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NUTRITIVE POTENTIAL AND PALATABILITY PREFERENCE OF BROWSE FOLIAGE BY LIVESTOCK IN ARID RANGELANDS OF CHOLISTAN DESERT (PAKISTAN)

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ABSTRACT

This study was conducted in Cholistan rangelands to collect information about the palatability and nutritive potential of browses that remained available throughout the year for livestock. Results revealed that ten browse species consisting of seven shrubs and three trees were observed to have preference, accessibility and abundance for grazing animals. Based on palatability *Prosopis cineraria* and *Acacia nilotica* were highly palatable, *Calligonum polygonoides, Suaeda fruticosa, Salsola baryosma, Haloxylon recurvum, Capparis decidua, Calotropis procera* and *Tamarix aphylla* were moderately palatable whereas *Haloxylon salicornicum* was less palatable. Free grazing animals were consisting of mix herds of sheep, goat, cattle and camel. They preferred different plants and their parts like leaf, shoot, flower, and fruits. Forage quality assessment showed significant differences ($p<0.05$) in nutrient values among selected species. The mean values of dry matter, crude protein, ether extract, crude fiber, total ash, nitrogen free extract, neutral detergent fibers, acid detergent fibers, hemicellulose and acid detergent lignin were 93.58%, 11.54%, 1.87%, 4.36%, 13.44%, 48.79%, 40.17%, 23.47%, 16.70%, and 7.22%, respectively which indicate fair level of nutrients. Consequently, this preliminary study has shown that identified browses have good palatability and feed potential for ruminants in the arid rangelands of Cholistan desert.

Keywords: Animal feed, Browse species, Cholistan rangelands, Palatability, Nutritive value.

INTRODUCTION

Pakistan is a sub-tropical country that comprises of vast arid and semi-arid tracks of lands, stretches over 68 million hectares. Out of which 49 million hectares has been categorized as rangelands which are almost consisting of arid to semiarid conditions. The rangelands of Pakistan show a great diversity of species composition, structure, productivity and ultimately their capacity to support livestock. Therefore, sustainable use of these rangelands is essential for the provision of forage to livestock (Majeed *et al.,* 2002).

In Pakistan, previous policies have always supported crops production over livestock, leading in the misuse of lands having economically less potential. Livestock sector play significant role because it provides numerous services for humankind and occupies a key position in rural economy of Pakistan for improving living standard of small resource peoples. The daily nutrient requirement of stock fluctuates in according to the physiological functions of grazing livestock and therefore growth, gestation, lactation, and fattening play key roles in determining daily nutrient demands. In contrast chemical composition of plants in rangelands varies according to species, soil type, climate, phenology, and abiotic factors (Khan *et al.,* 2005).

Unfortunately, rangelands of Pakistan are degrading and facing many problems like short growth period, over grazing, droughts, and marginal availability of perennial species. The herbaceous vegetation of these rangelands only flourishes in monsoon season; accordingly, livestock show pitiable health and produce poor yield of meat and milk. These problems are common everywhere in the world where arid or semiarid rangelands exist (Ahmad and Hasnain, 2001). Therefore, developing countries like Pakistan face analogous situation in their rangelands productivity. Presently these vast natural resources of Pakistan are not managed by scientific approaches and only 10-15% of their actual potential is being documented (Ali *et al.,* 2001).

The Cholistan rangelands were formerly prosperous but now largely converting into abandoned patches. The productivity of these rangelands is degrading because the livestock number is increasing; ultimately, carrying capacity of this area is lessening. Sustainability of life in this hot desert rotates around the annual rainfall. During summer season, weather is tremendously severe and harsh; certain xeric plant species survive but suffer high grazing pressure. Resultantly, palatable species are diminishing and

unpalatable species with less nutritious properties are becoming abundant. Continuous increase in human population for livelihood and multiplying number of livestock is adding towards desertification (Akhter and Arshad, 2006).

In Cholistan rangelands during summer season, camels remain in the desert, browsing on different shrubs and tree species. These browse species are one of the most important and nutritionally rich resources of feed for livestock in Cholistan rangelands (Arshad *et al.,* 2001). Especially browse plants (shrubs & tree foliage) beside grasses compose one of the cheapest sources of feed for animals in many parts of the World. Mostly the browses have advantage of maintaining their nutritive value and greenness during the dry season when grasses dry up and decline in both quantity and quality. This nutritious profusion and perennial performance of browse species afford round the year provision of forage for grazing livestock (Kibon and Orskov, 1993).

The significance of browse foliage for livestock feeding is determined by their availability, palatability and nutritive composition. The most important objective in range management is animal production that is based on nutritional composition of accessible forages. Livestock expert must know the nutritive properties of forage species to maintain growth of animals, and assure the reasonable importance of grazing lands (Ganskopp and Bohnert, 2003). There is scanty information on the nutritive potential of forages in different arid and semiarid regions of the world including those of the Pakistan.

