browses *Usher* least than that. McDowell (2003) report that different plant species will also have varying contents, browse and forbs plant species may have higher mineral concentrations than do some grasses. Raesi *et al* (2001) indicated that in dry conditions, physical, chemical and biological processes of soil formation will be slow significantly. Effects of plant species on earth will be effective in several ways: 1 - pour the leaf on the soil and creating litter and organic matter on its effects on soil fertility 2 - Roots activity and secretion of organic acids in the soil and increase or reduction of nutrients through this way 3 - The frequent removal of nutrient elements by plants and discharge the elements from soil. Therefore, study the amount of their form in the soil and reactions that they alone are doing with the other elements are the goals of soil fertility and soil management. This depends on the species composition of plant in differences in cellulose protein and lignin of that species that has significant effect on the rate of material decomposition, nutrient cycle, feed intake and eventually soil fertility (Ghorbanian *et al,* 2002). In plants differs from specie to specie and varies from one place to place in the soil of pasture and they are subjected by seasonal variation (Khan *et al,* 2006).

Table 1
Bite counts *(%)* of the species by goat in the flowering and seed satting stages at El Rosa protection, north Kordofan, Sudan.

Latin names	Local names	Flowering stage	Seed satting stage
Luffa aegyptiaca	Leflef	32.09	31.03
Andropogon gayanus	*Aborakhus*	17.30	16.02
Ergrostis tremula	Bano	13.04	11.13
Echinocloa colonum	Difra	11.05	10.15
Cenchrus biflorus	*Huskneet*	9.03	8.12
Calotropis procera	*Agoor*	6.05	5.26
Hymerocardia	*Himeira*	4.12	4.00
Geigeria alata	Gadgad	2.14	4.03
Aristida sp	*Gaw*	2.11	4.06
Schoenofeldia gracilis	Umfreido	1.04	2.10
Fimbristyls hispidula	Fisiya	1.02	2.03
Cucumis sativa	*Usher*	1.01	2.02

Means in the same column under the same factor with different letters are significantly different. * = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001).

3.2. Feed intake and digestibility

Table 2 showes the feed intake and in vitro dry matter digestibility by goats. Feed intake had higher significant (P < 0.001) in the protected range system on the flowering compared to open range system and seed setting stage. Showed that the goats were less selective feed intake with decrease in flowering stage with green plant and increased on the seed setting stage with dried forage. A significant (P < 0.05) inviter dry matter digestibility *(IVDMD*) in the protected range system on the flowering stage compared to open range system and seed setting stage. The main factor to *IVDMD* the dry matter digestibility decreased within the flowering plant and increased in leaf with age. Reid *et al* (1990) reported greater intake and digestibility by cattle than by goats and sheep, and greater digestibility by goats than sheep. Cattle exhibited slower passage rates than goats and sheep; however, goats were more efficient at digestion than sheep at the same passage rate; suggest that microbial efficiency may be better in goats than in sheep. Total digestible nutrient requirements for lactating and growing goats range between 60 and 68 percent (NRC, 1981). As goats eat a variety of plants, they are less likely to have mineral deficiencies than other species of animals that eat predominantly one plant species (McDowell, 2003).

Table 2
Feed intake and in vitro dry matter digestibility (%) in protected and open ange systems during the flowering and seed satting stages at El Rosa protection, North Kordofan, Sudan..

Parameters	Feed intake (g/day)	IVDMD (%)
Systems		
Protected range	0.54	0.65
Open range	0.42	0.62
Mean	0.48	0.64
SE±	0.02**	0.85*
Season		
Flowering	0.62	0.69
Seed setting	0.35	0.58
Mean	0.89	0.64
SE±	0.02**	0.85*

Means in the same column under the same factor with different letters are significantly different.
* = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001).

3.3. Nutritive Value of Diet

The nutritive values of diet were significantly highly (P<0.0001) on dry matter (DM), organic matter (OM) and crude protein (CP) in the protected range system during the flowering stage compared to seed setting stage. However; ash content and crude fiber (CF) were significantly (P<0.0001) higher during the seed setting stage than the flowering stage. A significant range ystem x growth stage interaction was increased nutritive values of Dm, Om and Cp in the closed rang system at the flowering stage and lowers ash and Cf in the open range system at the seed setting stage Table 3. Goats were selected plant highly crude protein dry matter and organic matter indicator that is often used of forage quality; however the leaves of grasses from forbs and shrubs are generally higher in Cp, Dm and Om than are grass leaves and stems at comparative stages of growth, these consistent in showing that goats generally selected diet highly nutritive value (Vansoest, 1982). In another studies seasonal effects on animal performance could be attributed to the changing nutritional status of the animals with the seasonal availability of good quality grazing, the nutritive value of rangeland grasses declines sharply during the dry season (El-Hag, 1992). Gatenby (1986) reported that as dry season proceeds, the nutritive value of vegetation falls, its fiber content increases and its digestibility, ME value, protein content and mineral content fall. The multifarious methods of utility of goat render the animal to be labeled as a 'poor man's cow'; however, low nutrient content of tropical grasses during dry season is the main limiting factor to ruminant livestock production consequently resulting in low productivity (Osakwe, 2006).

