Arch. Biol. Sci., Belgrade, 65 (4), 1473-1478, 2013 DOI:10.2298/ABS1304473A

CHEMICAL CONSTITUENTS OF *CENCHRUS CILIARIS L.* FROM THE CHOLISTAN DESERT, PAKISTAN

MUHAMMAD AQEEL ASHRAF[1,2], KARAMAT MAHMOOD[3], ISMAIL YUSOFF[1] and AHMAD KALEEM QURESHI[2]

[1] *Department of Geology, University of Malaya,* 50603 Kuala Lumpur, Malaysia
[2] *Department of Chemistry, University of Malaya,* 50603 Kuala Lumpur, Malaysia
[3] *Department of Chemistry, Islamia University of Bahawalpur,* 63100 Bahawalpur, Pakistan

Abstract – The Cholistan Desert is an extension of the Great Indian Desert, covering an area of 26,330 km^2. The desert can be divided into two main geomorphic regions: the northern region, known as Lesser Cholistan, constituting the desert margin and consisting of a series of saline alluvial flats alternating with low sand ridges/dunes; and the southern region, known as Greater Cholistan, a wind-resorted sandy desert comprised of a number of old Hakra River terraces with various forms of sand ridges and inter-ridge valleys. Cholistan Desert presents a complex pattern of alluvial and aeolian depositions. In the present study we evaluated the nutritive value of different accessions of the perennial range grass *Cenchrus ciliaris* collected from the Cholistan Desert, Pakistan. Standard method, Benedict's quantitative reagent for carbohydrates, crude protein and nitrogen by the Kjeldahl method, mineral analysis by flame photometer and estimation of crude fiber by using acid base treatment, were utilized. The results suggest that *Cenchrus ciliaris* has medicinal and nutritional importance, and that it could be a good source of important nutrients for humans, helping to alleviate poverty in poor local communities.

Key words: Cenchrus, minerals, nitrogen, protein, carbohydrates; phytochemicals

INTRODUCTION

Cenchrus ciliaris L. is an important perennial range grass species of Cholistan desert. It belongs to the family Poaceae, locally known as "Dhaman", and is the first choice of grazing animals. At maturity, it ranges in height from 10-150 cm (averaging 70 cm). This is a widely distributed grass and is resistant to a number of harsh environmental conditions. It can withstand strong winds, low annual rainfall, acute erosion and a nutrient-depleted soil profile (Ziegler et al., 2000). *Cenchrus ciliaris* has also been used as folk medicine for kidney pain, tumors, sores and wounds. It can be used as anodyne (pain reliever), lactogogue (increase milk flow), and diuretic and as an emollient (Duke 1983). It is very important species for grazing cattle, and is considered to increase the milk production of cows when they graze on this grass species. It is very well distributed in sandy and sandy-loam areas of this desert (Rao and Arshad, 1991, Arshad et al., 1999). *Cenchrus ciliaris* L. has sufficient variability in the form of different agro-ecotypes. This vast genetic resource, adapted to the multiple-stress environment of the Cholistan Desert, could be utilized for higher productivity potential. Noor (1991) determined the comparative performance of 10 ecotypes of *Cenchrus ciliaris* under rainfed conditions and recorded a high amount of ecotypic variation. Rai et al. (1982) ob-

served significance variation in forage yield of eight strains of *Cenchrus ciliaris*. Agarwal et al. (1999) evaluated 55 accessions of the perennial range grass *Dichanthium annulatum* L. (Stapf) on the basis of agro-morphological attributes and observed a wide diversity among the accessions.

No important work has examined the nutritional value of the important range plants in the Cholistan Desert, Pakistan. Keeping in mind the importance of the plant *Cenchrus ciliaris,* this research was done to evaluate the nutritional value of the *Cenchrus ciliaris* in the Cholistan Desert and to study the vegetation characteristics of the study area. Such information, as well as information on forage quantity, are essential for the sustainable use of rangelands.