Knowledge on nutritional composition of forages for grazing ruminants would form a base-line data about Cholistan rangelands. To preserve the optimum production and justifiable use of range resources in future, information about the current range resources is very important. Therefore, this study was being planned to collect the base line data about the nutritive potential and palatability classification of browses in Cholistan rangelands.

MATERIALS AND METHODS

Study Area: This study was carried out in Cholistan desert that is found in southern part of Punjab Pakistan (Fig. 1). It spreads between longitudes 69° 52′ and 75° 24′ E and latitudes 27° 42′ and 29° 45′ N casing an area of about 2.6 million hectares. Cholistan desert is placed in arid subtropical continental monsoonal zone where mean annual rainfall varies from less than 100 mm in west to 200 mm in east, mostly received in monsoon season (July to September) (Akbar *et al.,* 1996). Aridity has been the most prominent feature of this with dry and wet years occurring in clusters. Temperature is high in summer and mild in winter without frost. The mean summer temperature (May-July) is 34-38°C with the highest reaching over 51.6°C (Fig. 2). The soil of Cholistan desert is mostly alkaline, saline, and gypsiferous composed of schists, gneiss, granites, and slates (Arshad *et al.,* 2008). The vegetation of this desert consists of xerophytes, adjusted to low moisture, extremely hot temperature, and more salinity with wide variation of edaphic factors. The scarce vegetation of Cholistan commonly comprises perennial shrubs with dispersed small trees. Several ephemeral and annual species emerge after rains, complete life cycle in short duration and dry up after producing seeds. Many species have surprising capacity to reproduce even with minimum rainfall. The economy of this area is mainly pastoral and people have been living as nomadic life style from centuries. The pastoralists have smaller to large herds of cattle, camels, sheep, and goats. The movement pattern of nomadic herders is mostly dictated by the start and distribution of monsoon rains (Arshad and Akbar, 2002). The aerial view of Cholistan rangelands has been showed in Fig. 3.

Identification of Plants: Floristic surveys were conducted in different seasons to collect and identify the browse species of Cholistan Desert. Complete specimens of each species were collected in triplicate, dried, preserved, and mounted on herbarium sheets by conventional method. The plants were identified with the help of Flora of Pakistan and available literature (Ali and Qaiser, 1993-2007; Arshad and Rao, 1994). The determined specimens were checked and confirmed from National Agricultural Research Council (NARC) Pakistan and Cholistan Institute of Desert Studies (CIDS) Islamia University Bahawalpur.

Degree of Palatability: Classification of browse species based on palatability, parts used and animal's preferences was recorded by direct observing the grazing livestock (cattle, sheep, goats & camel) in field for two consecutive years from 2012-2013. These field observations were further confirmed from knowledge gathered from graziers and nomadic peoples at different range sites of Cholistan desert.

To calculate the degree of palatability, following palatability classes were used.

i) Highly palatable ii) Moderately palatable iii) Less palatable iv) Non-palatable

The palatable species were classified into four categories based on parts used by livestock.

i) Leave grazed ii) Shoot grazed iii) Flower grazed and iv) Fruit grazed

The livestock mostly differ in their selection of browsing species at different range sites. In present case, browsing species were classified whether grazed by cattle, sheep, goat, or camel (Hussain and Durrani, 2009).

Procurement of Samples: The samples of selected browse species were collected in spring seasons (February) 2013 from the different range sites of

Cholistan desert. The collected browse samples were mostly consisting of mixture of leaves, twigs, and inflorescence. The samples were air dried under shade then pooled for ground using Willey mill with 2 mm sieve for laboratory analysis. Ground samples were stored in plastic whirl-pack sample bags until put to use for further analysis.

Nutritional Analysis: The collected browse samples were subjected to proximate analysis for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and total ash according to official methods of Association of Official Analytical Chemists (AOAC, 2005). Nitrogen-free extract was determined on dry matter basis as; %NFE = 100 – (%crude protein + %crude fiber + %ether extract + %Ash).

The fiber fractions, neutral detergent fiber (NDF), acid detergent fiber (ADF), and lignin were estimated by the methods followed by (Van Soest *et al.,* 1991). Hemicellulose was determined by difference of NDF and ADF. All the chemical analyses were done in triplicate at the Institute of Animal Nutrition and Feed Technology, University of Agriculture, Faisalabad.

Statistical Analysis: The data collected regarding proximate composition, and fibers fraction was analyzed for variance analysis (ANOVA) in completely randomized design. Significance between means was tested using the least significance difference (LSD) (Steel *et al.,* 1997). Significance was accepted at 5% level of probability. All the statistical procedures were performed using Statistical Analysis System Computer Package (SAS, 2000).

