

Nutritional Evaluation and Palatability of Major Range Forbs from South Darfur, Sudan

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Abstract

The nutritive value of rangelands in Southern Darfur, Sudan could be improved by introduction and multiplication of nutritious forbs with the objective of increasing livestock production in the area. The present study was conducted to evaluate the nutritive value and palatability of eleven range forbs collected at flowering stage from Gahzal Gawazat, Southern Darfur, Sudan using chemical analysis. The crude protein (CP) ranged from 6.8% in *Oxygonum atriplicifolium* with lowest digestible crude protein (DCP) 2.8% to 16.4% in *Zornia diphylla* with highest DCP 11.73%. The highest and the lowest crude fiber (CF) values were obtained in *Commelina* spp (56.4%) and *Sesamum alatum* (25.9%), respectively. NDF and DMI values were maximum and minimum for *Zornia diphylla* (44.9 and 2.67%) and *Alysicarpus glumaceus* (35.3 and 3.4%), respectively. The total digestible nutrients (TDN) ranged from 57.1% in *Blepharis linariifolia* to 69.3% in *Tribulus terrestris* with highest digestible energy (DE) in later while the lowest DE was obtained in *Commelina* spp (2.4%). The calculated *in vitro* organic matter digestibility (IVOMD) was highest for the *Canavalia ensiformis* (50.27%) and lowest value (43.17%) for *Commelina* spp. *Zornia diphylla*, *Tribulus terrestris* and *Sesamum alatum* showed highest nutritive value, while *Alysicarpus glumaceus*, *Oldenlandia senegalensis* and *Chrozophora brocchiana* showed highest palatability. It is concluded that these rangeland forbs are palatable and their CP and energy contents are sufficient to support different classes of livestock in South Darfur, Sudan.

Keywords

Forbs, Nutritive Value, Palatability, Relative Feed Value, Energy Value

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1. Introduction

Sudan is, as one of the largest countries in Africa, characterized by multi-environmental regions which permit different types of plants to grow naturally to meet the requirements of various types of livestock [1]. The total area of rangelands in South Darfour is about 466.5 ha and annual rainfall is 428 mm [2]. As per recent estimate, South Darfour had 11.2 million livestock consisting 4.2 million cattle, 3.8 million sheep, 3 million goats and 0.2 million camels [3].

Rangeland is defined as uncultivated land that sustains animals through grazing and browsing [4] and contributes substantially in national economy by means of animal products for local consumption and exports. Under Sudan's Savannah environment, the pasture is composed predominantly of annual grasses with some forbs. In general, the majority of the ruminants in sub-Saharan Africa are raised on rangelands where feed resources are mostly natural grazing grasses, forbs with some browse shrubs and trees [5]. To improve the nutritive value of rangelands introduction and multiplication of nutritious forbs is important to increase the livestock production. Keeping this in view, 11 dominant forbs of Gahzal Gawazat (Southern Darfur State) were evaluated for nutritive value and palatability attributes (intake, relative feed value).

2. Materials and Methods

2.1. Study Area

The samples have been collected from Ghazal Gawazat Livestock and Range Research Station in 2013 rainy season, South Darfur spread in 51.2 Km² area, divided by fire-lines into twenty (20) equal grazing paddocks of 2.56 Km² each, covering an area of about 5310 ha [6].

2.2. Samples Collection

The plants species of natural range were collected from Gahzal Gawazat by line transect method of [7] when herbs start set a flowering stage.

Line Transect Method

Equipments used:

- (1) one meter tape (100 m);
- (2) loop (3/4 inches);
- (3) recording sheet.

The number of samples being used in this experiment depends largely on the approximate count of the most common species available in the area. Since it is rather difficult to measure or count the entire species population. In this method, numbers of samples were determined by plotting the number of species and samples recorded in vertical and horizontal axis respectively (**Figure 1**) using many random transects across the study area. A general vegetation survey-list was obtained for the most commonly repeated range vegetation species in the study area.

As shown in **Figure 1**, the number of species recorded was about 74 species in each 500 observation per each paddock where no more new species were recorded.

The numbers of samples taken were recorded in the horizontal axis of the curve. As the curve indicates when the number of samples increases the number of new species recorded increases till no new species found, the curve remain still or started to decline with the increase of sample's number. This point is called "point of diminishing returns" where no new species were recorded with the increased number of samples.

