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MACRO-MINERAL QUANTIFICATION OF THE FORAGE GRASS SPECIES IN THE GANDGAR HILLS, WESTERN HIMALAYA, PAKISTAN

ZIA-UR-REHMAN MASHWANI*[1,2], MIR AJAB KHAN[2], MUSHTAQ AHMAD[2], MUHAMMAD ZAFAR[2], NAVEED IQBAL RAJA[1], MUHAMMAD ARSHAD[1]AND SAMIULLAH[2]

[1]*Department of Botany, PMAS Arid Agriculture University, Rawalpindi*
[2]*Department of Plant Sciences, Quaid-i-Azam University, Islamabad*
**Corresponding author E-mail: zia.botany@gmail.com, mashwani@uaar.edu.pk*

Abstract

The present study was conducted in Gandgar Range, the foothills of Western Himalaya to determine the macro-mineral composition in locally available forage grass species. The study area extends from 33°52′ to 34°25′ north latitude and from 72°30′ to 72°55′ east longitude. A total of twenty one forage grass species included: *Apluda mutica, Arthroxon prinodes, Avena sativa, Bracharia repten, Bracharia ramosa, Chrysopogon aucheri, Cymbopogon jawaracusa, Cymbopogon martini, Cynodon dactylon, Dactyloctinium aegypticum, Dicanthum annulatum, Digitaria singuinales, Echinocloa colona, Eleusine indica, Eragrostis cilianances. Heteropogon contortus. Pennesitum orientales, Phalaris minor, Poa annua, Sorghum helipenses, Themeda anathera,* were identified and analyzed. Samples were acid digested and their macro-mineral (Ca, Na, K, Mg,) quantification is done by atomic absorption spectrophotometer (AAS). The result shows the highest concentration of Ca in the *Digitaria sanguinalis,* and lowest in *Eleusine indica*. Highest concentration of Na in *Arthraxon prionodes*, and lowest in *Themeda anathera*, Highest concentration of K in *Pennesitum orientale*, and lowest in *Arthraxon prionodes*, highest concentration of Mg in *Pennesitum orientale*, while lowest in *Arthraxon prionodes*. The forage grass species have high concentration of macro-minerals and suitable to fed livestock with some supplementation for different stages of production and kinds of livestock.

Introduction

Living organism require various mineral to perform the normal functioning of their life. Some of these minerals require in large amount are macrominerlas, while minerals needed in very small quantity are referred as the micro nutrients (McDowell, 2003).

Their basic source of minerals, for man, is the food chain. An important link in the transfer of trace elements from plant to man are livestock animal (Lozak *et a*l., 2002). Livestock usually uptake most of their nutritive elements from the feedstuffs and forages they consume. However, significant quantities of minerals also be taken by soil and water. Feed source of mineral are generally divide into various base feedstuff, such as range or pasture plants, harvested forages, concentrates and mineral supplements (McDowell & Arthington, 2005, Khan *et al*., 2009).

Rangelands support 30 million herds of livestock, which contribute US $ 400 million to Pakistan's annual export earnings (Anon., 2006). Past policies have often favored crops over livestock production, resulting in misuse of land having economically inefficient production potentials (Sultan *et al.,* 2007). In Pakistan and other Asian countries, malnutrition occur in poorly managed livestock. Grazing animal in Pakistan depends mainly on poor quality feedstuff in non-developed pastures in arid and semi arid regions (Khan *et al*., 2007).

There is a handsome share of various grass species to the feeding of animals during scarcity periods. For prolonged winter scarcity, the grasses are harvested from protected hillside rangelands and stored as hay. Grasses from fertile cropland sides and adjacent uneven areas are also cut several times during summer and are fed to livestock (Khan *et al*., 2004). Grasses are generally considered good sources of energy primarily because of their high content of cellulose. In very rank grasses however, digestibility will be so low as to reduce intake and thereby reduce total energy intake.

The main consideration in livestock production on rangelands is the decline of nutritive value of grasses as the growth approached towards maturity (Kothumann, 1980; Ullah *et al*., 2010). To improve productivity and forage utilization, it is necessary to have knowledge of nutritive value of range species and their impact on livestock production (Islam & Adams, 2000).

Plant species with higher P and K in their leaves are more productive and beneficial for livestock, because both of these elements are very important for livestock (Ashraf *et al.,* 1992; Irigoyen *et al.,* 1992). Ca and Mg are also useful for livestock because of their essence for normal growth of livestock (Walker, 1980; Underwood, 1981; Khan *et al*., 2004).