RESULTS

Palatability Classification: In reconnaissance surveys of Cholistan rangelands ten browse species consisting of seven shrubs and three trees were identified to have preference and palatability by grazing livestock there. Identified species were almost easily accessible and abundantly available in the study area especially during monsoon and spring season. Based on palatability *Prosopis cineraria* and *Acacia nilotica* were highly palatable, *Calligonum polygonoides, Suaeda fruticosa, Salsola baryosma, Haloxylon recurvum, Capparis decidua, Calotropis procera* and *Tamarix aphylla* were moderately palatable whereas *Haloxylon salicornicum* was less palatable. Grazing livestock was consisting of mixed herd of sheep, goat, cattle and camel and were freely grazed in the study area. They preferred the different plants and their parts during grazing and browsing like leaf, shoot, flower, and fruit. The details of taxonomic classification and palatability observations of browse species are given in Table 1.

Nutritive Composition: Nutritive composition of selected browse species of Cholistan rangelands is presented in Table 2. The contents of dry matter (DM) varied significantly ($p<0.05$) among species from 92.41 to 94.59%. The highest value of dry matter was observed in *Haloxylon recurvum* and lowest in *Calotropis procera*. The concentration of crude protein (CP) was ranging from 08.25 to 17.46% and highest ($p<0.05$) contents of CP were observed in *Suaeda fruticosa* and lowest in *Prosopis cineraria*. Ether extract (EE) was significantly ($p<0.05$) varied from 01.03 to 03.44% with maximum in *Suaeda fruticosa* and minimum in *Haloxylon salicornicum*. Highest value ($p<0.05$) of crude fiber (CF) was observed in *Calotropis procera* (33.45%) and lowest in *Haloxylon recurvum* (13.45%) that ranged from 13.45 to 33.45% among the species. Similarly, maximum contents of ash (TA) were present in *Suaeda fruticosa* and lowest in *Prosopis cineraria* and concentration of ash was significantly ($p<0.05$) varied from 08.24 to 18.60%. Subsequently mean concentration of nitrogen free extract (NFE) was 48.79% that was highest ($p<0.05$) in *Haloxylon recurvum* and lowest in *Suaeda fruticosa.*

The concentration of neutral detergent fibers (NDF) were varied ($p<0.05$) from 29.33 to 44.00% with mean value 40.17%. The highest NDF was observed in *Prosopis cineraria* and *Acacia nilotica* besides lowest was observed in *Haloxylon recurvum*. The acid detergent fibers (ADF) were ranged from 12.33 to 33.67% with mean value 23.47%. *Calligonum polygonoides* was found to have maximum ($p<0.05$) value of ADF and *Haloxylon recurvum* has lowest value. Whereas, the concentration of hemicelluloses was significantly varied ($p<0.05$) from 10.00 to 21.67%. Highest contents of hemicellulose were observed in *Haloxylon salicornicum* (21.67%) and lowest in *Calligonum polygonoides* (10.00%). Similarly, mean concentration of lignin was 07.22% that was highest in *Prosopis cineraria* (09.87%) and lowest in *Calotropis procera* (05.40%).

