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Nutritional Evaluation of Major Range Grasses from Cholistan Desert

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Abstract: A study was conducted with the objective of evaluating the nutritional status of ten grass species from Cholistan desert. The evaluated species were: *Aeluropus lagopoides*, *Cenchrus ciliaris*, *Cymbopogon jwarancusa*, *Lasiurus scindicus*, *Ochthochloa compressa*, *Panicum antidotale*, *Panicum turgidum*, *Pennisetum divisum*, *Sporobolus iocladus* and *Stipagrostis plumosa*. Proximate analysis showed that the investigated grasses have deficient levels of crude protein and ether extract to meet the requirements of ruminants being reared there but have sufficient supplies of dry matter, crude fiber and ash. However, fiber analysis reflected that all the ten investigated grasses have high levels of neutral detergent fiber, acid detergent fiber, hemi-cellulose and lignin.

Key words: Cholistan desert, grasses, nutritive value, fiber analysis

INTRODUCTION

Cholistan desert is an extension of Great Indian Desert and located in southern part of Punjab province (Pakistan). It lies between latitudes 27°42' and 29°45' North and longitudes 69°52' and 75°24' east (Baig *et al.*, 1980). The major chunk of land comprising of sandy and clay patches. Based on topography, parent material and soil, whole desert is divided into two geomorphic zones lesser and greater Cholistan. The lesser Cholistan consists of large saline compact areas ('Dahars') alternating with low sandy ridges. Sand dunes are stabilized, semi-stabilized or shifting, while the valleys are mostly covered with sand. The soils of desert are categorized as either saline or saline sodic; with pH varied from 8.2 to 8.5 and 8.9 to 9.7, respectively (Akhter and Arshad, 2006). The greater Cholistan is a wind sorted sandy desert and consist of river terraces, large sand dunes and a lesser amount of interdunal areas. Cholistan is one of the hottest deserts in Pakistan. The climate of the study area is hot arid with rainfall being the major factor influencing the life of local people as well as livestock. Temperatures are high in summer and mild in winter with no frost. In summer, temperature may reach to more than 51°C and in winter it drops down below freezing point (Hameed, 2002; Arshad *et al.*, 2008). May and June are the hottest months with mean temperature 34°C. Average annual rainfall varies from 100 mm to 200 mm. Most of the rainfall is received during monsoon (July-September) but winter rains (January-March) are also often (Arshad *et al.*, 2006). Due to scanty and unpredictable rainfall along with long spells of droughts, water is a limited resource in Cholistan desert. Aridity is the most striking characteristic of the area with dry and wet years occurring in clusters (Akhter and Arshad, 2006).

The nutritional quality of grasses in natural rangelands is very important for maintaining the health of grazing animals. Most of the rangelands in arid regions have less productivity due to low soil moisture and rainfall (Walker and Knoop, 1987). This might be results in seasonal shortage and low nutritional value of available grasses that can limit animal production (Bergstrom and Skarpe, 1999). Grass chemical composition can be used as an index of overall diet quality, although chemical composition of grass varies among species (Norton, 1982). Additionally, grass nutritional quality differs with space and time (Jones and Wilson, 1987). Generally, if grasses are not of adequate quality to overcome deficiencies in these dietary parameters, range managers are forced to utilize expensive supplements to lessen the nutrient deficiencies and maintain livestock production because low grass quality has a great negative effect on animal performance (Bransby, 1981). Several factors can affect nutritional quality of grasses and ultimately, animal production. Soil quality (Snyman, 2002), water availability (Milchunas *et al.*, 1995), grazing (McNaughton, 1992) and fire (Trollope, 1982) and have been identified as the major factors affecting nutritional quality of grass in rangelands.

Range animal productivity depends upon the amount and nutritive quality of vegetation available to grazing animals. The nutritional demands of livestock vary with age and physiological functions of the grazing animal such as growth maintenance, gestation, fattening, lactation etc. Plant material is divisible into fibrous and non-fibrous fractions. Chemical composition varies from plant to plant and within different parts of the same plant (Driehuis *et al.*, 1997). It also varies within plants from different geographic locations, climate, ages and

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edaphic conditions. Most of rangelands of Pakistan have insufficient forage of low palatability due to over-stocking. Many studies have assessed the nutritional value of forage in natural rangelands (Islam *et al*., 2003; Nasrullah *et al*., 2003).