Due to deficiencies and excess of some minerals in forages in semi arid rangelands of northern Pakistan, cannot support ruminants an acceptable level of production. This study was aimed to evaluate the macro-minerals composition and various morphological characteristics of different forage grass species. This evaluation of nutritive status would be useful to suggest mineral supplementation strategies to improve growth and reproductive efficacy of cattle's under rangeland condition for Pakistan as well as other Asian countries with similar climate and ecological conditions.

Materials and Methods

Study site: Grazing pastures of Gandgar Mountains were selected as experimental sites. The Gandgar Mountains form a small range running east to the Tarbela reservoir (giant rock-fill dam on the river Indus). Gandgar ranges are the continuation of western Himalayas making foothills with the highest peak of 4401 feet. It extends from 33°52′ to 34°25′ north latitude and from 72°30′ to

72°55′ east longitude. The local population of the area depends on meadows and pastures of the range for their dairy herds grazing. Nowhere else in the Islamic world, can one find such a varied repertoire of different motifs combined in a single local tradition.

Sample collection: Comprehensive survey of Gandgar Range was done in order to explore the indigenous forage grass species. Forage grass species were selected by interviewing the nomads and farmers involved in keeping animals in the study area. Different meadows were screened for forage collection. A wide range of questions regarding the forage grasses include, quantity of grass, type of grazing animal, nutritive value, and availability were focused. Forage sampling was done after Fick *et al.,* (1979). Samples were initially collected for their taxonomic authentification according to standard procedure as described by the Judd *et al*., (2002). And their taxonomic status was confirmed with the help of Flora of Pakistan (Cope, 1982). Voucher specimens were deposited in the Herbarium of Pakistan, Quaid-i-Azam University, Islamabad.

Acid-digestion: The samples were grounded using a pestle and mortar. The pulverised and powdered forage grass samples were transferred into sealed plastic bags. All samples were treated in an identical manner. The availability of different minerals in all the selected fodder grass species were determined following the standard procedure of mentioned by Fick *et al*., (1979), Allen, (1974) and Mpofu *et al*., (1995).

Samples (0.2500 g) were weighed into a pre-cleaned beaker. And add 6.5 ml of mixed concentrated acid solution i.e., Nitric acid (HNO_3), Sulfuric acid (H_2SO_4), Perchloric acid ($HCLO_4$) (5:1:0.5) in it and boiled it in fume hood on hot plate until digestion was complete, which was indicated by white fumes coming out from the flasks. The digested sample was then allowed to cool before being transferred quantitatively into clean 25 ml volumetric flasks. The samples were then diluted to volume by the addition of ultra pure water. Then filter the extract with Whatmann filter paper No 42 and filtrate were collected. The extract was used for analysis. Four replicate digestions were made for each sample.

Analysis of minerals: Macro-minerals (Ca, Na, K, and Mg) were analyzed by atomic absorption spectrophotometer (Shimadzu AA-670) in the General Lab. Faculty of Biological sciences, Quaid-i-azam University, Islamabad. Samples were run along with the Stock standard solutions of individual metals (1000 or 10,000 mg L^{-1}), supplied by Merck. Data was calculated by using the following formula to prepare it for statistical analysis.

$$\text{Nutrient cation in plants} = (\text{ppm in extract - blank}) \times \frac{A}{W} \times \text{dilution factor}$$

A = Total volume of extract (ml)

All results were the mean of the four replicates and are quoted on a dry weight basis. The data collected were analyzed by the analysis of variance technique. Duncan's New Multiple Range test at 5% level of probability that was used to test the significance of means (Steel & Torrie, 1980).

Result and Discussion

In the present investigation, after a comprehensive survey twenty one different forage grass species were recognized in the Gandgar Hills. The representative forages along with vernacular names and their flowering periods in the study area were recorded (Table 1).

Table 1. List of the selected forage grass species in the Gandgar Hills, Western Himalaya, Pakistan.