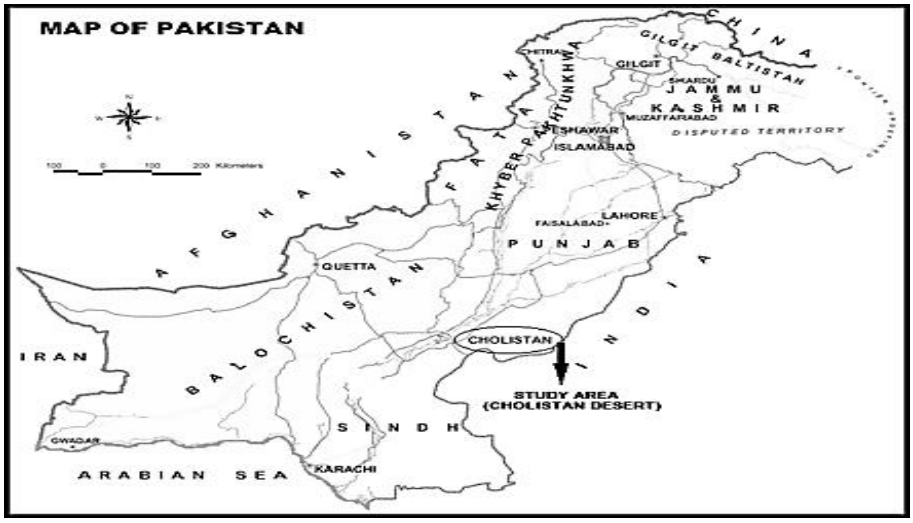

Fig. 1. Map of Pakistan showing the study area Cholistan desert

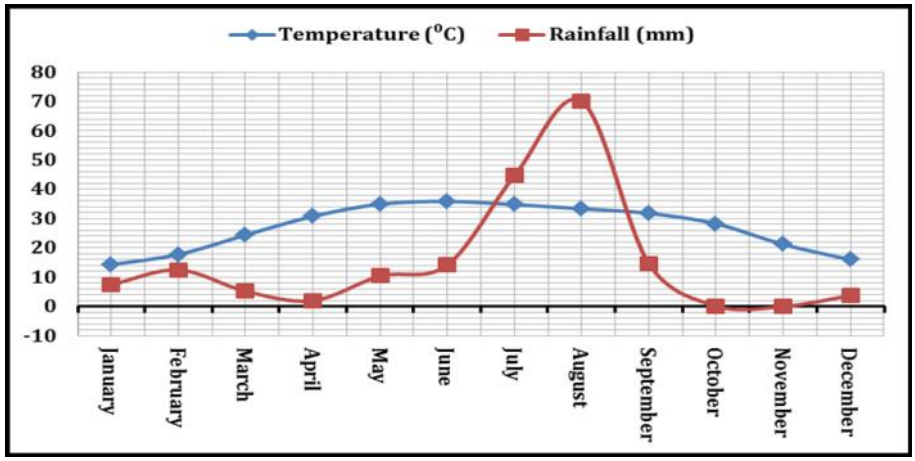

Fig. 2. Showing the mean annual variation of temperature and rainfall

Fig. 3. Aerial view of Cholistan rangelands (photo taken by author)

Table 1. Palatability information of the selected browse species in Cholistan rangelands.

Sr. No.	Family	Botanical Name	Local Name	Habit	Palatability	Animals types	Parts used
1	Asclepiadaceae	*Calotropis procera* (Aiton.) Aiton.	Ak	Shrub	Moderate palatable	Sheep, Goat, Cattle	Leaf, Flower
2	Capparaceae	*Capparis decidua* (Forsskal.) Edgew.	Karir	Shrub	Moderate palatable	Camel, Cattle, Goat	Shoot, Fruit
3	Chenopodiaceae	*Haloxylon recurvum* Bunge. ex. Boiss.	Khar, Sajji	Shrub	Moderate palatable	Camel	Shoot
4	Chenopodiaceae	*Haloxylon salicornicum* (Moq.) Bunge.	Lana	Shrub	Less palatable	Camel	Shoot
5	Chenopodiaceae	*Salsola baryosma* (Roem. et. Scult.) Dany.	Lani	Shrub	Moderate palatable	Camel, Sheep	Shoot
6	Chenopodiaceae	*Suaeda fruticose* (Linn.) Farsskal.	Kali Lani	Shrub	Moderate palatable	Camel	Leaf, Shoot
7	Mimosaceae	*Acacia nilotica* (Linn.) Del	Kiker, Babul	Tree	High palatable	Sheep, Goat, Cattle, Camel	Leaf, Shoot, Flower, Fruit
8	Mimosaceae	*Prosopis cineraria* (Linn.) Druce.	Jand, Kanda	Tree	High palatable	Sheep, Goat, Cattle, Camel	Leaf, Shoot, Flower, Fruit
9	Polygonaceae	*Calligonum polygonoides*Linn.	Phog	Shrub	Moderate palatable	Camel, Goat, Cattle	Shoot, Flower
10	Tamaricaceae	*Tamarix aphylla* (Linn.) Karst.	Frash, Ukan	Tree	Moderate palatable	Camel	Shoot

Table 2. Nutritive composition of browse species from Cholistan rangelands (on DM basis).

Sr. No.	Species Name	DM (%)	CP (%)	EE (%)	CF (%)	TA (%)	NFE (%)	NDF (%)	ADF (%)	Hemicellulose (%)	Lignin (%)
	Shrubs										
1	*Calligonum polygonoides*	93.64^{bc}	11.54^{d}	1.47^{d}	23.37^{e}	09.48^{e}	54.17^{b}	43.67^{a}	33.67^{a}	10.00^{f}	8.80^{b}
2	*Suaeda fruticosa*	94.43^{ab}	17.46^{a}	3.44^{a}	25.52^{d}	18.60^{a}	34.98^{g}	33.00^{c}	21.00^{de}	12.00^{f}	5.73^{ef}
3	*Salsola baryosma*	94.33^{ab}	12.27^{c}	1.08^{def}	20.69^{f}	16.40^{b}	49.56^{de}	41.67^{ab}	21.00^{de}	20.67^{a}	6.60^{de}
4	*Haloxylon recurvum*	94.59^{a}	12.21^{cd}	1.04^{ef}	13.45^{i}	16.55^{b}	56.75^{a}	29.33^{c}	12.33^{f}	17.00^{cde}	5.73^{ef}
5	*Haloxylon salicornicum*	93.42^{c}	13.18^{b}	1.03^{f}	19.51^{g}	15.24^{c}	51.04^{cd}	42.33^{ab}	20.67^{de}	21.67^{a}	6.27^{def}
6	*Capparis deciduas*	94.44^{ab}	08.98^{f}	1.50^{d}	32.34^{b}	08.59^{fg}	48.60^{e}	42.67^{a}	24.33^{cd}	18.33^{bc}	6.70^{cd}
7	*Calotropis procera*	92.41^{d}	12.52^{bc}	2.49^{b}	33.45^{a}	14.35^{d}	37.18^{f}	38.67^{b}	19.00^{e}	19.67^{ab}	5.40^{f}
	Trees										
8	*Tamarix aphylla*	92.57^{d}	08.65^{fg}	1.46^{de}	18.39^{h}	17.81^{a}	53.69^{b}	42.33^{ab}	27.33^{bc}	15.00^{e}	7.53^{c}
9	*Prosopis cineraria*	93.48^{c}	08.25^{g}	2.04^{c}	31.45^{c}	08.24^{g}	50.02^{de}	44.00^{a}	28.67^{b}	15.33^{de}	9.87^{a}
10	*Acacia nilotica*	92.52^{d}	10.29^{e}	3.11^{a}	25.48^{d}	09.18^{ef}	51.91^{c}	44.00^{a}	26.67^{bc}	17.33^{cd}	9.57^{ab}
	Mean	**93.58**	**11.54**	**1.87**	**24.36**	**13.44**	**48.79**	**40.17**	**23.47**	**16.70**	**7.22**
	SEM	**0.27**	**0.24**	**0.14**	**0.30**	**0.29**	**0.51**	**1.33**	**1.27**	**0.68**	**0.31**