Natural grazing land includes annual and perennial species of grasses, forbs and trees. Grasses are directly related to the quantity and quality on offer (Ramirez *et al*., 2004). While there are many quality characteristics that influence the intake of grasses by livestock, the most useful are digestibility and crude protein; hence, where available, these figures are provided for individual species. Poor nutrition is one of the major limitations to livestock production (Osuji *et al*., 1993). This tends to minimize the nutritional quality of available fodder. As a result, ruminants are incapable to meet their energy, protein and mineral necessities (Simbaya, 1998; Van Niekerk, 1997). Grasses are the main source of energy and nutrition during wetter months of the year; however, mineral contents in grasses become deficient for normal maintenance of health and growth of ruminants during dry season (Moe, 1994). The majority of grass species in Cholistan desert starts germination, flowering and seed setting in the wet season, while in the dry season the residue of nearly all grasses become indigestible and lignified. Although these grasses grow readily, remain green and are important source of feed for grazing animals but their nutritional composition was not known until now. Therefore, this study was planned to fulfill the previous gap with the aim to provide baseline information about the nutritious status of major grasses from Cholistan desert.

MATERIALS AND METHODS

Procurement of samples: The samples of grass species consisting of leaves, flowers and tender branches were collected during the monsoon season. These samples were dried in the air and stored in polythene bags for further analysis in the laboratory. Each sample was analyzed three times to get the authenticity of results.

Proximate analysis: Dry Matter (DM), Crude Protein (CP), Crude Fiber (CF), Ether Extract (EE) and Ash of the samples were determined according to AOAC (1994). Nitrogen Free Extract was determined by using following formula:

$$\text{NFE \%} = 100 - (\text{\% Crude protein} + \text{\% Crude fiber} + \text{\% Ether extract} + \text{\% Ash})$$

Fiber analysis: The cell wall contents Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and lignin were determined by the methods of Van-Soest *et al*. (1991). Hemicellulose was calculated by the difference of NDF and ADF.

Data analysis: The data obtained were subjected to analysis of variance while least significance was used to estimate difference between treatments mean by using the computer software Statistica 3.1 (Steel *et al*., 1997).

RESULTS

Results of proximate analysis of ten range grasses from Cholistan desert are presented in Table 1. The dry matter contents in grass species was ranged from 95.15% (*Ochthochloa compressa*) to 96.50% (*Lasiurus scindicus*) and the average was 95.48%. The DM values for other grasses were *Cymbopogon jwarancusa* 95.30%, *Sporobolus iocladus* 95.33%, *Stipagrostis plumosa* 95.33%, *Panicum antidotale* 95.40%, *Pennisetum divisum* 95.20%, *Cenchrus ciliaris* 96% and *Panicum turgidum* 96.20%. The crude fat in grass species was ranged from 1% (*Sporobolus iocladus*) to 2.51% (*Panicum antidotale*). The mean value of all grasses was 1.91%. The EE values for other grasses were *Aeluropus lagopoides* 2.40%, *Cenchrus ciliaris* 1.50%, *Cymbopogon jwarancusa* 2.40%, *Lasiurus scindicus* 1.16%, *Ochthochloa compressa* 1.49%, *Panicum turgidum* 2.49%, *Pennisetum divisum* 2.50% and *Stipagrostis plumosa* 1.60%. The highest percentage of crude fiber was recorded in *Pennisetum divisum* (58.53%) and lowest was in *Cenchrus ciliaris* 30.89%. However, CF values for other grasses were *Aeluropus lagopoides* 44%, *Cymbopogon jwarancusa* 35.15%, *Lasiurus scindicus* 55.18%, *Ochthochloa compressa* 39.56%, *Panicum antidotale* 43.21%, *Panicum turgidum* 45.47%, *Sporobolus iocladus* 46% and *Stipagrostis plumosa* 37.20%. The ash contents in grasses were varied from 4.62% (*Pennisetum divisum*) to 20.69% (*Cenchrus ciliaris*) and the mean value was 10.54%. Whereas, crude ash values for other grasses were *Aeluropus lagopoides* 9.60%, *Cymbopogon jwarancusa* 9.81%, *Lasiurus scindicus* 10.28%, *Ochthochloa compressa* 9.93%, *Panicum antidotale* 7.17%, *Panicum turgidum* 9.15%, *Sporobolus iocladus* 14.94% and *Stipagrostis plumosa* 9.20%. The maximum percentage of nitrogen free extract was recorded in *Cymbopogon jwarancusa* (48.26%) and the lowest was in *Lasiurus scindicus* (29%). The mean NFE values for other grasses were *Aeluropus lagopoides* 38.37%, *Cenchrus ciliaris* 42.78%, *Ochthochloa compressa* 40.76%, *Panicum antidotale* 41.64%, *Panicum turgidum* 36.69%, *Pennisetum divisum* 29.45%, *Sporobolus iocladus* 32.96% and *Stipagrostis plumosa* 44.50%. The neutral detergent fiber contents in the grass species was varied from 64% (*Aeluropus lagopoides*) to 74% (*Pennisetum divisum*). However, NDF values for other

