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A comparative assessment of proximate and elemental composition six weedy grasses for their potential use as fodder

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Summary. In the current study six weedy grasses samples; *Alopecurus myosuroides*, *Brachiaria ramosa*, *Chrysopogon aucheri*, *Phalaris minor*, *Pennisetum orientale* and *Stipa capensis* were collected and evaluated for their potential use as fodder. These species were analyzed for their proximate and mineral composition in three phenological stages. A total of ten elements (Ca, Na, Si, S, Cu, K, Al, Mg, Cl and Fe) that are vital for proper development, health and to produce milk, were detected in varied contents from species to species and phenological stages. Minerals content were mostly detected maximum at reproductive and post-reproductive stages. All six species were also a good and valuable source of nutrients (NDFs, ADFs, ADLs, cellulose and hemicellulose). All species had low moisture and high dry matter contents. Ash contents were high in pre-reproductive stages. *Stipa capensis* has highest nitrogen (57.96%) contents in pre-reproductive stage in all studied grasses. All the assessed species in the light of current findings (minerals and proximate composition) shows that they are a good potential source of fodder for cattles and will be very helpful to fulfill the current crisis of fodder.

Key words: proximate analysis, elemental composition, weedy grasses, fodder

Introduction

Wild grasses have a significant role in feeding grazing livestock in pastures, rangelands, plains as well as mountain ecosystems. The health and performance of cattles depends on the availability and concentration of nutrients and mineral elements present in these grasses (1). Different types of physiological disorders, reproductive problems and diseases in livestock are directly related to lower nutrient contents and deficiency of mineral. Quantity of nutrients and minerals varies at different phenological stages and also influenced by climatic condition, grazing pressure, soil fertility and geographical distribution. Reduction in milk production and many diseases are the direct cause of mineral deficiency of both major elements and trace elements (1). Same researchs investigated the reindeer forage plants for their minerals (K, Na, Ca, Mg, Cl, P, S, Fe, Mn, Zn, Cu, Co and Mo) and proximate composition in Svalbard. Fodder species with that has low Cu and lower to moderate Zn levels are usually considered best for dietary needs of livestock. Amount and quality of nutrients of fodder available to animals are important in determination animals' productivity and growth. 90% of the dry weight of a diet is composed of carbohydrates, fats and proteins (2). Due to deficiency of fodder many ecologically, economically, threatened and medicinally important plants are grazed and collected by the local inhabitants as fodder regardless there conservation. Akram et al.

(3) also evaluated the effects of uncontrolled grazing that leads to overgrazed pastures. Grasses are the most abundant in number of individuals on earth and found almost in every habitat from equator to poles. They can be best choice for fodder purposes due to the cosmopolitan availability, easy accessibility, good taste, fast digestibility and high nutritive values. So grasses has a great potential to be utilized as an alternative source of forage for livestock and can be used to feed and provide the nutritive requirements when the normal sources of fodder are in shortage (4). Grasses provide feed to about 53% of the total fodder to the ruminants (5). Pakistan as an agriculture country mainly depends on crops and livestock for its economy. Livestock rearing is a common practice in Pakistan and a source of food and livelihood (1). The current feeding resources of forage are deficient and provides only 62 to74% of the required nutrients (4). These grasses contribute about US $ 400 million annually to export earnings of Pakistan's in rage land ecosystems of Pakistan by supporting 30 million herds of livestock. Similarly in Northern areas of the country about 55% to the gross provincial income comes from livestock rearing (6). The increase in demand of fodder species to fill the gap between fodder availability and consumption needs alternative forage resources. The current fodder crops are unable to meet the demand in many tropical and subtropical countries. On this regard grasses possess a great potential to be utilized as alternative due to their fast growth, abundance and cosmopolitan distribution (5). Traditionally only a few plants species are used for fodder purposes and almost no data is available about the proximate and mineral analysis of most of the plants. Grasses holds a tremendous potential as fodder species due to their wide distribution rage. The mineral and proximate composition of grasses are commonly changed seasonally and both excess and deficient condition effects the productivity of grasses (4). In Pakistan about 492 grass species are reported most of which are palatable and hold great potential as fodder species (7). Most of the grasses are weeds on different crops, but they also have rich nutrients and possess a great potential to be used as forage grasses. The information on mineral and nutrition composition will provide a base line to uses these species to feed livestock. Nutritional, proximate and elemental analysis of these wild weedy grasses will result in the identification of potential forage grasses. This will result in better health of livestock and will play important role in increasing the financial stability of the farmers and will contribute in the economy of the country.

In this study six weedy grasses samples *Alopecurus myosuroides*, *Brachiaria ramosa*, *Chrysopogon aucheri*, *Phalaris minor*, *Pennisetum orientale, Stipa capensis* were evaluated for their potential use as fodder and for the purpose of contributing to such works.

