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Proximate Chemical Composition of Herbaceous Forage in Rangelands of South Kordofan

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Abstract

This study was conducted in three sites at Tillow area, Kadugli locality, South Kordofan State for two seasons (2006/2007). The main objective of the study was to investigate the effects of the four management practices on some forage quality attributes in rangeland. The applied practices were "protection by fence", "protection by fence and removal of undesirable plants", "grazing" and "grazing and burning". Samples were taken using line transects and quadrates. Two trials were arranged in a randomized complete block design in late rainy and mid dry seasons. Forage biomass of herbaceous plants was analyzed chemically for crude protein, crude fiber, major elements (P, Ca, Mg, Na and K) and trace elements (Cu, Zn, Mn, Fe and Co) content. The results showed that no significant difference ($P > 0.05$) among management practices on most of the studied parameters. However, crude protein and minerals contents of forage biomass of herbaceous plants in the late rainy season and mid dry season was below the maintenance requirements of the ruminants. It was suggested that herbaceous forage should be harvested and preserved before maturity in Tillow area and other similar environment to improve feed quality in the dry season. Moreover, supplements provided to ruminant livestock in such areas should also incorporate mineral elements in available forms at proper ratios.

Keywords: *Management practices, Chemical composition, Herbaceous, Rangelands, South Kordofan.*

INTRODUCTION

Sudan ranks at the top of the African and Arabian countries as regard livestock population that depends almost entirely on natural pasture for feed. The contribution of rangeland to feed dry matter requirements of Sudan national herd is estimated at 77% (Abusuar and Darrag, 2002), quoted in Abuswar (2007). Rangelands in South Kordofan are not grazed significantly by livestock until the dry season when forage has declined sharply in both quantity and quality, with nutrient values well below the maintenance requirement of livestock (WSARP, 1983). Knowledge on response of some quality attributes of forage biomass of herbaceous plants to management practices, such as protection by fence, grazing, browsing, burning and removal of undesirable plants under Sudan condition is still lacking. This study was undertaken to determine the effects of such range management practices on forage proximate chemical composition and its mineral contents.

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MATERIALS AND METHODS

The study was conducted at Tillow area (latitude 13º 52′ and longitude 31˚ 58′ approximately) in Kadugli Locality, South Kordofan State (latitudes 9^{o}:00'-13^{o}:00'N, longitudes 27^{o}:00-32^{o}:00E), for two consecutive seasons (2006/2007).

The agro-climatic zone at Tillow area is classified as low rainfall savannah in special area, dominated by tall coarse annual grasses and *Dichrostaychys cinere*a (L.) Wight and Arn. (Kadad). The average annual rainfall was 711 mm during the period of the study. The study area serves as summer residence for migratory transhumance. The livestock kept includes cattle as main species, goats and sheep.

The management practices applied were protection by fence, protection by fence and management by removal of undesirable plants (protected plots), "grazing " and "grazing and burning"(opened plots). Nine plots were selected at the three blocks (A, B and C). The first plot at each block was protected by fence and divided into two equal sub-plots or two small plots to minimize the cost of fencing. One sub-plot was managed through mechanical removal of undesirable plants, either manually for herbaceous plants or using traditional hand tools and big scissor for trees and shrubs, whereas the other sub-plot was left unmanaged. The second plot at each site was freely grazed while the third plot at each site was freely grazed and burned annually in early dry season. Fire lines were opened around plots annually. Plot size was (54 m × 54 m). Two meters were left as margin in each of the four sides.

The plot measurement area was (50× 50 m). Each plot or subplot was divided in to two strata. In each stratum one permanent line transect (50 meter length) was placed. A total of two lines transect at each plot or sub-plot was placed.

Four Quadrates (1m × 1m) were placed along each transect for measuring forage quality attributes of herbaceous plants. Two quadrates were placed at intervals 20 m in the late rainy season (early October/2006/2007). Also, two quadrates were placed at intervals 22 m in the mid dry season (early January/ 2006/2007). All the above ground vegetation to a height of 3 c m (grazing level) was harvested from each quadrate. All desirable plants species were selected. Plants and plant parts, which were not palatable, were discarded. The samples were air dried to constant weight. Each sample was well mixed, and then one representative sub-sample for each plot or sub-plot was prepared.

All sub-samples were finely milled before analyses.

A total of four chemical analyses were conducted for each component for each sub sample (ash, crude protein, crude fibre and ether extract). All analyses followed the method of (AOAC, 1980).

Further chemical analyses of herbaceous for Calcium, Magnesium, Sodium, Potassium, Copper, Manganese, Iron and Cobalt were determined by using atomic absorption spectrometer model 3110. Phosphorus was determined by using Spectrophotometer 20.

The data were statistically analyzed as a randomized complete block design with four treatments (4 management practices) and three replications (three blocks) in the rainy season and with three treatment and three replications in the dry season. JMP statistical package (1995) by SAS Corporation was used.