Table 1: Proximate and fiber composition (%) of grasses

Species name	DM	EE	CF	CA	CP	NFE	NDF	ADF	Hemi cellulose	Lignin
Aeluropus lagopoides	95.40^{abc}	2.40^{a}	44.00^{d}	9.60^{cd}	5.63^{c}	38.37^{f}	64^{e}	41^{cd}	23^{g}	4.6^{cd}
Cenchrus ciliaris	96.00^{ab}	1.50^{b}	30.89^{h}	20.69^{a}	4.37^{e}	42.78^{c}	73^{ab}	37^{e}	38^{a}	5.6^{ab}
Cymbopogon jwarancusa	95.30^{bc}	2.40^{a}	35.15^{g}	9.81^{cd}	4.38^{e}	48.26^{a}	70^{bc}	43^{bc}	27^{ef}	4.8^{c}
Lasiurus scindicus	96.50^{abc}	1.16^{bc}	55.18^{b}	10.28^{c}	4.38^{e}	29.00^{h}	72^{abc}	41^{cd}	31^{bcd}	5.9^{a}
Ochthochloa compressa	95.15^{c}	1.49^{b}	39.56^{e}	9.93^{c}	8.27^{a}	40.76^{de}	72^{abc}	39de	33^{b}	4.9^{c}
Panicum antidotale	95.40^{bc}	2.51^{a}	43.21^{d}	7.17^{e}	5.47^{cd}	41.64^{cd}	69^{cd}	42^{bcd}	27^{ef}	4.8^{c}
Panicum turgidum	96.20^{a}	2.49^{a}	45.47^{c}	9.15^{d}	3.20^{f}	39.69^{ef}	65^{e}	33^{f}	32^{bc}	4.6^{cd}
Pennisetum divisum	95.20^{bc}	2.50^{a}	58.53^{a}	4.62^{f}	4.90^{de}	29.45^{h}	74^{a}	50^{a}	24^{fg}	5.8^{ab}
Sporobolus iocladus	95.33^{bc}	1.00^{c}	46.00^{c}	14.94^{b}	4.98^{de}	32.96^{g}	66de	37^{e}	29^{cde}	4.4^{d}
Stipagrostis plumosa	95.33^{bc}	1.60^{b}	37.20^{f}	9.20^{d}	7.50^{b}	44.50^{b}	73^{ab}	45^{b}	28de	5.5^{b}
Mean	95.48	1.91	43.52	10.54	5.31	38.74	69.8	40.8	29.2	5.09
SEM	0.28	0.16	0.35	0.24	0.22	0.55	1.2	1.197	1.154	0.106

Key: Mean with same superscripts ^{abc} in the same column within the grass species does not differ significantly at $p>0.05$.
SEM: Standard Error of mean; Mean values based on three replicates; DM: Dry Matter; EE: Ether Extract; CF: Crude Fiber; CA: Crude Ash; CP: Crude Protein; NFE: Nitrogen Free Extract; NDF: Neutral-detergent fiber; ADF: Acid-detergent fiber. * Values on dry matter basis.