The method of counting of the vegetation included recording of information being observed such counts were taken every one-meter along the 100 meter tape using ¾ inch loop. Resulting information's were listed in the recording sheet.

The harvest was at a height of 5 cm using scissor, for each herb separately as shown in **Table 1**.

2.3. Sample Preparation

The samples were air dried under shade and then in oven at 65°C and the dried samples were ground to pass through a 1mm screen using grinding mill. About 250 gram of each sample was kept in plastic bag for analysis.

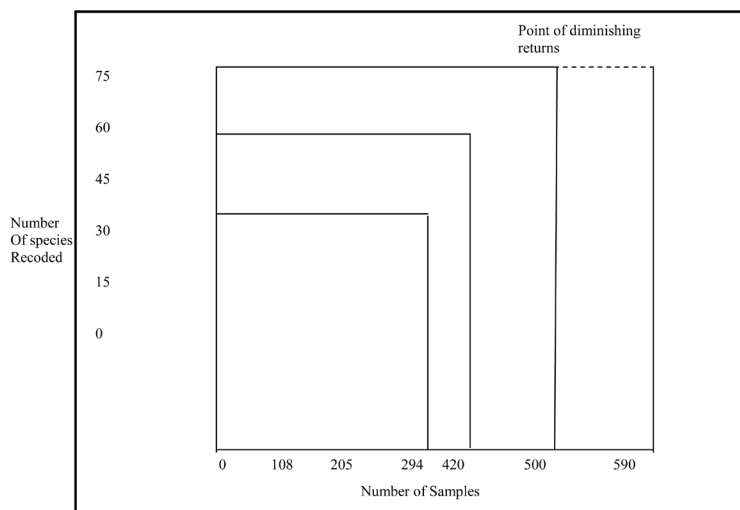


Figure 1. Vegetation measurement by area curve method.

Table 1. Botanical, family name and local name of range forbs.

Scientific Name	Family name	Local name
<i>Alysicarpus glumaceus</i>	Papilionoideae	Abu Niggaigira
<i>Blepharis linariifolia</i>	Acanthaceae	Bighail
<i>Canavalia ensiformis</i>	Fabaceae	Lubia El Feel
<i>Chrozophora brocchiana</i>	Euphorbiaceae	Argise
<i>Commelina spp</i>	Commelinaceae	Bead
<i>Indigofera spp</i>	Papilionoideae	Ashrot
<i>Oldenlandia senegalensis</i>	Rubiaceae	Garagoub
<i>Oxygonum atriplicifolium</i>	Polygonaceae	Um Hamid
<i>Sesamum alatum</i>	Pedaliaceae	Simsim El gumal
<i>Tribulus terrestris</i>	Zygophyllaceae	Deraisa
<i>Zornia diphylla</i>	Fabaceae	Losaik

2.4. Chemical Analysis

Proximate analyses were determined according to [8]. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were estimated as per procedure of [9].

The digestible crude protein (DCP) was estimated as $DCP\% = 0.93CP - 3.52$ [10] and the *in vitro* organic matter digestibility (IVOMD) was estimated using the regression equation: $Y = 57.49 - 0.232X - 0.725Z$ [11]. Where Y is the true IVOMD, X is the crude fiber, and Z is the ether extract. While the total digestible nutrients (TDN), digestible energy (DE), net energy for lactation NE_L , net energy for maintenance NE_M , net energy for growth NE_G , dry matter intake (DMI), dry matter digestibility (DMD) and relative feed value RFV were determined by using following formulas :

$$TDN\% = 104.97 - (1.302 \times ADF)$$

$$DE(kcal/g) = TDN \times 0.04409$$

Equations given by [12]

$$NE_L = 3.058 - (0.04409 \times ADF) \tag{1}$$

$$NE_M = (TDN \times 0.029) - 0.129 \quad (2)$$

$$NE_G = (TDN \times 0.029) - 1.01 \quad (3)$$

$$DMI\%/weight = 120/NDF \quad (4)$$

$$RFV = DMI \times DMD \times 0.775 \quad (5)$$

Equations given by [13]

$$DMD\% = 0.98CC + NDF(1.473 - 0.789\text{Log ADF}) - 12.9 \quad (6)$$

where CC is cell contents, NDF the neutral detergent fiber and ADF the acid detergent fiber [14].