RESULTS AND DISCUSSION

Chemical composition of herbaceous plant forage

The average chemical composition of feed samples of herbaceous forage and the content of major and trace elements inside protected plots and opened plots are presented in tables 1-3. Management practices had no significant effect ($P > 0.05$) on chemical composition of herbaceous forages (Table 1). However, the late rainy season, crude protein content was slightly higher inside grazed and protected plots (5.6 and 5.4% respectively) than in protected and managed plot and grazed and burned plot (4.2% for both). This relative variation could be mainly attributed to the variation in species composition. In the mid dry season the crude protein was higher inside grazed plots than in protected plots. It was observed that grazed plots contained relatively higher forbs density and forbs cover in comparison with the protected ones. It was also found that crude protein contents of range plants were higher during the late rainy season compared with the mid dry season (Table 1).

Protected plots plants had relatively higher ($P > 0.05$) crude fiber than grazed plots in the late rainy season and mid dry season (Table 1).

Moreover, the comparison between specific plots in late rainy season and mid dry season showed that the vegetation had more crude fiber contents in mid dry season.

Generally, the crude protein content inside all plots in late rainy season and mid dry season may be inadequate to meet the microbial requirement (6-8%) and ruminants' requirement (7-20%) as reported by Heitschmidt and Sluth (2005). The low and the decrease in crude protein content in mid dry season in all plots may be due to age and maturity of grasses, which are dominant in the study area. This result is similar to observation of Herzell and Oxenham (1964) who mentioned that crude protein content in pasture decline with maturity and age. WSARP (1985), found a CP content of 3.7% in the mid-dry season and 8% in late rainy season.

The CP in the diet selected by cattle was 3.7 and 9.0% in the mid-dry season and late rainy season respectively. Selection, in addition to CP from browse was able to meet the requirements for a reasonable production from cattle during the rainy season. Deficiency in CP in the dry season is difficult to mitigate from the range as leaves from browse have shed. This is aggravated with the shortage in energy, and the increased requirements for walking, hence the acute loss in weight in dry season that amounts to some 36% of body weight.

The increase in crude fiber in mid dry season in contrast to a relatively low crude fiber in the late rainy season was probably due to the fact that at early stage of growth plants have low crude fiber. As they mature cell wall contents increase as represented by Neutral Detergent Fiber. Butler and Bailey (1973) reported that at early stage of forage growth, leaves contain high protein and low fiber. According to Annon (2004) in South Kordofan there is sharp decline in crude protein and increase in crude fiber at maturity. The findings are in line with WSARP (1982) and WSARP (1985) who reported that when livestock return to South Kordofan at the start of the dry season, the grasses already have lost much of their nutritive value and forage declines both in quality and abundance.

Major elements content of herbaceous plant forage

The results in table 2 indicated that content of Phosphorus, Calcium, Magnesium, Sodium and Potassium in all plots in late rainy season and mid dry season were probably less than the requirements of the ruminants. According NRC (1996) the concentrations in forage needed to meet requirements of beef cattle for Phosphorus, Calcium, Magnesium, Sodium and Potassium were 1.9g/kg, 3.2 g/kg, 1.15 g/kg, 672 mg/kg and 5.76 g/kg respectively.

The results in table 2 indicated that the phosphorus content was higher in open plots than in protected plots in late rainy season. There was a relative decrease in phosphorus content in mid

dry season when comparing the same plot in the late rainy season and mid dry season (Table 2). The variation in Phosphorus content in protected plots and open plots in the late rainy season and the variation in phosphorus content between dry season and rainy season may be attributed to the variation in species composition and mineral concentration dynamics from rainy season to dry season. Gascopp and Dave (2003) reported that livestock and wildlife managers must be aware of the nutrition dynamics of forage to sustain satisfactory growth and reproduction of their animals and assure fair value of pasture. Moreover, this result is similar to the findings of Cook and Fadlalla (1987).

Also, these results agreed with WSARP (1983) who reported low soil phosphorus in Kadugli area. The results indicated that Calcium content in the late rainy season and mid dry season was higher in grazed plots than in protected plots. Furthermore, the findings are in line with (Elhag *etal*, 1997).

These results agreed with Heitschmidt and Sluth (2005) who reported that Sodium was the most deficient in range forage.

The results in table 2 indicated that Potassium concentration in the late rainy season was higher in protected plots (0.06%) and grazed and burned plots (0.06%) than grazed plots (0.05%) and protected and managed plots (0.05%). Also, the results indicated although protected plot had the highest Potassium content (0.06%) in the late rainy season, the protected had the least potassium content in the mid dry season (0.03%).

The variation in Potassium content in protected plots in the late rainy season and mid dry season may be attributed to the mineral concentration dynamics from rainy season to dry season as mentioned before.

