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Nutritive value and palatability of some range grasses in low rainfall woodland savanna of South Darfur in Sudan

Abu bakr Omer Ismail[1], Mohammed Fatur[1*], Faisal Awad Ahmed[2], El Hadi Omer Ahmed[2] and Magda Elmahdi Elbushra Ahmed[3]

[1]Dept. of Animal Nutrition, College of Animal Production, University of Bahri, Sudan
[2]Ministry of Science and Technology, Range and Animal Research Station, Sudan
[3]Dept. of Animal Production, faculty of Agriculture, Sinnar University, Sudan
[*]Corresponding author email: fatour3@hotmail.com
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Abstract

Present study was conducted to evaluate the nutritional status and palatability of some range grass species at flowering stage from Ghazal Gawazat, Southern Darfur State, Sudan. Average CP and CF contents of the grasses were within the range of 5.57-10.74% and 37.06-51.29%, respctively. Nitrogen free extract (NFE) content was lower in *Brachiaria publifolia* (34.82) and higher in *Fimbritylis dichotoma* (50.07%). Average NDF and ADF contents of evaluated grasses varied significantly ($P<0.05$) and were within the range of 41.72-48.04 and 27.56-43.13% respectively. Energy value in terms of TDN, DE, ME, NE_M, NE_G and NE_L were maximum for *Brachiaria spp* (64.65%, 2.84, 2.33, 2.07, 1.76 and 0.66 Kcal/g, respectively) and minimum for Digitaria *spp* (46.74%, 2.05, 1.68, 1.45, 1.20 and 0.47 Kcal/g, respectively). DDM values were also highest and lowest for *Brachiaria spp* (67.42%) and *Digitaria spp* (55.29%), respectively. Average dry matter (DMI) and total digestible nutrients intake (TDNI) ranged from 2.49% in *Brachiaria spp* to 2.87% in *Cenchrus ciliaris* and 1.29% in *Digitaria spp* to 1.70% in *Fimbritylis dichotoma*, respectively. Relative feed value (RFV), quality index (QI) and relative forage quality (RFQ) values were higher for *Cenchrus ciliaris*, *Brachiaria spp* and *Fimbritylis dichotoma*, respectively, while RFV (104.79%) was lowest for *Fimbritylis dichotoma* and QI (1.36) and RFQ (105.08%) for *Digitaria spp*. *Brachiaria spp* had highest nutritive value, while *Cenchrus ciliaris* and *Fimbritylis dichotoma* exhibited highest palatability.

Keywords: Energy value, Grasses, Nutritive value, Palatability, Relative feed value

Abbreviations: ADF: Acid detergent fiber; **CF:** Crude fiber; **CP:** Crude protein; **DCP:** Digestible crude protein; **DDM:** Digestible dry matter; **DE:** Digestible energy; **DMI (%/BW):** Dry matter intake (percentage of body weight); **DMI (g/MW):** Dry matter intake ($MW=WKg^{0.75}$); **EE:** Ether extract; **ME:** Metabolize energy; **NDF:** Neutral detergent fiber; **NFE:** Nitrogen free extract; **NE_G:** Net energy for growth; **NE_L:** Net energy for lactation; **NE_M:** Net energy for maintenance; **OM:** Organic matter; **OMD:** Organic matter digestibility; **QI:** Quality index; **RFQ:** Relative forage quality; **RFV:** Relative feed value; **SD:** Stander deviation; **SEM:** Standard error of mean; **TDN:** Total digestible nutrients; and **TDNI:** Total digestible nutrient intake

Introduction

In Sudan, 80-90% of livestock is possessed by nomadic tribes who depend on rangelands for their livestock production. Natural rangelands support and provide feeds for a large number of livestock, which in turn plays a vital role in the national economy through provision of animal products for local consumption and exports (Fatur and Khadiga, 2007). Herbaceous species grown on natural rangelands play an important role in ruminant feeding worldwide (Arzani *et al*., 2006). Browse plants, beside grasses, also constitute as one of the cheapest sources of feeds for ruminants on rangelands (Ahamefule *et al.,* 2006). Although, grasses are more widespread than any other family of flowering plants (Patra *et al*., 2011). But nutritive value of such forages is mainly governed by its nutrient composition, digestibility and intake in animals (Singh and Shukla, 2010). Information on chemical composition and some other nutritional parameters on those forages/grasses have been reported earlier (Ganskopp and Bohnert, 2001; Balgees *et al*., 2011), however, data on palatability attributes (RFV, QI and RFQ and nutrients intake) and energetic efficiency for different animal functions are lacking. Although data on these parameters gives more precise and accurate information related to the nutritive value of grasses for animal

production. Keeping this in view the present study was undertaken to evaluate the range grasses for their nutritive value and palatability parameters at flowering stage from Gahzal Gawazat -Southern Darfur State of Sudan.