Mean values based on 03 replicates; SEM: Standard error of means

Means in same column with different superscript (a, b, c, d, e, f, g) are significantly different ($P<0.05$)

DM=Dry matter, CP=Crude protein, EE=Ether extract, CF=Crude fiber, TA=Total ash, NFE=Nitrogen free extract, NDF=Neutral detergent fiber, ADF=Acid detergent fiber

DISCUSSION

Palatability Classification: It is obvious that successful range management requires the knowledge of palatability and nutritional value of range plants for livestock. This study has identified ten browse species that have palatability to varying degree, easily accessible to browsing and abundantly available in the study area especially during monsoon (July to September) and spring (February to March) seasons. Results showed that maximum browse species were used for their leaves and shoot as feed by grazing animals. The livestock usually prefer the leaves and shoot of all forages, might be due to high crude protein, phosphorus and low lignin and fiber contents than woody parts. Generally, animals desire fresh foliage than dried and non-succulent forages that can be eaten easily. Likewise, soft green herbaceous parts, in addition having good taste and odor are rapidly digestible.

Rangelands of Cholistan desert are freely grazed by mixed herds of cattle, sheep, goats and camels. According to our results, camel ranked first in exploring maximum number of species. It has been observed that *Acacia nilotica,* and *Prosopis cineraria,* were highly palatable and preferred for their leaf, shoot, flower, fruit by all the grazing animals like sheep, goat, cattle, and camel. It was observed that in Cholistan rangelands maximum forage species was available during monsoon season. Numerous species of ephemeral and annual appear after rains, complete their life cycle in short duration and vanish. However, grazing pressure starts as vegetation emerge and sprout after the availability of moisture from rain (Akbar *et al.,*1996).

It was observed that grazing animals select the most palatable plant species first. It may lead to complete replacement of superior quality forages by non-palatable species. Animals face forage deficiency in Cholistan rangeland in winter (December & January) due to dormant season. The selected browse species of trees and shrubs maintain their foliage during the winter (dormant) also and may continue to be palatable for livestock. A very little information was available about palatability, seasonal availability, and animal preferences of forage plants of Cholistan rangelands (Abdullah *et al.,* 2013).

Nutritive Composition: This was preliminary report about the nutritive composition of browse species in the arid rangelands of Cholistan desert. The comparison of ten major browse species of Cholistan rangelands showed that there were significant differences in nutrients among species. In forages, dry matter (DM) is the actual amount of feed stuff after removing water, volatile acids and bases if they are present (Azim *et al.,* 2011). The results revealed that DM contents were high in browse species, which may be determined by late stage of maturity of foliage's at the time of sampling as DM is found to increase with maturity of forages (Sanon *et al.,* 2008). In this study, high DM contents could be due to the time of sampling in spring season (March) after 5-6 months of fresh growth of plant species in monsoon because in Cholistan desert, maximum plant growth has been observed during monsoon (July to September). It indicates that browse species of this area serves as an essential and consistent source of DM, along other nutrients for feeding the livestock of Cholistan. The contents of DM in this study had almost similar ranges as those stated previously (Njidda and Ikhimioya, 2010).

Crude protein (CP) mainly includes all nitrogenous compounds present in forages and considered as reliable source of overall nutritional status of animal feed (Ganskopp and Bohnert, 2001). Crude protein below 6-7% causes low production of milk, meat, and wool. It also disturbs the reproduction process in animals. Deficiency of crude protein may also reduce microbial activity in the rumen of animals' due to poor availability of nitrogen. The concentration of CP in browse species was higher than minimum level of 7-8%, essential for optimum feed intake and function of rumen in grazing animals (Van Soest, 1994). This prominent level of CP signifies their high nutritive value; therefore, browses can be used as protein supplements for poor quality pastures. The animal feeds with less than 6% CP are not likely to provide the minimum level of ammonia that is required for maximum microbial growth in rumen (Norton, 1994).