MATERIALS AND METHODS

Site selection and sampling

Desert grass *Cenchrus ciliaris* L. collecting expeditions were performed in 2009 and 2010 in different habitats of the Cholistan Desert from a range of sites. A field survey of the valley was performed for this purpose, which comprised of the following three aspects: selection of sites, collection of data, and analysis of data. Based on the findings of a preliminary survey, ten study sites were selected because of the variation in their ecological attributes, especially topography, vegetation type and soil composition. Information about the ecology, geological position and soil properties of these sites are presented in Table 1. Plant samples of *Cenchrus ciliaris* (green leaves or leaflets and immature pods) were collected concurrently from the ten sites. A total 250 plant samples were collected. The collected samples were dried under shade and crushed in a grinder and used for further analyses.

Sample preparation

To dried ground material (0.5 g/tube), 5 ml of concentrated H_2SO_4 were added (Wolf 1982). All the tubes were incubated overnight at room temperature; 0.5 mL of H_2O_2 (35%) was poured down the sides of the digestion tube; the tubes were heated at 350°C until fumes were produced and then heated for a further 30 min. The digestion tubes were removed from the block and cooled; 0.5 mL of H_2O_2 was slowly added to each tube and placed back into the digestion block. The above step was repeated until the cooled digested material was colorless. The volume of the extract was made up to 50 ml. The extract was filtered and used for determining K, Ca, Na and Cl.

Chemical analyses

The study involved destructive sampling. The samples were washed under running water and blotted dry. The moisture content of the leaf samples was determined at 60°C (AOAC 2009). The dried matter obtained was ground to a fine powder and stored at 5°C in airtight containers prior to further analysis. Different standard methods described in AOAC 2009 were used for nutritive analyses. Benedict's quantitative reagent (BQR) was utilized for carbohydrates. Crude protein and nitrogen was determined by the Kjeldahl method. Mineral analyses were carried out using a flame photometer. Extraction of crude protein was carried out with a Soxhlet apparatus. Estimation of crude fiber was carried out by acid base treatment.

The moisture content of the collected samples was determined by using the following formula:

$$\text{Moisture content\%} = \frac{(\text{initial weight of sample} - \text{final weight of sample})}{\text{initial weight of sample}} \times 100$$

Estimation of the crude fiber content

A known weight of sample was boiled in the presence of 1.25% NaOH, followed by 1.25% H_2SO_4 to dissolve alkali and acid soluble components. The residue containing crude fiber was dried to a constant weight. The loss of weight on ignition in a muffle furnace at 500°C was used to calculate the crude fiber as follows:

$$\text{Crude fiber\%} = \frac{\text{loss in weight on ignition}}{\text{weight of the sample}} \times 100$$

Table 1. Ten sampling sites in the Cholistan Desert.

Accession Number	Collection Number	Name of the Site	Soil Texture	Habitat Description	Vegetation Type
1	LS1/3	Lal Suhanra	Silt loam	Plain surface in the periphery	Dominant grasses and shrubs
2	LS1/2	Kalay Paharr	Coarse sand	Plain surface in the periphery	Dominant herbs with grasses and few shrubs
3	KP1/2	Kalay Paharr	Clay	Inside desert	Dominant grasses with herbs
4	KP1/3	Kalay Paharr	Clay	Inside desert	Dominant large shrubs with grasses
5	KP2/2	Kalay Paharr	Coarse sand	Inside Desert	Small shrubs and herbs with grasses
6	KP2/4	Kalay Paharr	Silt loam	Inside Desert	Mixture of grasses and herbs
7	DR2/3	Derawar Fort	Clay	Moderate slope	Sedges and small shrubs
8	SZE1/15	Sheikh Zaid Enclosure	Silt loam	Steep slope	Dominant grasses with large and medium shrubs
9	SZE1/13	Sheikh Zaid Enclosure	Coarse sand	More or less flattered peripheral area	Dominant grasses with herbs
10	SZE1/9	Sheikh Zaid Enclosure	Coarse sand	Uneven peripheral area	Dominant grasses and shrubs

The total nitrogen content of the samples was determined by the micro-Kjeldahl method. Finely ground material (1 g) was put in a digestion flask with 3 g of digestion mixture (mercury sulfate ($HgSO_4$) and potassium sulphate (K_2SO_4) at a ratio of 1:9) and 20 ml concentrated H_2SO_4. The samples were boiled in a digestion apparatus for about 2 h until the contents became clear. The digested material was diluted to 250 ml. Ten ml were transferred to the micro-Kjeldahl distillation apparatus and distilled in the presence of 50 mg Zn dust and 10 ml NaOH (40%). The distillate was collected in a receiver containing 5 ml boric acid (2%) and methyl red as indicator solution. The contents of the receiver were titrated against sulfuric acid to a light pink color end-point. From the volume of acid, the percentage of nitrogen was estimated and protein was determined using the formula:

$$\text{Nitrogen\%} = \frac{\text{volume of } 0.1\ NH_2SO_4 \times 0.0014 \times 250}{\text{Weight of sample} \times 10} \times 100$$

$$\text{Protein\%} = N \times 6.25$$

A dried (1 g) sample was carbonized on an oxidizing flame until no fumes came out. It was then ignited at 600^0C in a muffle furnace to burn off all organic matter.