Trace elements content of herbaceous plants forage

The results in table 3 indicated that content of Copper, Iron, Manganese, and Zinc in all plots in late rainy season and mid dry season were probably less than the requirement of the ruminants whereas Cobalt Content may be adequate to meet the requirement of the ruminants with exception of protected plot in the late rainy season. According NRC (1996) the concentrations in forage needed to meet requirements of beef cattle for copper, iron, manganese and Zinc were 9.6 mg/kg, 48 mg/kg, 38 mg/kg and 28.8 mg/kg respectively. Chesworth (1992) reported that level exceeding 0.1mg/kg dry matter in the diet of Cobalt will meet the requirements of the ruminant animals.

Overall, cattle can possibly have adequate mineral nutrition in the rainy season by selectively grazing among the mixture of grasses.

Conclusions

The effect of the four management practices on quality of forage of herbaceous plants was minor after the grasses reach maturity stage.

In protected and open plots in the late rainy season and mid dry season the crude protein content of forage of herbaceous plants was below the maintenance requirement of the ruminants.

Also, in protected and open plots in the late rainy season and mid dry season the contents of Ca, Mg, P, K, Cu, Zn, Mn, Fe, and Na of forage biomass of herbaceous plants were less than requirement of the ruminants whereas the cobalt content was adequate to meet the requirement of the ruminants.

The study suggests harvest of herbaceous forage before maturity and preserved in Tillow area and other similar environment to improve feed quality in the dry season.

The study recommends provision of a mineral supplement for animals grazing in Tillow area rangelands especially in the dry season and that the formulation should include at least Ca, Mg, P, K, Cu, Mn, Fe, Zn and Na in available forms and proper ratios.

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Table 1.Effect of four management practices on crude protein and crude fiber contents of herbaceous plants' forage at Tillow area in South Kordofan in late rainy and mid dry seasons (2006/2007).

Item	Practice	Late rainy season (%)	Mid dry season (%)
Crude protein	Protected	5.4	3.4
	Protected and managed	4.2	3.2
	Grazed	5.6	4.0
	Grazed and burned	4.2	NA
	SE±	0.7ns	0.2ns
Crude fiber	Protected	35.5	36.9
	Protected and managed	35.3	37.9
	Grazed	34.1	35.3
	Grazed and burned	33.2	NA
	SE±	1.2ns	1.0ns

NA= Not Available

ns= No significant difference
$P < 0.05$

Table 2.Effect of four management practices on major elements (g/100g) contents of herbaceous plants' forage at Tillow area in South Kordofan in late rainy and mid dry season (2006/2007).

Minerals	Practice	Late rainy season (%)	Mid dry season (%)
Phosphorus	Protected	0.02	0.01
	Protected and managed	0.02	0.01
	Grazed	0.03	0.01
	Grazed and burned	0.03	NA
	SE±	0.005ns	0.004ns
Calcium	Protected	0.09	0.08
	Protected and managed	0.09	0.09
	Grazed	0.1	0.1
	Grazed and burned	0.1	NA
	SE±	0.008ns	0.003ns
Magnesium	Protected	0.03	0.03
	Protected and managed	0.03	0.03
	Grazed	0.03	0.04
	Grazed and burned	0.04	NA
	SE±	0.005ns	0.003ns
Sodium	Protected	0.001	0.002
	Protected and managed	0.002	0.001
	Grazed	0.002	0.002
	Grazed and burned	0.001	NA
	SE±	0.0003ns	0.0003ns
Potassium	Protected	0.06	0.03
	Protected and managed	0.05	0.05
	Grazed	0.05	0.05
	Grazed and burned	0.06	NA
	SE±	0.01ns	0.01ns

NA= Not Available

ns= No significant difference
$P<0.05$

Table 3.Effect of four management practices on trace elements (ppm) contents of herbaceous plants' forage at Tillow area in South Kordofan in late rainy season and mid dry season (2006/2007).

Minerals	Practice	Late rainy season (ppm)	Mid dry season (ppm)
Copper	Protected	0.09	0.03
	Protected and managed	0.07	0.05
	Grazed	0.06	0.07
	Grazed and burned	0.03	NA
	SE±	0.01ns	0.01ns
Iron	Protected	7.8	7.7
	Protected and managed	7.4	6.4
	Grazed	5.6	6.8
	Grazed and burned	8.3	NA
	SE±	2.0ns	1.9ns
Manganese	Protected	0.3	0.2
	Protected and managed	0.2	0.2
	Grazed	0.2	0.2
	Grazed and burned	0.2	NA
	SE±	0.05ns	0.02ns
Zinc	Protected	0.4	0.3
	Protected and managed	0.5	0.2
	Grazed	0.5	0.5
	Grazed and burned	0.50	NA
	SE±	0.09ns	0.12ns
Cobalt	Protected	0.06	0.12
	Protected and managed	0.11	0.13
	Grazed	0.11	0.11
	Grazed and burned	0.11	NA
	SE±	0.01ns	0.03ns

NA= Not Available

ns= No significant difference
P< 0.