Based on level of CP suggested for the maintenance of several wild and domestic herbivores by NRC (1984) 7.5% CP was established as satisfactory forage quality threshold. According to results, contents of CP in browse species were higher than 8%, which were sufficient for medium level of production in ruminants. Therefore, these browses could be a good quality protein supplements if they were properly degraded and were non-toxic to the microbes of rumen and host animal. The concentration of CP was found almost consistent with previous study of Arzani *et al.* (2006). The CP range in present study was slightly higher than what had been stated for range forages in earlier study (Towhidi and Zhandi, 2007) and was little lower than the range presented by Melaku *et al.* (2010). These variations in contents of CP in browses may be due to time of sampling because same species varying in CP level by about 30 to 40% when harvested at various times of the year.

Ether extract (EE) is a component of lipid and animals mainly derive their energy from it for their body production and maintenance. The high contents of EE in feed samples are a sign of higher energy level for the animals (Odedire and Babayemi, 2008). According to our results, maximum value of EE was observed as 03.44% (*Suaeda fruticosa*) and minimum 01.03% (*Haloxylon salicornicum*). Our findings were almost comparable with work of Mahala *et al.* (2009). The results were showing

little high values of EE as determined previously (Towhidi and Zhandi, 2007) but slightly lower than Njidda and Ikhimioya (2010).

In this study, mean concentration of crude fiber (CF) was 24.36%, which varied from 13.45 to 33.45% among browse species. These results were showing slightly lower contents of CF as determined previously by Towhidi and Zhandi (2007). However, these results were almost in line with Azim *et al.* (2011). Ash represents the mineral level in animal feed, which is mostly consisting of calcium, phosphorus, potassium and large amount of silica. According to our results, concentration of ash was ranging from 08.24 to 18.60% with mean value 13.44%. Different researchers have determined the different ratios of ash in different plant species between 07.60 and 22.20% (Tan and Yolcu, 2001). Our results were in this limit and can be compared with previous study (Sultan *et al.,* 2010). However, our results were slightly higher than the results of Melaku *et al.* (2010).

Similarly, in this study mean concentration of nitrogen free extract (NFE) was calculated as 48.79% ranging from 34.98 to 56.75%. This range was almost in agreement with range reported by Okoli *et al.* (2003). Our results showed that browses were of paramount importance for rangelands management in Cholistan desert. The proximate composition of browse species did not vary much from values published in previous literature. The slight variations in chemical composition of browse species among different studies could be attributed to plant variety, agro climatic conditions, or even growth stages of plants at sampling and sampling procedures. It was decided that the browse species investigated in present study could be a reliable source of DM and protein.

Neutral detergent fiber (NDF) is an important determinant of forage quality and digestibility, and it directly affects the performance of an animal. The high concentration of NDF lower the neutral detergent soluble which mostly consisting of starches, sugar, fat, CP. El Shaer and Gihad (1994) has reported that contents of NDF can range from 35-40% which is considered as the normal range of nutritious fodder. Results revealed that concentration of neutral detergent fiber (NDF) present in browses was ranged from 29.33 to 44.00%. Browse species investigated in current study consisted below 45% NDF on DM basis and this render them as good quality roughages, because fibrous feed with less than 45% NDF have been classified as good quality feed (Singh and Oosting, 1992). High contents of NDF in *Prosopis cineraria* and *Acacia nilotica* as compare to others may have low DM intake because high contents of NDF lower the feed intake rate in animals. Our findings were very close to the results of Melaku *et al.* (2010) who has studied the chemical composition of browses in Ethiopia.

The results showed that concentration of acid detergent fiber (ADF) in selected browse species was ranged from 12.33 to 33.67%. Shimelse (2010) has reported almost similar range of ADF contents. It was observed that *Calligonum polygonoides,* which has higher content of ADF may have poor digestibility, since it has been reported that digestibility of feed and ADF contents are negatively correlated (McDonald *et al.,* 2002). In all the investigated species, except for *Haloxylon recurvum, Haloxylon salicornicum* and *Calotropis procera* the ADF was a large part of NDF fraction that showed high content of cellulose and lignin and low content of hemicellulose. In this study, hemicellulose was ranging from 10.00 to 21.67% with the mean value 16.70%. Our results were almost in line with Foguekem *et al.* (2011) who has evaluated the nutritional status of various forage plants.

Lignin is a cell wall component and formed as part of cell wall thickening process (Boudet, 1998). Results revealed that mean concentration of lignin in browses was 07.22% that was varying from 05.40 to 09.87%. Our results were almost in line with contents range of previous study (Santra *et al.,* 2008). However, from a nutritional point of view, it is remarkable that lignin value is kept low to avoid jeopardizing the digestibility of other nutrients. Different studies have reported a negative correlation between lignin contents and cell wall digestibility because lignin acts as a physical barrier in the functioning of microbial enzymes. According to our results, the differences in structural constituents among selected browse species could be attributed to facts that these species were different, and even growing in similar environmental conditions, they may have different chemical composition, a result of genetic diversity of species.