grasses were *Cenchrus ciliaris* 73%, *Cymbopogon jwarancusa* 70%, *Lasiurus scindicus* 72%, *Ochthochloa compressa* 72%, *Panicum antidotale* 69%, *Panicum turgidum* 65%, *Sporobolus iocladus* 66% and *Stipagrostis plumosa* 73%. The mean value of all ten grasses for NDF was 69.8%. The ADF contents of grasses ranged from 33% (*Panicum turgidum*) to 50% (*Pennisetum divisum)* among selected species and their mean was 40.8%. However, ADF contents in other grasses was *Aeluropus lagopoides* 41%, *Cenchrus ciliaris* 37%, *Cymbopogon jwarancusa* 43%, *Lasiurus scindicus* 41%, *Ochthochloa compressa* 39%, *Panicum antidotale* 42%, *Sporobolus iocladus* 37% and *Stipagrostis plumosa* 45%. The percentage of hemi-cellulose contents in the grasses of Cholistan rangeland were varied between 38% in *Cenchrus ciliaris* to 23% in *Aeluropus lagopoides* and the mean was 29.2%. Whereas hemicellulose contents in remaining grasses was *Cymbopogon jwarancusa* 27%, *Lasiurus scindicus* 31%, *Ochthochloa compressa* 33%, *Panicum antidotale* 27%, *Panicum turgidum* 32%, *Pennisetum divisum* 24%, *Sporobolus iocladus* 29% and *Stipagrostis plumosa* 28%. The lignin contents of Cholistan rangeland grasses were varied between 4.4% in *Sporobolus iocladus* to 5.9% in *Lasiurus scindicus* with mean value 5.09%. However, lignin contents in other grasses was *Aeluropus lagopoides* 4.6%, *Cenchrus ciliaris* 5.6%, *Cymbopogon jwarancusa* 4.8%, *Ochthochloa compressa* 4.9%, *Panicum antidotale* 4.8%, *Panicum turgidum* 4.6%, *Pennisetum divisum* 5.8% and *Stipagrostis plumosa* 5.5%.

DISCUSSION

Dry matter is the actual amount of feed material leaving water and volatile acids and bases if present. The DM contents of these grasses are used for feeding livestock in the study area. Generally, grasses had more dry matter than shrubs. In present study, the mean value of all ten grasses was 95.48%, showed that the grasses of Cholistan desert have high dry matter production. Findings of present study indicated that the grasses of Cholistan desert constitute a major, reasonable and dependable source of dry matter. Our results are in agreement with some earlier researchers who have reported high dry matter production in various forages (Kramberger and Klemencic, 2003; Groberek, 2004).

Ether extract is the lipid fraction which is a major form of energy storage in the plant. This energy is derived from the plants and is used for body maintenance and production in livestock. In the present study, the mean value for ether extract of all grasses was 1.91%. The low concentration of ether extract or crude fat is a characteristic of forages of arid regions (Adu and Adamu 1982; Aregherore, 2001). Our results are similar to the findings of Shakeri and Fazaeli (2004) but lower as reported by Hussain and Durrani (2009a).

Ash contents play an important role in promoting the balanced growth of animals. In present study, results showed that the grasses have optimum level of crude ash. Similar to our findings, Kilcher (1981) also reported ash contents of different forages. The ash content of grasses in present study can be compared with that of forages analyzed by Groenewald *et al.* (1967) but was much higher than the values reported by Smith *et al.* (1980) and Underwood and Suttle (1999).

Results showed that the mean value for crude protein of all investigated grass species was 5.31%. The ruminant requirements for crude protein in the daily diet range from 7-20% depending upon sex, species and physiological status (Huston *et al.*, 1981). The results of protein contents in present study are in consistent with the values recorded by Mero and Uden (1998) and those reported by Matizha *et al.* (1997) in the tropical region. Crude protein contents in these grass species growing under natural conditions were below the expected value. Plant age and environmental conditions may affect the nutritive value of grasses (El-Shatnawi *et al.*, 2004). Tuna *et al.* (2004) has reported that the protein contents of grasses were between 3.85-7.80% which was nearly to our results but lower than values reported by Kearl (1982) who suggested that 11-13% level of crude protein in the diet is sufficient for maintenance and growth requirements of sheep and goats. Our findings are also in accordance with those of Distel *et al.* (2005), Sultan *et al.* (2007) and Hussain and Durrani (2009b), who have analyzed the crude protein in several grass species.

Grasses generally had greater crude fiber contents than any other forage plants (Holechek *et al.*, 1998). Although a high crude fiber usually shows a high level of lignification and thus reduced the amount of available energy (Nordfeldt *et al.*, 1961). In our findings, the highest percentage of crude fiber was observed in *Pennisetum divisum* (58.53%) and lowest was in *Cenchrus ciliaris* (30.89%). Mature plants usually contained high CF than young plants. Seasonal variations affect the crude fiber contents (Azim *et al.*, 1989). The range of crude fiber in the present study was greater when compared to other grass species as reported by Ashraf *et al.* (1995).

The grasses have generally higher NFE value than other forages. The highest percentage of nitrogen free extract was recorded in *Cymbopogon jwarancusa* (48.26%) and the lowest was in *Lasiurus scindicus* (29%) while the mean value for all grass was 38.74%. The NFE values were ranged higher in the present case as compared to those reported by Liu (1996) for other pasture plants of arid land. Our findings are similar to the results of Cook and Stubbendieck (1986) and Naseem *et al.* (2006) who have also reported NFE in various grass species.