$$\text{Ash\%} = \text{weight of ash} \times 100$$

The dry matter of the samples was determined using the formula: Dry matter% = 100 − moisture content.

For estimation of lipid content, a dried sample (2 g) was extracted with petroleum ether (40^0C–60^0C) in a Soxhlet apparatus to remove the ether soluble component. The extracted material was dried to a constant weight in an oven at 70^0C. The lipid content was calculated using the following formula:

$$\text{Fat\%} = \frac{\text{weight of ether extract}}{\text{weight of sample}} \times 100$$

Nitrogen Free Extractable Substances (N.F.E.S.) were calculated by using the formula: NFES% = 100 − (CP + MM + Fat + Fiber).

Table 2. Fiber, lipid, sodium, potassium, nitrogen and protein contents in different *Cenchrus* samples

Serial No.	Accessions	Site names	Lipids	Fiber	Sodium	Potassium	Nitrogen	Protein
1	LS1/3	Lal Suhanra	3.2±0.1	37.34±0.3	0.2±0.09	4.7±0.1	2.8±0.1	17.5±0.3
2	LS1/2	Kalay Paharr	3.2±0.2	24.34±0.4	0.5±0.08	5.8±0.2	2.42±0.2	15.1±0.1
3	KP1/2	Kalay Paharr	3.0±0.2	27.55±0.2	0.6±0.07	3.8±0.2	2.24±0.1	14.0±0.2
4	KP1/3	Kalay Paharr	3.2±0.2	32.6±0.5	0.3±0.06	5.0±0.1	2.14±0.2	13.4±0.2
5	KP2/2	Kalay Paharr	2.7±0.1	30.7±0.3	0.3±0.10	4.1±0.2	2.42±0.2	15.1±0.3
6	KP2/4	Kalay Paharr	5.3±0.2	37.13±0.4	0.4±0.08	5.8±0.1	2.42±0.1	15.1±0.1
7	DR2/3	Derawar Fort	2.8±0.1	38.39±0.3	0.4±0.09	6.0±0.2	2.8±0.1	17.5±0.2
8	SZE1/15	Sheikh Zaid Enclosure	3.1±0.2	27.6±0.2	0.7±0.08	5.9±0.2	2.14±0.2	13.1±0.2
9	SZE1/13	Sheikh Zaid Enclosure	3.5±0.2	26.2±0.2	0.6±0.7	5.8±0.2	2.20±0.2	13.2±0.2
10	SZE1/9	Sheikh Zaid Enclosure	3.4±0.2	28.0±0.3	0.8±0.7	6.0±0.3	2.19±0.2	13.3±0.2

Table 3. Carbohydrates concentrations in different *Cenchrus ciliaris* samples.

Serial No.	Accession	Site name	Reducing sugar	Non-reducing	Total sugars	Starch
1	LS1/3	Lal Suhanra	4.00±0.2	5.80±0.3	9.8±0.4	9.50±0.5
2	LS1/2	Kalay Paharr	2.85±0.1	5.31±0.3	8.16±0.4	9.50±0.5
3	KP1/2	Kalay Paharr	4.00±0.2	2.11±0.1	6.12±0.4	9.50±0.4
4	KP1/3	Kalay Paharr	3.33±0.1	5.80±0.3	5.44±0.3	6.78±0.3
5	KP2/2	Kalay Paharr	4.00±0.2	4.80±0.2	9.80±0.5	9.50±0.4
6	KP2/4	Kalay Paharr	5.00±0.3	3.16±0.1	9.80±0.4	9.50±0.5
7	DR2/3	Derawar Fort	4.00±0.2	4.16±0.2	3.16±0.2	6.80±0.3
8	SZE1/15	Sheikh Zaid Enclosure	4.00±0.2	4.16±0.2	8.16±0.5	9.50±0.4
9	SZE1/13	Sheikh Zaid Enclosure	4.00±0.2	2.12±0.1	6.12±0.2	9.50±0.4
10	SZE1/9	Sheikh Zaid Enclosure	4.00±0.2	5.80±03	9.80±0.4	7.91±0.3

Na^+ and K^+ were determined with a flame photometer (Jenway, PFP-7) using standards ranging from 5-25 mg/l.