Conclusion: The identification, palatability and nutritive evaluation of browses have created a detail map about productive potential of browses in Cholistan rangelands. Nutritive evaluation showed that proximate composition (DM, CP, EE, CF, TA & NFE), structural constituents (NDF, ADF, Hemicellulose & Lignin) composition were varying significantly ($p<0.05$) among the selected species. Results have revealed that these species have fair level of palatability, nutrients and sever as potential source of feed for range livestock in Cholistan. Generally, it was first comprehensive attempt to summaries what was known about the potential of browses in Cholistan rangelands. This data should be incorporated into the current management plan and the subsequent vegetation map should serve as a valuable tool in the planning, conservation and management of these rangelands. It is very further recommended to determinate the comparative nutrient value of all available browse resources during various seasons, phenological stages to

meet animal requirements for optimum livestock production.

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REFERENCES

Abdullah, M., R.A. Khan, S. Yaqoob and M. Ahmad (2013). Mineral profile of browse species used as feed by grazing livestock in Cholistan rangelands, Pakistan. Pakistan J. Nutri. 12(2): 135-143.

Ahmad, S. D. and G. Hasnain (2001). Evaluation of introduced fescue grass for forage and soil conservation in hilly areas of Pakistan. Online J. Biol. Sci. 1(6): 442-445.

Akbar, G., T. N. Khan and M. Arshad (1996). Cholistan desert Pakistan. Rangelands 18: 124-128.

Akhter, R. and M. Arshad (2006). Arid Rangelands in Cholistan Desert Pakistan. Scheresse 17: 1-18.

Ali, M., I.A. Qamar, A. Ali, M. Arshad and J. Iqbal (2001) Evaluation of tropical grasses for forage yield and crude protein content in the Pothowar plateau of Pakistan. Online J. Biol. Sci. 1: 466–467.

Ali, S.I. and M. Qaiser (1993-2007). Flora of Pakistan. Eds. (fascicles series 193-215) Karachi (Pakistan).

AOAC, (2005). Official Methods of Analysis of the official analytical chemists, 18th Ed. (Hoewtiz, W. Eds.), Association of Official Analytical Chemists, Washington DC.

Arshad, M. and A.R. Rao (1994). Flora of Cholistan Desert (Systematic list of trees, shrubs and herbs). J. Econ. and Taxon. Bot. 18(3): 615-625.

Arshad, M. and G. Akbar (2002). Benchmark of Plant Communities of Cholistan Desert. Pakistan J. Biol. Sci. 5(10): 1110-1113.

Arshad, M., A.R. Rao, G. Akbar. (2001). Sustainability pattern of livestock in Cholistan desert Pakistan. Sustainable development of desert communities. a regional symposium Iran, UNDP. 2: 185-192.

Arshad, M., A.U. Hassan, M.Y. Ashraf, S. Noureen and M. Moazzam (2008) Edaphic factors and distribution of vegetation in the Cholistan desert, Pakistan. Pakistan J. Bot. 40(5): 1923-1931.

Arzani, H., M. Basiri, F. Khatibi and G. Ghorbani 2006. Nutritive value of some Zagros Mountain rangeland species. Small Rumi. Res. 65: 128–135.

Azim, A., S. Ghazanfar, A. Latif and M.A. Nadeem. 2011. Nutritional evaluation of some top fodder tree leaves and shrubs of district Chakwal, Pakistan in relation to ruminant's requirements. Pakistan J. Nutri. 10(1): 54-59.

Boudet, A.M. (1998). A new view of lignification. Trends in Plant Sci. 3: 67-71.

El Shaer, H.M. and E.A. Gihad (1994). Halophytes as animal feeds in Egyptian deserts (Ed: Squires, VR, Ayoub, AT). Halophytes as a resource for livestock and for rehabilitation of degraded lands. Kluwer Academic Publishers; 281–284 p.

Foguekem, D., M.N. Tchamba, L.N. Gonwouo, P. Ngassam and M. Loomis (2011). Nutritional status of forage plants and their use by elephant in Waza national park, Cameroon. Scient. Rese. and Essays 6(17): 3577-3583.

Ganskopp, D. and D. Bohnert (2003). Mineral concentration dynamics among 7 northern Great Basin grasses. J. Range Manag. 56: 174-184.

Ganskopp, D. and D. Bohnert (2001). Nutritional dynamics of 7 northern Great basin grasses. J. Range Manag. 54: 640-647.

Hussain, F. and M.J. Durrani (2009). Seasonal availability, palatability and animal preferences of forage plant in harboi arid rangeland, Kalat, Pakistan. Pakistan J. Bot. 41(2): 539-554.