Materials and Methods

The samples of some range grasses (*Brachiaria spp, Brachiaria publifolia, Digitaria spp, Cenchrus ciliaris, Cenchrus biflourus, Eragrotis ganyetica, Eragrotis spp, Fimbritylis dichotoma, Setaria spp)* were collected from Ghazal Gawazat Livestock and Range Research Station, South Darfur State, Sudan. The climate of the study area is described as semi-arid with rainfall. Temperatures range from as low as 17°C in December to as high as 40°C in April, May and June during the peak summer prior to the rainy season. Rainfall ranges between 300 to 800 mm/year and its quantity increases from north to south. The total area of the research station is around 51.2 km^2 (Hunting Technical Services, 1976).

After harvesting the grass samples were dried in a hot-air oven and processed in a grinding machine. Organic matter (OM), crude protein (CP), ether extracts (EE) and crude fiber (CF) contents were determined from processed samples as per the procedure of AOAC (1992). Nitrogen free extract was determined by using the equation of Harris (1972), NFE % = 100 - (% crude protein + % Crude fiber + % ether extract + % ash). The digestible crude protein (DCP) was estimated as DCP% = 0.93 CP - 3.52 (Demmewguilly and Weiss, 1970). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were estimated following the procedure of Van Soest *et al*. (1991). Total digestible nutrients (TDN), metabolize energy (ME), net energy for maintenance (NE_M), net energy for growth (NE_G), net energy for lactation (NE_L), digestible dry matter (DDM), dry matter intake by percentage of body weight (DMI) and relative feed value (RFV)were calculated as per the procedure of Mantana State University (2012).

TDN% = 96.35-(1.15×ADF%), ME (Mcal/ kg) = 0.0362×TDN, NEM (Mcal/ kg) = (1.37 ME-0.138ME2+0.0105ME3-1.12)/2.205, NEG=(1.42 ME-0.174ME2+0.0122ME3-1.65)/2.205, NEL (Mcal/ kg) = (%TDN×0.01114)-0.054, DDM %= 88.9-(%ADF×0.779), DMI %/BW = 120/%NDF and RFV= (DDM × DMI)/1.29.

Organic matter digestibility (OMD), dry matter intake by metabolic weight ($Wk_g^{0.75}$), quality index (QI), relative forage quality (RFQ) and total digestible nutrient intake (TDNI) were calculated using following equations reported by Moore *et al*. (1984).

OMD% = 32.2+0.49×IVOMD%

DMI g/MW (MW = $Wk_g^{0.75}$) = 120.7 - 0.83 × NDF% of DM

TDNI g/MW = DMI g/MW×TDN % of DM / 100

QI = TDNI g/MW / 29

RFQ = (DMI% of BW) × (TDN% of DM) / 1.23

TDNI (% of BW) = RFQ×0.0123

While *in vitro* organic matter digestibility (IVOMD) was estimated using the regression equation: IVOMD% = 57.49 - 0.232CF - 0.725EE (Geri and Sottini, 1970), to calculate OMD. Each data point was obtained by making at least 3 independent measurements and data were subjected to statically analysis following the standard procedure. The results were expressed as mean ± SD (standard deviation) and SEM (standard error of mean).

Results and Discussion

Chemical composition: The nutritive value of any forage depends on its nutrient content such as protein, which is essential for the growth, development and production of ruminant animals (Habtamu *et al*., 2012). The mean CP contents of grasses was 7.88%, however its value ranged between 5.75-10.74% among the grasses (Table 1). It was earlier reported that CP content of herbaceous plants varied within the range of 6-8% which was found to be adequate for ruminants (Ganskopp and Bohnert, 2001). On the contrary, Minson (1990) argued that the critical level of CP content for tropical herbaceous species should be greater than 10.6%. In the present investigation, mean CP content of the studied grass species in Ghazal Gawazat was 7.88%, which was within the critical threshold level (Ganskopp and Bohnert, 2001), but it was still much below the critical level reported by Minson (1990).