The information about NDF digestibility in forage is important for efficient livestock feeding due to its direct effect on animal performance and variability in rumen degradation (Oba and Allen, 1999). Cholistan desert have hot arid climate and low soil moisture which influence the plant growth and effect its nutritional status. In present study, NDF contents ranged from 64% (*Aeluropus lagopoides*) to 74% (*Pennisetum divisum*). The results of the present study are similar to those of Bohn (1990) who reported that soil with lower moisture produced more stems with higher NDF and lignin contents. Likely, Inam-ur-Rahim (2002) reported that the free grazing and marginal rangeland grasses revealed the characterize components depending on their anatomical structure and growing pattern. Neutral detergent fiber is the most important determinant for overall quality and digestibility of forage (Linn, 2004). Higher the NDF percentage, the lower the crude protein, fats, starches and sugars. High level of NDF also lowers the voluntary dry matter intake of ruminants. Our findings are almost in line with those of Kandil and El-Shaer (1990), Andrighetto *et al.* (1993) and Hussain and Durrani (2009c). They have reported NDF contents in different range plants.

In current study, ADF contents of grasses ranged from 33% (*Panicum turgidum*) to 50% (*Pennisetum divisum*). Higher ADF contents in analyzed grasses are might be due to extreme climatic conditions of the study area (Van Soest *et al.*, 1991). Similar trend was observed by Ghadaki *et al.* (1975), who reported that, an increase in fiber constituents depend upon plant growth and environmental conditions. Tuna *et al.* (2004) investigated that grasses have low protein content but higher NDF and ADF that are close to our findings. Our findings are also supported by those of Ashraf *et al.* (1995), Kramberger and Klemencic (2003) and Sultan *et al.* (2007), who have reported ADF contents in different grasses.

The hemi-cellulose concentration was varied between 23 to 38% and the mean was 29.2%. The highest hemi-cellulose value was observed for *Cenchrus ciliaris* and the lowest for *Aeluropus lagopoides*. Grasses generally have higher hemicelluloses contents than other forages (Foroughbakhch *et al.*, 2012). Livestock preferred grasses as they can efficiently use cellulose and hemi-cellulose because the micro-organisms in their digestive system are capable of digesting them (Holecheck *et al.*, 1998). Present findings are similar to those reported by Fariani (1996), Hussain and Durrani (2009b) and Inam-ur-Rahim (2002).

Lignin is usually considered as a major factor that limits the digestibility but it does not affect all feed components. Non-cell wall components are not influenced by lignin but they often can be highly correlated (Jancik *et al.*, 2010). In current study, lignin concentration was in the range of 4.4 to 5.9% and the mean was 5.09%. The highest value was observed for *Lasiurus scindicus* and lowest value was for *Sporobolus iocladus*. Our findings are in line with those of Robles and Boza (1993) who found lower lignin contents in grasses than shrubs. Similarly, Azim *et al.* (1989) also reported that lignin contents increase with age and cause a corresponding decrease in the nutritive value. Lignin digestibility of plants is quite unpredictable and variable by ruminants. It was observed in present study that non/less palatable species such as *Cymbopogon jwarancusa* and *Saccharum bengalence* grow vigorously with better distribution and plant cover. It was suggested that rapid growth of cell wall components, rapid lignification and quick reduction in CP might permit the unpalatable plants to avoid from grazing (Hussain and Durrani, 2007, 2008; Sultan *et al.*, 2007). NDF, ADF and lignin are negatively related with digestibility. Crude protein and readily digested carbohydrates start decreasing with the maturity of plant and on the other hand, lignin, fiber and cellulose increase (Stoddart *et al.*, 1975). The majority of grasses in dry regions have low nutritional status because of high lignin and hemi-cellulose contents. Our findings are in line with Brown *et al.* (1984) and Ammar *et al.* (1999) who have reported lignin concentration in various forage plants.

Conclusion: Based on results, the selected grass species have been considered as deficient and nutritionally poor. It might be due to harsh climatic conditions, over grazing, poor soil and exploitation of nutritious grasses for various purposes. The data presented in current study provide an indication of existing nutritional status of major grass species. Therefore, it is suggested that besides improving the fertility of soil and vegetation of rangeland, the ruminant also require some supplementary source particularly when forage quantity and quality is reduced below the required level. In view of the nutritive value of grasses, artificial reseeding using nutritious species is needed in grazing reserves where they would supply the required nutritional requirements and readily provide vitamins and mineral elements to local livestock.

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