Khan, Z. I., E. Valeem, A. Hussain, M. Ashraf, M.Y. Ashraf, McDowell, M. S. Akhtar and M. A. Mirza (2005). Effect of seasonal variation on Zn content of soil, forage, water, feed and small ruminants grazing the native and improved pasture during different seasons in the semi-arid regions of Pakistan. Inter. J. Biol. and Biotech. 2: 465–74.

Kibon, A. and E.R. Orskov (1993). The use of degradation characteristics of browse plants to predict intake and digestibility by goats. Ani. Prod. 57: 247-251.

Mahala, A.G., I.V. Nsahlai, N.A.D. Basha and L.A. Mohammed (2009). Nutritive evaluation of the natural pastures at early and late rainfall season in kordofan and butana, Sudan. Aust. J. Basic and Appl. Sci. 3(4): 4327-4332.

Majeed, A., M. Azam and D.A. Mumtaz (2002). Drought and Water Management Strategies in Pakistan. Proceedings of SAARC Workshop on Drought and Water Management Strategies. Pakistan Council of Research in Water Resources, Islamabad, Pakistan.

McDonald, P., R.A. Edwards, J.F.D. Greenhalgh and C.A. Morgan (2002). Animal Nutrition (6th. edition). Pearson Educational Limited, Edinburgh.

Melaku, S., T. Aregawi and L. Nigatu (2010). Chemical composition, in vitro dry matter digestibility and in sacco degradability of selected browse species used as animal feeds under semi-arid conditions in Northern Ethiopia. Agroforestry System 80: 173–184.

Njidda, A.A. and I. Ikhimioya (2010). Correlation between chemical composition and in vitro dry matter digestibility of leaves of semi-arid browses of north-eastern Nigeria. American-Eurasian J. Agri. and Envir. Sci. 9(2): 169-175.

Norton, B.W. (1994). The nutritive value of tree legumes. In: (Ed. R. C. Gutteridge and H. M. Shelton), Forage Tree Legumes in Tropical Agriculture, CAB international. 177-191 p.

NRC. (1984). Nutrient requirements of domestic animals, no. 4. Nutrient Requirements of Beef Cattle, 6th Rev. ed. National Academic Press, Washington, DC. 100 p.

Odedire, J.A. and O.J. Babayemi (2008). Comparative studies on the yield and chemical composition of *Panicum maximum* and *Andropogon gayanus* as influenced by *Tephrosia candida* and *Leucaena leucocephala*. Livestock Rese. for Rur. Develop. 20(2): 1-8.

Okoli, I.C., M.O. Anunobi, B.E. Obua and V. Enemuo (2003). Studies on selected browses of southeastern Nigeria with particular reference to their proximate and some endogenous anti nutritional constituents. Livestock Rese. for Rur. Develop. 15 (9).

Sanon, H.O., C. Kabore-Zoungrana and I. Ledin (2008). Nutritive value and voluntary feed intake by goats of three browse fodder species in the Sahelian zone of West Africa. Animal Feed Sci. and Tech. 144: 97-110.

Santra, A.K., S. Pan, A.K. Samanta, S. Das and S. Halder (2008). Nutritional status of forage plants and their use by wild elephants in South West Bengal, India. Tropical Ecol. 49(2): 251-257.

SAS. (2000). SAS/STAT Software: Changes and Enhancements through Release 8.1, SAS Institute Inc., Cary, NC.

Shimelse, S. (2010). Vegetation ecology, forage biomass and evaluation of nutritive value of selected browse species in Nechisar national park, Ethiopia. M.Sc. thesis. School of Graduate Studies, Addis Ababa University Ethiopia.

Singh, G.P. and S.J. Oosting (1992). A model for describing the energy value of straws. Indian Dairyman XLIV: 322–327.

Steel, G.D., J.H. Torrie and D.A. Dickey (1997). Principles and procedures of statistical and biometrical approach. 3rd Ed. McGraw Hill Book; New York. 182 p.

Sultan, J.I., Inam-ur-Rahim, A. Javaid, M.Q. Bilal, P. Akhtar and S. Ali (2010). Chemical composition, mineral profile, Palatability and in vitro digestibility of shrubs. Pakistan J. Bot. 42 (4): 2453-2459.

Tan, M. and H. Yolcu (2001). The nutrition value of some wild plants as a forage crops. Türkiye 4. Field Crops Congress, 199-204 p.

Towhidi, A. and M. Zhandi (2007). Chemical composition, in vitro digestibility and palatability of nine plant species for dromedary camels in the province of Semnan, Iran. Egypt. J. Biol. 9: 47-52.

Van Soest, P.J. (1994). Nutritional Ecology of the Ruminant. 2nd Ed. Comstock-Cornell University Press Ithaca; NY. (USA). 122-139 p.

Van Soest, P.J., R.B. Son and B.A. Lewis (1991). Method for dietary fiber, neutral detergent fiber and non-starch poly sacharides in relation to animal nutrition. J. Dairy Sci. 74: 3583-3597.