S. No.	Botanical name	Vern. name	Flowering period
1.	*Apluda mutica*	Mauritian Grass	August-November
2.	*Arthroxon prinodes*	Small Carpgrass, Hairy jointgrass	June-Sept. or Oct.
3.	*Avena sativa*	Wild Oats, Folle Avoine	May-August, sometimes as early as March
4.	*Bracharia repten*	Common Sandbur	June-Oct.
5.	*Bracharia ramosa*	Browntop Millet	June-Oct.
6.	*Chrysopogon aucheri*	Mackie's Pest, Lovegrass	March-May and again Sept.-Nov.
7.	*Cymbopogon jawaracusa*	Khavi	June-Sept.
8.	*Cymbopogon martini*	Rauns, Thisankah	Sept.-Nov.
9.	*Cynodon dactylon*	Dog's-tooth or Bermuda Grass, Dub, Khabbal	All year round.
10.	*Dactyloctinium aegypticum*	Durban Crowfoot, Egyptian Finger-grass, Madhana	July-Oct.
11.	*Dicanthum annulatum*	Palwan, Marvel	March-Nov.
12.	*Digitaria singuinales*	Hairy Crabgrass	July-Sept.
13.	*Echinocloa colona*	Awnless Barnyard Grass, Sanwak	May –Sept.
14.	*Eleusine indica*	Crab or Crowfoot Grass	June-August
15.	*Eragrostis cilianances*	Stinkgrass	May-October.
16.	*Heteropogon contortus*	Speargrass, Sarwala, Abdarka, Kursali.	June-Oct. or Nov.
17.	*Pennesitum orientales*	White Fountaingrass	April-Oct.
18.	*Phalaris minor*	Lesser Canary Grass	March-May
19.	*Poa annua*	Annual Meadow-grass	throughout most of the year, esp. March-Sept.
20.	*Sorghum helipenses*	Baru, Baran	May-Oct.
21.	*Themeda anathera*	Loonder	June-Oct.

Sodium requirements for growth and reproduction of mammals range from 0.05% to 0.15% of the diet (Robbins, 1983) supported the present results in Fig. 1A Fig. 2A revealed that among the selected 21 grass species the highest concentration of 3600 µg/g of Na^+ ion was found in *Arthroxon prinodes* followed by *Chrysopogon aucheri* and *Sorghum helipenses* with 2806 µg/g and 2011 µg/g respectively whereas, *Themeda anathera, Heteropogon contortus* and *Phalaris minor* showed the least tendency of sodium accumulation of 645 µg/g, 770 µg/g and 840 µg/g respectively. The remaining 15 species showed considerable accumulation of Na^+.

Among the selected grass species *Pennesitum orientales, Cymbopogon jawaracusa* and *Digitaria singuinales* were found the hyper accumulator of K^+ ions with 1478.62 µg/g, 1317.86 µg/g and 1291.32 µg/g respectively as shown in Fig. 1B and Fig. 2B while the least accumulation was reported in *Bracharia ramose* (241.12 µg/g), *Arthroxon prinodes* (348.12 µg/g) and *Dactyloctinium aegypticum* (395.4 µg/g). Mengel & Kirkby (1987) reported that the bulk of the K^+ ion is taken up during vegetative growth and as plants mature and no new tissue is developed, K^+ leaches from the leaves supported the presented work.

Results indicated in Fig. 1C and Fig. 2C that *Digitaria singuinales* accumulated the highest of 19067 µg/g of Ca^{+2} ion followed by *Bracharia repten* and *Dactyloctinium aegypticum* with 17840.2 µg/g and 16855.6 µg/g. *Eleusine indica, Pennesitum orientales* and *Cymbopogon jawaracusa* showed the least accumulation of 3353 µg/g, 3369 µg/g and 3556 µg/g respectively. Considerable amount of Ca^{+2} ions was reported in the remaining plants species. The amount of Ca^{+2} the beef cow or sheep would potentially consume from the Gandgar Hills appeared to be sufficient to meet their needs (Fig. 1C). According to Rauzi *et al*., 1969, Sims & Taylor 1973, Munshower & Neuman 1978, Greene *et al*., 1987 and Grings *et al*., 1996 most of the grass species contain an adequate amount of Ca to meet livestock nutrient needs supported the present work.

Magnesium (Mg^{+2}) ion concentration among the macro-minerals in the selected grass species was shown in Fig. 1D and Fig. 2D maximum of 304.36µg/g was reported in *Pennesitum orientales* followed by *Avena sativa* and *Digitaria singuinales* with 250.44µg/g and 207.46µg/g respectively. *Arthroxon prinodes, Cynodon dactylon* and *Dicanthum annulatum* were considered the minor accumulator of Mg^{+2} with 63.84µg/g, 66.5µg/g and 77.6µg/g respectively.