Statistical analysis

Each experiment was repeated three times. The results are presented as means and standard errors. The results were prepared using MS Excel, 2003 version.

RESULTS AND DISCUSSION

The crude fiber, lipids, sodium, potassium, nitrogen and protein contents in *Cenchrus ciliaris* plant samples from different sites are presented in Table 2. The highest lipid concentration (5.3 g/100 g) was recorded at KP2/4, the lowest (2.7 g/100 g) was observed at KP2/2 (Kalay Paharr Cholistan Desert). The mean CP content is shown in Table 1.The protein contents ranged from 13-17.5 g/100g, the differences between the highest and lowest values were significant ($P<0.05$).

Mean CF contents for *Cenchrus ciliaris* are shown in Table 1. The highest crude fiber content (39.48g/100g) was in SZE1/9 (Sheikh Zaid Enclosure), while the lowest was 24.34 g/100 g in LS1/2 (Kalay Paharr); the difference was significant ($P<0.05$). The CF content in all specimens positively correlated with the CP content, which is in agreement with Ramirez et al. (2004).

The protein content of *Cenchrus ciliaris* ranged between 13-17.5 g/100 g. The highest crude fiber

(39.48 g/100 g) content was in samples from SZE1/9 (Sheikh Zaid Enclosure) (Table 2).

The concentration of minerals was very low. The highest concentration of sodium (0.7 g/100 g) was in SZE1/15 (Sheikh Zaid Enclosure); the lowest concentration (0.2 g/100 g) was in samples from LS1/3 (Lal Suhanra site). These results confirm that the soils of Cholistan Desert are poor in sodium concentration (Ashraf et al., 1990). The low concentration of minerals in *Cenchrus ciliaris* may be due to the reason that the Cholistan Desert soils, in particular the sand dunes, have very poor mineral composition (Ashraf et al., 1990). Minerals move from the soil into plants, and if they are not replaced by decaying organic matter, the soils will be gradually have a reduced mineral content and will be unable to support plants growth (Ganskopp and Bohnert, 2001).

The concentrations of reducing sugars ranged from 2.85-4 g/100 g; of non-reducing sugars from 2.11-5.31 g/100 g; of total sugars from 3.16-9.8 g/100 g; the concentration of starch (9.5 g/100 g) was similar in all examined samples (Table 3).

Significant differences among accessions for nutritive and minerals indices were evident. However, not all the parameters studied appeared to be equally useful for screening the accessions of the plant for their nutritive value. As Cook and Stubbendieck (1986) reported, the chemical content of plant species may differ because of an inherent ability to withdraw certain nutrients from the soil and to concentrate them in tissues. Plants may also vary in susceptibility to leaching, or may produce different proportions of leaves, stems, and flower stalks at various stages of maturity or because of previous grazing treatments (Arzani et al. 2001; 2004). Grass species show relatively lower forage quality compared to other species. This agrees with previous findings (Ghadosi and Azrani, 1997; Ghourchi, 1995; Norton, 1982). *Cenchrus ciliaris* consistently displays a high protein content, variable but relatively low fat and relatively high carbohydrate contents. The plant contains significantly higher amounts of total protein (17.5%) than local agricultural plants, such as sorghum (11.4% protein content), millet (11.9%), and manioc (0.9%). According to Smith et al. (1986), the potential nutritive value of grasses diminish as they mature, tropical grasses more so than temperate ones, while legumes do not lose quality with maturity as fast as grasses do. The quality of legumes is generally high except when compared to very young grasses. Holechek et al. (2001) reported much greater declines in nutritive quality of annual grasses than for perennial grasses. Tall grasses typically cure out with lower levels of nutrients than short grasses because tall grasses have lower leaf-to-stem ratios than short grasses.