Each data point was obtained by making at least 3 independent measurements. The results were expressed as mean \pm SD (Standard deviation).

3. Results and Discussion

The organic matter contents in forbs species ranged from 66.7% (*Tribulus terrestris*) to 97% (*Canavalia ensiformis*) with mean value of 90.1% (Table 2). The highest percentage of CP was recorded in *Zornia diphylla* (16.4%) and lowest was in *Oxygonum atriplicifolium* (6.8%) and these values are within the range of CP values reported for forbs by [5]. Reference [15] reported mean CP content of herbaceous species in rangeland is 10.6% during the main growing season also substantiate our results. Earlier studies on a wide variety of naturally growing native herbaceous in East Africa [16] and [17] indicated CP content in the range of 9.5% - 35.9%. The mean of eleven species evaluated in present study was within this range. The CP content of herbaceous plants within the range of 6% - 8% is adequate for ruminants [18]. On the contrary, [19] argue that the critical level of CP content for tropical herbaceous species should be greater than 10.6%.

The highest percentage of crude fiber was recorded in *Commelina* spp (56.4) and lowest in *Sesamum alatum* (25.9%). However, the mean value of ether extract in forbs species was ranged from 1.5% (*Blepharis linariifolia*) to 2.7% (*Oxygonum atriplicifolium*). Neutral detergent fiber is the most important determinant for overall quality and digestibility of forage (Linn 2004). The NDF contents in the forbs species varied from 35.3% (*Alysicarpus glumaceus*) to 44.9% (*Zornia diphylla*) with a mean value of 40.4%. These values of NDF are lower than reported by [1], and this variation in NDF contents may be due to difference in maturity stage of forbs. The ADF contents of herbs ranged from 27.4% (*Tribulus terrestris*) to 38.6% (*Commelina* spp), among selected species and their mean was 34.1% and these results are similar to the findings of [20].

Energy value and palatability attributes of forbs were shown in Table 3. Total digestible nutrients of forbs were lowest in *Commelina* spp (54.7) with highest in *Tribulus terrestris* (69.3%). Mean values of DE and DCP of rangeland herbs were 2.7 Kcal/g and 6.18%, which ranged between 2.4 - 3.06 Kcal/g and 2.8% - 11.73% among the evaluated forbs. Net energy value for maintenance, growth and lactation varied amongst the forbs from 1.45 - 1.88, 0.58 - 1.0 and 1.4 - 1.85 Kcal/g, respectively. Highest *in vitro* organic matter digestibility was recorded in *Canavalia ensiformis* (50.27%) and the lowest was in *Commelina* spp (43.17%), while the mean value of IVOMD for herbs was 47.25%.

The DMI of the forbs were as low as 2.65% in *Tribulus terrestris* and as high as 3.4% in *Alysicarpus glumaceus* with mean value of 3%.

Mean (DMD%) of the forbs was 56.3 with maximum value of 59.53% for *Alysicarpus glumaceus*. Since the intake is the function of crop chemical composition and its digestibility. Judging from the calculated coefficients of dry matter digestibility, all of these species have digestibility values above 45% which is considered adequate for high animal performance on pastures [21] [22]. On the same hypothesis hybrids with more CP and low fiber along with higher digestibility exhibited higher dry matter intake [23]. The RFV of forbs ranged from 108.3 for *Commelina* spp to 156.9 for *Alysicarpus glumaceus*, with its mean value of 130.7%.

The results of study revealed that *Zornia diphylla* had highest nutritive value, but not highest palatability. This is because beside its nutritive value in terms of chemical composition contents, it may tends to consist of some aromatic smells and it tends to a very fast attachment on the animal's skin causing some injuries, that, repels grazing animal from being of their priority preference during selective grazing. Reference [24] argued that many

Table 2. Chemical compositions (%) of forbs on dry matter basis.