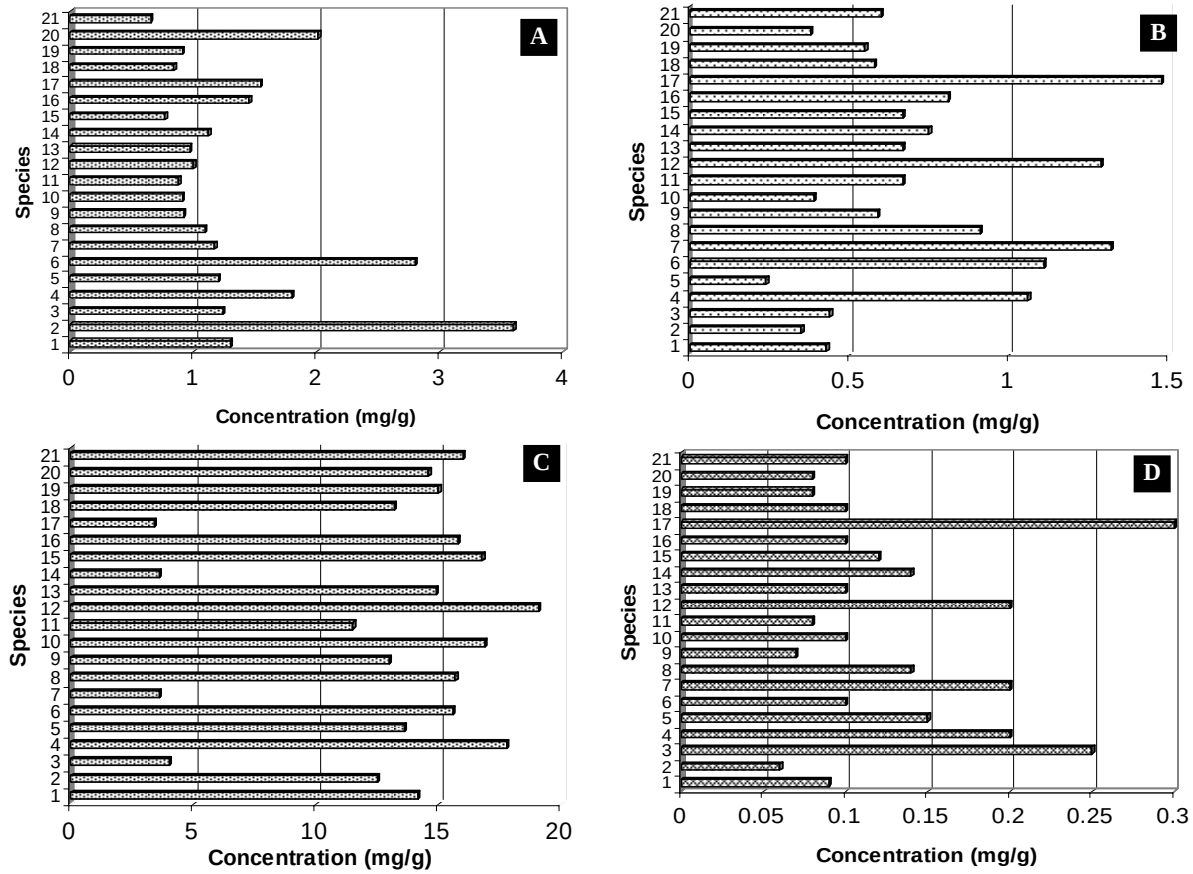

Fig. 1. represents the comparative bar charts of the mineral concentration (mg/g) in 21 different grasses. "A" represent the Sodium (Na) concentration, "B" represent the Potassium (K) concentration. "C" represents the Calcium (Ca) concentration, and "D" represents the Magnesium (Mg) concentration. Species are *Apluda mutica* (1), *Arthroxon prinodes*(2), *Avena sativa*(3), *Bracharia repten*(4), *Bracharia ramosa*(5), *Chrysopogon aucheri* (6), *Cymbopogon jawaracusa*(7), *Cymbopogon martini* (8), *Cynodon dactylon*(9), *Dactyloctinium aegypticum*(10), *Dicanthum annulatum*(11), *Digitaria singuinales* (12), *Echinocloa colona* (13), *Eleusine indica* (14), *Eragrostis cilianances* (15). *Heteropogon contortus* (16). *Pennesitum orientales* (17), *Phalaris minor* (18), *Poa annua* (19), *Sorghum helipenses* (20), *Themeda anathera* (21).