In this study, the mean values of CP content was similar to those reported by Balgees *et al*. (2011) and Habtamu *et al*. (2012), but higher than to those reported by Chaurasia *et al*. (2006) and lower than to those reported by Eroarome (2001). This variation was probably due to differences in the species and also stage of maturity of grasses. The mean CF, NDF, and ADF contents of grasses were 44.34, 44.29 and 36.69 %, respectively. Fiber in forages is often the main source of energy for fore-gut fermenters (Graham and Aman, 1991). The mean NDF and ADF values for the individual grass species reported in this study were lower than the values reported by Chaurasia *et al*. (2006) and Muhammad *et al*. (2013). The cell wall constituents, *viz*., neutral detergent fiber, acid detergent fiber, hemi - cellulose and acid detergent

lignin were lowest at pre-flowering stage and increase continuously with the advancement of growth stage (Kharage *et al.,* 2014). Lower NDF and ADF contents in the present study were probality due to differences in maturity stage of grass harvested, i.e. at flowering stage. The OM, EE and NFE contents of the grasses varied between 94.96-97.58, 1.09-2.52 and 41.72-48.04%, respectively. The mean DCP contents were 3.81 % among the grasses. The EE and NFE values reported for grass species in current study were almost similar to the values reported by Eroarome (2001), but comparatively high in OM and DCP contents.

Energetic composition: Average TDN content (54.14%) of grasses was relatively higher when compared to the range of TDN values reported for grasses by earlier workers (Eroarome, 2001; Fatur and Khadiga, 2007; Chaurasia *et al*. 2006). However, the TDN contents in the present study corroborated with the TDN values of grasses (55-60%) reported by Stalling (2005). Digestible energy, metabolize energy and net energy values for different functions (maintenance, growth and lactation) varied across the grasses (Table 2). Mean DE and ME values were 2.37 and 1.95 k cal/g which ranged between 2.05-2.84 and 1.68- 2.33 k cal/g among the evaluated grasses. Although, mean values of DE and ME of grasses were lower when compared to the range of values reported by Eroarome (2001). DE and ME values in the present study corroborated with the reported values for grasses by Arab and Middle East Tables of Feed Composition (1979). Net energy value for maintenance, growth and lactation varied from 1.45-2.07, 1.2-1.76 and 0.47-0.66 kcal/g amongst the grasses.

Palatability attributes and forage quality indices of grasses: The DMI (% of body weight) of the evaluated grasses were as low as 2.49 in *Brachiaria spp* and as high as 2.87 in *Cenchrus ciliaris* with mean value of 2.71, while TDNI (% of body weight) was as low as 1.29 in *Digitaria spp* and as high as 1.70 in *Fimbritylis dichotoma* with mean value of 1.47 (Table 3). Indeed, the intake is the function of chemical composition of any forage/grass and its digestibility in the animals. Hence, forages / grasses with more CP and low fiber contents

Table 1. Chemical compositions and digestible crude protein content (% DM basis) of grasses

Grasses	OM	CP	CF	EE	NFE	NDF	ADF	DCP
Brachiaria spp	97.58	8.41	44.05	1.09	44.01	48.04	27.56	4.30
Brachiaria publifolia	95.36	10.74	48.52	1.27	34.82	44.45	37.59	6.47
Digitaria spp	94.96	9.26	45.27	2.52	37.89	43.34	43.13	5.08
Cenchrus ciliaris	96.50	6.91	48.92	2.12	38.53	41.72	36.50	2.90
Cenchrus biflourus	96.73	7.23	51.29	1.57	36.64	45.49	40.49	3.20
Eragrotis ganyetica	95.50	7.93	41.54	1.69	44.34	44.64	34.57	3.85
Eragrotis spp	94.75	6.88	37.09	1.46	49.31	45.09	40.99	2.88
Fimbritylis dichotoma	96.36	7.87	37.06	1.36	50.07	42.92	31.35	3.79
Setaria spp	97.58	5.75	45.39	2.24	41.90	43.00	38.08	1.82
Mean	95.89	7.88	44.34	1.70	41.94	44.29	36.69	3.81
SD	0.94	1.46	5.02	0.48	5.44	1.84	4.91	1.36
SEM	0.31	0.48	1.67	0.16	1.81	0.61	1.63	0.45