Forbs	OM	CP	CF	EE	NDF	ADF
<i>Alysicarpus glumaceus</i>	95.9	07.5	42.7	2.4	35.3	35.2
<i>Blepharis Linariifolia</i>	96.3	09.2	37.9	1.5	37.8	36.8
<i>Canavalia ensiformis</i>	97.0	12.1	26.1	1.6	43.2	33.4
<i>Chrozophora brocchiana</i>	95.7	08.6	27.2	2.1	37.2	35.2
<i>Commelina spp</i>	96.9	07.5	56.4	1.7	44.2	38.6
<i>Indigofera spp</i>	95.7	10.8	26.3	2.1	38.0	36.9
<i>Oldenlandia senegalensis</i>	94.9	08.6	48.5	1.9	36.9	32.7
<i>Oxygonum atriplicifolium</i>	82.1	06.8	43.6	2.7	43.1	29.4
<i>Sesamum alatum</i>	86.4	15.2	25.9	1.7	39.2	34.9
<i>Tribulus terrestris</i>	66.7	12.0	37.5	1.6	44.2	27.4
<i>Zornia diphylla</i>	83.4	16.4	45.1	2.5	44.9	35.1
Mean	90.1	10.4	37.9	2.0	40.4	34.1
SD	9.6	3.2	10.5	0.4	3.6	3.3

DM = Dry matter, OM= Organic matter, CP = Crude protein, CF = Crude fiber, EE = Ether extract, NDF = Neutral detergent fiber, ADF = Acid detergent fiber.

Table 3. Energy value and palatability attributes of forbs.

Forbs	TDN %	DE Kcal/g	NE _M Kcal/g	NE _G Kcal/g	NE _L Kcal/g	DMI %	DMD %	RFV %	IVOMD %	DCP %
<i>Alysicarpus glumaceus</i>	59.2	2.61	1.59	0.71	1.51	3.40	59.53	156.9	45.84	3.46
<i>Blephariis Linariifolia</i>	57.1	2.52	1.53	0.65	1.44	3.25	57.00	143.5	47.61	5.04
<i>Canavalia ensiformis</i>	61.4	2.71	1.65	0.77	1.58	2.78	54.40	117.3	50.27	7.73
<i>Chrozophora brocchiana</i>	59.8	2.64	1.61	0.73	1.51	3.22	58.11	145.0	49.66	4.48
<i>Commelina spp</i>	54.7	2.40	1.45	0.58	1.40	2.71	51.58	108.3	43.17	3.46
<i>Indigofera spp</i>	57.0	2.51	1.52	0.64	1.43	3.17	56.82	139.9	49.87	6.52
<i>Oldenlandia senegalensis</i>	62.3	2.75	1.68	0.80	1.62	3.26	59.12	149.2	44.86	4.47
<i>Oxygonum atriplicifolium</i>	66.8	2.95	1.81	0.93	1.77	2.70	56.48	118.2	45.42	2.80
<i>Sesamum alatum</i>	59.5	2.62	1.60	0.72	1.52	3.06	56.72	134.5	50.25	10.62
<i>Tribulus terrestris</i>	69.3	3.06	1.88	1.00	1.85	2.65	56.59	116.3	47.63	7.64
<i>Zornia diphylla</i>	59.3	2.61	1.59	0.71	1.51	2.67	52.43	108.7	45.21	11.73
Mean	60.5	2.70	1.60	0.70	1.60	3.00	56.30	130.7	47.25	6.18
SD	4.3	0.2	0.1	0.1	0.1	0.3	2.5	17.4	2.5	3.0

TDN = Total digestible nutrients, DE = Digestible energy, NEM = Net energy for maintenance, NEG = Net energy for growth, NEL = Net energy for lactation, DMI = Dry matter intake, DMD = Dry matter digestibility, RFV = Relative feed value, IVOMD = In vitro organic matter digestibility and DCP = Digestible crude protein.

forage species known to be highly nutritious in terms of chemical content may lack palatability and thus have lesser value as animal feed. The chemical composition of forage in itself is an incomplete measure of nutritive value of forage [15].

4. Conclusion

Forbs are important components of grassland ecosystem of the semi-arid and dry sub-humid savannas of West Africa. It can be concluded from the results of this study that these rangeland forbs are palatable and their CP content is high and promising to support different classes of livestock. The forbs appear promising in terms of their energy content for supporting production in South Darfur.

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