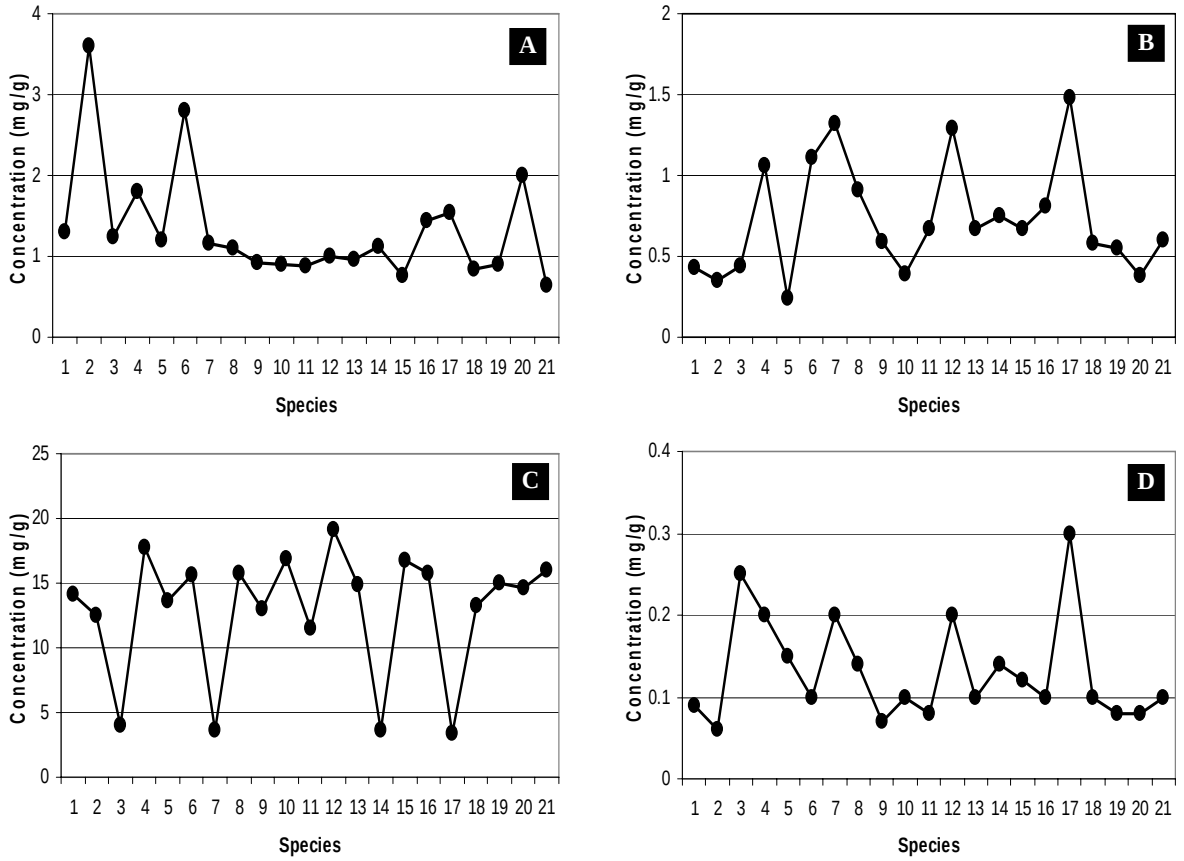

Fig. 2. Represents the comparative line charts of the mineral concentration (mg/g) in 21 different grasses. "A" represent the Sodium (Na) concentration, "B" represent the Potassium (K) concentration. "C" represents the Calcium (Ca) concentration, and "D" represents the Magnesium (Mg) concentration. Species are *Apluda mutica* (1), *Arthroxon prinodes*(2), *Avena sativa*(3), *Bracharia repten*(4), *Bracharia ramosa*(5), *Chrysopogon aucheri* (6), *Cymbopogon jawaracusa*(7), *Cymbopogon martini* (8), *Cynodon dactylon*(9), *Dactyloctinium aegypticum*(10), *Dicanthum annulatum*(11), *Digitaria singuinales* (12), *Echinocloa colona* (13), *Eleusine indica* (14), *Eragrostis cilianances* (15). *Heteropogon contortus* (16). *Pennesitum orientales* (17), *Phalaris minor* (18), *Poa annua* (19), *Sorghum helipenses* (20), *Themeda anathera* (21).

Conclusion

From the present work it has been concluded that *Digitaria sanguinalis* was considered rich in resspect of macrominerals like K^+, Ca^{2+}, Mg^{2+} and Na^+. *Pennesitum orientales* was rich in K^+ and Mg^{2+} both, but Ca^{2+} was found lowest in this grass. *Cymbopogon jawarancusa*, *Dactyloctinium aegypticum,* and *Bracharia reptens* was considered among the hyper-accumulator of Ca^{2+}, Mg^{2+} and Na^+. *Arthroxon prinodes* was the grass species, rich in Na^+, only but K^+, Ca^{2+}, Mg^{2+} was found in least quantity.

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