3.4. Distant walked

The results revealed that the goats significantly highly (P<0.0001) walked (m/h) were incresed distance in the open range system (100.17 m/h) during the seed setting stage (90.54 m/h) and decresd in the closed range system (32.81 m/h) during the flowering stage (42.44 m/h). A significant range ystem x growth stage interaction was increased in the open rang system on the seed setting stage (140 m/h) with the highly distant walked by goat and lower in the closed range system on the flowering stage (24.54 m/h) Table 4. NRC (1981) reported they were many factors affect of the distance were change to 2-day watering in seed satting stage (August) has the effect of increasing forage accessibility by extending the grazing orbit away from the water point, but without increasing the distance walked daily. Nevertheless, there is still a daily energy deficit of 10.3 MJ ME despite the drop in milk yield, which is where the greatest energy saving is made.

Table 3
Nutritive value of diet (%) in protected and open rang systems during the flowering and seed setting stages at El Rosa protection, North Kordofan State, Sudan.

Parameters	DM %	OM %	Ash %	CF %	CP %
Systems					
Protected range	0.95	0.86	0.01	0.27	0.10
Open range	0.94	0.83	0.12	0.33	0.08
Mean	0.94	0.84	0.11	0.30	0.09
SE±	0.15***	0.16***	0.15***	0.24***	0.11***
Season					
Flowering	0.96	0.86	0.09	0.25	0.11
Seed setting	0.93	0.82	0.13	0.35	0.07
Mean	0.94	0.84	0.11	0.30	0.09
SE ±	0.15***	0.16***	0.15***	0.24***	0.11***
Season x system					
Flower x protected	0.96a	0.88a	0.12a	0.21a	0.12a
Flowering x open	0.95b	0.85b	0.14b	0.28b	0.10b
Seed x protected	0.94c	0.84c	0.08c	0.33c	0.08c
Seed x open	0.92d	0.81d	0.10d	0.38d	0.07d
Mean	0.94	0.84	0.11	0.30	0.09
SE ±	0.15***	0.16***	0.15***	0.24***	0.11***

Means in the same column under the same factor with different letters are significantly different. * = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001).

Table 4
Distant walked (m/hr) by goats in protected and open range systems at the flowering and seed satting stages at El Rosa protection, north Kordofan, Sudan.

Parameters	Distance walked (m/hr)
Systems	
Protected range	32.81
Open range	100.17
Mean	66.49
SE±	2.37***
Season	
Flowering	42.44
Seed setting	90.54
Mean	66.49
SE ±	2.37***
Season x sestem	
Flower x protected	24.54
Flowering x open	60.33
Seed x protected	41.08
Protected x open	140.00
Mean	66.49
SE ±	2.37***

Means in the same column under the same factor with different letters are significantly different. * = significant (P < 0.05), ** = high significant (P < 0.01) and *** = highly significant (P < 0.001).

3.5. Live weight gains

Live weight gains of goats during the flowering stage significantly highly (P<0.0001) gained weight (25.00 g/day), when compared to seed setting stage (21.83 g/day) compared to seed setting stage (0.60) Table 5. National Research Council (NRC, 1981) reported they were many factors affect the nutritional requirements of goats: maintenance, growth, pregnancy, lactation, fiber production, activity and environment. As a general rule of thumb, goats will consume at least 3% of their body weight on a dry matter basis in feed; the exact percentage varies according to the size (weight) of the goat, with smaller animals needing a higher intake (percentage-wise) to maintain their weight. McDowell *et al* (1983) reported that during the dry season, inadequate protein and energy result in animals losing weight which lowers mineral requirements.

Table 5
Body weight gains of goats during the flowering and seed satting stages at El Rosa protection, north Kordofan, Sudan.

Parameters	Body weight gains (g/day)
Seasons	
Flowering stage	21.83
Seed satting stage	0.60
Mean	11.22
SE ±	1.67***

Means in the same column under the same factor with different letters are significantly different.
* = significant (P < 0.05),
** = high significant (P < 0.01) and *** = highly significant (P < 0.001).

4. Conclusions

It was concluded that at flowering stage higher goat's preference on bite counts of the different species and body weight gain. However; feed intake, *in vitro* dry matter digestibility dry matter, organic matter and crude protein in the protecte range. During the seed satting stage were higher ash contents, crude fiber and distance walked by goats for diet search in the open range system.

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