Table 2. Energy value of grasses

Forbs	TDN(%)	DE (kcal/g)	ME(kcal/g)	NE_M(kcal/g)	NE_G(kcal/g)	NE_L(kcal/g)
Brachiaria spp	64.65	2.84	2.33	2.07	1.76	0.66
Brachiaria publifolia	53.11	2.33	1.91	1.67	1.41	0.53
Digitaria spp	46.74	2.05	1.68	1.45	1.20	0.47
Cenchrus ciliaris	54.37	2.39	1.96	1.72	1.45	0.54
Cenchrus biflourus	49.78	2.19	1.79	1.56	1.30	0.49
Eragrotis ganyetica	56.58	2.49	2.04	1.79	1.52	0.57
Eragrotis spp	49.21	2.16	1.77	1.54	1.29	0.49
Fimbritylis dichotoma	60.28	2.65	2.18	1.92	1.63	0.61
Setaria spp	52.55	2.31	1.89	1.66	1.39	0.52
Mean	54.14	2.37	1.95	1.70	1.43	0.54
SD	5.65	0.24	0.20	0.19	0.17	0.06
SEM	1.88	0.08	0.06	0.06	0.05	0.02

Table 3. Palatability attributes of grasses and some indices of forage quality

Grassesspecies	DDM (%)	OMD (%)	DMI (g/MW)	TDNI (g/MW)	DMI (%/BW)	TDNI (%/BW)	RFV (%)	QI	RFQ (%)
Brachiaria spp	67.42	54.96	2.49	80.82	1.60	52.20	130.19	1.80	130.35
Brachiaria publifolia	59.61	51.39	2.70	83.80	1.43	44.48	124.63	1.53	116.39
Digitaria spp	55.29	54.31	2.76	84.71	1.29	39.61	118.48	1.36	105.08
Cenchrus ciliaris	60.46	54.04	2.87	86.06	1.56	46.82	134.78	1.61	127.18
Cenchrus biflourus	57.35	53.97	2.64	82.92	1.31	41.27	117.33	1.42	106.79
Eragrotis ganyetica	61.96	55.03	2.69	83.62	1.60	47.34	129.46	1.63	130.31
Eragrotis spp	56.96	55.62	2.65	83.27	1.30	40.98	117.31	1.41	106.30
Fimbritylis dichotoma	64.47	55.66	2.80	85.06	1.70	51.41	104.79	1.77	138.36
Setaria spp	59.23	54.40	2.79	85.00	1.46	44.67	128.41	1.54	119.48
Mean	60.30	54.37	2.71	83.91	1.47	45.42	122.82	1.56	120.03
SD	3.83	1.28	0.11	1.53	0.15	4.46	9.22	0.15	12.24
SEM	1.27	0.42	0.03	0.51	0.05	1.48	3.07	0.05	4.08

along with higher digestibility exhibited higher dry matter intake (Singh and Shukla, 2010). Mean of DDM and OMD of the grasses was 60.30 and 54.37%, respectively with maximum value of 67.42% for *Brachiaria spp* and 55.66% for *Fimbritylis dichotoma*. This variability in grasses for DDM and OMD might be due to differences in CP as well as cell wall (ADF, NDF) contents. The RFV of evaluated grasses ranged from 117.31 to 134.78% with its mean value of 122.82%. RFV of a forage varied with NDF and ADF contents and these values were higher than the range of RFV values reported for different grasses in semi-arid rangelands of Ethiopia at rainy season. Quality index (QI) and relative forage quality (RFQ) values for grasses were also ranged between 1.41 to 1.8 and 105.08 to 138.36%, respectively.

Conclusion

It was concluded that wide variability exists in the protein, fiber, digestible dry matter contents and other nutritional attributes (TDN, NE_L, NE_G, NE_M and RFV). *Brachiaria spp* was superior in nutritive value and *Cenchrus ciliaris* and *Fimbritylis dichotoma* exhibited highest palatability. Hence, these range grasses may be exploited for rehabilitation of rangelands in south Darfur state of Sudan.

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