CONCLUSION

In the present study, we assessed the nutritive potential of different accessions of the perennial range grass *Cenchrus ciliaris* from the Cholistan Desert, Pakistan. Our results reveal the variability of the nutritional potential of the grass and its link to the sampling locality. These findings could serve as a starting point for an eventual intervention aimed at improving the quality and sustainability of the analyzed rangelands.

Acknowledgments - The work reported herein was carried out in the Analytical Laboratory, Department of Chemistry, Islamia University of Bahawalpur Pakistan, and in the Department of Geology, University of Malaya, Centre for Ionic Liquids (UMCiL), through a research grant HIR UM-MOHE F00004-21001. The authors are grateful to the Chemistry Department for its support

REFERENCES

Agarwal, D.K., Gupta, S., Roy, A.K. and *S.R. Gupta* (1999). Study on agromorphological variation vis-à-vis geographical distribution in marvel grass *Dichanthium annulatum L.* (Stapf). *Plant Gen. Res. Newsletters*, **118**: 27-29.

AOAC, (2009). Official methods of analysis, 16th ed., Association of Official Analytical Chemists: Washington, D.C. pp. 600.

Arshad, M. and *A.R. Rao* (1994). Flora of Cholistan desert (Systematic list of trees, shrubs and herbs). *J. Econ. Taxon. Bot.* **18**: 615-625.

Arzani, H.,Torkan, J., Jafari, M., Jalili, A. and *A. Nikkhah* (2001). Effects of phenological stages and ecological factors on forage quality of some range species. *Iran. J. Agric. Sci.* **32**, 385-397.

Arzani, H., Zohdi, M., Fish, E., Zahedi Amiri, Gh., Nikkhah, A. and *D. Wester* (2004). Phenological effects on forage quality of five grass species. *J. Range Man*. **57**, 624-629.

Ashraf, M. (1990). Physico chemical analysis of soils of Cholistan Desert. *Pak. J. Biol. Sci*. **2**, 430-433.

Cook, C.W. and *J. Stubbendieck* (1986). Range Research: Basic Problems and Techniques. Society for Range Management, Colorado, pp. 317.

Duke, J.A. (1983). *Cenchrus ciliaris* L. Handbook of Energy Crops. http://www.hort.purdue.edu/newcrop/duke_energy/Cenchrus_ciliaris.htm.

Ganskopp, D. and *D. Bohnert,* (2001). Nutritional dynamics of seven northern Great basin grasses. *J. Range Man*. **54**, 640-647.

Ghodsi Rasi, H. and *H. Arzani* 1997. Investigation on effective factors on palatability of some important range species in Charbagh region of Gorgan. *J. Pajouhesh Sazandegi* **36**, 50-53.

Goel, A. K. (2002). Ex-Situ conservation studies on some rare, endangered, and endemic plant species at NBRI botanic garden. *Ind. J. Forest*. **25**, 67-78.

Holechek, J.L., Pieper, R.D. and *C.H. Herbel* (2001). Range management principles and practices. Prentice Hall, Englewood Cliff, pp. 587

Noor, M. (1991). Comparative performance of *Cenchrus ciliaris* ecotypes under Barani conditions at Peshawar. *Pak. J. Forest*. **1**, 183-187.

Norton, B.W. (1982). Differences between species in forage quality. In: Hacker, J.B. Ed. Nutritional Limits to Animal Production from Pasture. Commonwealth Agricultural Bureaux, Farnham Royal, UK, pp. 89-110.

Rai, P., Pathak, P.S., Kanodia, K.C. and *G.K. Dwivedi* (1982). Performance of *Cenchrus setigerus* strains under rainfed conditions. *Forage Res*. **8**, 133-139.

Rao, A.R. and *M. Arshad* (1991). Perennial grasses of Cholistan Desert and their distribution. Proceedings of national seminar on people's participation in the management of resources in arid lands. Islamia University, Bahawalpur, Pakistan, pp. 6-11.

Smith, B., Leung, P.S. and *G. Love* (1986). Intensive Grazing Management: Forages, animals, Men, Profits. The Graziers, Honolulu Hawaii, 350 pp.

Ziegler, A.D., Warren, S.D., Perry, J.L. and *T.W. Giambelluca* (2000). Reassessment of revegetation strategies for Kahoolawe Island, Hawaii. *J. Range Man*. **53**, 106-1.