Materials and Methods

Collection of grass samples

A total of six wild weedy grasses (*Alopecurus myosuroides*, *Brachiaria ramosa*, *Chrysopogon aucheri*, *Phalaris minor*, *Pennisetum orientale* and *Stipa capensis*) were collected from district Peshawar, Pakistan in three phenological stages. About 2 kg of each species were collected and dried in shade for 15 days, grinded into powder and then kept in air tight containers at 5^{o}C. The Peshawar district Peshawar has an area of 1,257 km^2, situated between 33°44′ and 34°15′ North latitude and 71°22′ and 71°42′ East longitudes and approximately 1173 feet (358 meter) msl. Surrounded in the west by Mohmand and Khyber Agency, in the north side by Charsadda District, by Nowshera District in the east and the south east parts are bounded by tribal areas joining Kohat and Peshawar District. With semi-arid climate District Peshawar has very hot summers and mild winters (Table 1).

Proximate analysis

The collected species were evaluated for proximate analysis moisture, crude fiber, crude fats, total ash, carbohydrates and proteins determined by standard methods of AOAC (8). Percent Organic Matter = 100 - % Ash

Cell wall constituents

Acid detergent lignin (ADL) was analyzed for lingo-cellulose (residue of ADF) contents by using Goering and Van Soest (9) and Waldern (10) method. In This method cellulose was dissolved in 72% H_2SO_4

Table 1. Botanical, common names, palatability and distribution of six weedy grassy species.

Botanical name	Common name	Palatability	Distribution in Pakistan	Distribution in world
Alopecurus myosuroides	Black grass, Slender meadow foxtail	Moderately palatable	Baluchistan, Khyber Pakhtunkhwa & Kashmir	Europe and temperate Asia; introduced in North America and other temperate regions
Brachiaria ramosa	Brown top millet, Dixie signal grass, Shamokha	Moderately palatable	Sind, Baluchistan, Punjab, Khyber Pakhtunkhwa & Kashmir	Senegal to Yemen and southwards to Malawi, Rhodesia and South Africa; tropical Asia
Chrysopogon aucheri	Aucher's grass	Highly palatable	Sind, Baluchistan, Punjab, Khyber Pakhtunkhwa & Kashmir	Egypt, Arabia, Iran, Afghanistan and northern India.
Phalaris minor	Canary grass, Little seed canary grass, Mediterranean canary grass	Highly palatable	Baluchistan, Punjab, Khyber Pakhtunkhwa & Kashmir	Throughout the world, but apparently native only in the Mediterranean region and eastwards to Baluchistan and the Northwest Himalayas.
Saccharum bengalense	Munj sweet cane, Tall cane, Baruwa sugarcane, Baruwa grass	Highly palatable	Sind, Punjab, Khyber Pakhtunkhwa & Kashmir	North and Northwest India
Stipa capensis	Spear grass, Mediterranean needle-grass	Highly palatable	Baluchistan, Punjab, Khyber Pakhtunkhwa & Kashmir	Mediterranean region eastwards to Northwest India

and residues of lignin and acid insoluble ash remains. By Van Soest and Robertson (11) method that is the difference between neutral detergent fiber and acid detergent fiber is an estimate of hemicelluloses:

Macro and micronutrient analysis

By using Atomic Absorption Spectrometer mineral (Model Perkin Elmer AA Analyst 700) by using standard of 1000 ppm for each species, the elemental contents of all six collected grasses species were determined.

Results and Discussion

Macro and micronutrient assessment

The table 1 and table 2 show that all the six species has high proximate value and can be used as a good source of fodder. Variation has been observed in composition of minerals as well as nutrients. The results show that the magnesium contents are maximum in the reproductive stage and *Alopecurus myosuroides* has the highest magnesium contents (0.32 mgL^{-1}). While *Phalaris minor* and *Pennisetum orientale* magnesium contents were not detected in all three phenological stages. *Pennisetum orientale* has high sodium contents (0.67mgL^{-1}) in pre-reproductive stage, while in *Chrysopogon aucheri* and *Stipa capensis* has no sodium contents (Table 2). Ferric was detected only in *Phalaris minor* (0.30 mgL^{-1} and 0.24 mgL^{-1} in reproductive and post-reproductive stage respectively) and *Stipa capensis* (0.38 mgL^{-1} only in reproductive stage). *Brachiaria ramosa* has the maximum (39.95mgL^{-1}) cupper contents, while *Alopecurus myosuroides* it is absent in all three phenological stages. Cupper deficiencies results in anaemia and bone abnormalities in cattles. Calcium contents were analysed and observed to decrease from vegetative to post-reproductive stage and absent in *Brachiaria ramosa* in all phenological stages. Calcium is important to animals as the play important role in formation of bones. Hussain and Durrani (12) also reported that with maturity of forage plants composition certain elements decreases. Potassium contents were absent in *Pennisetum orientale* in all three phenological stages, while *Brachiaria ramosa* has the maximum contents (5.45 mgL^{-1}) in post-reproductive stage. For proper physiological function of plants at least 0.5 ppm potassium is essential (13). Chlorine contents were detected in all grasses except *Brachiaria ramosa* (Table 2). Sulphur contents were absent in *Pennisetum orientale* in all phenological stages (Figure 3). Phosphorus contents were present in trace amount

Table 2. Mean mineral content (mg/L) at three phenological stages of six weedy grassy species.

Botanical name	Phenological stages	Mineral content (mg/L)													
		C	N	O	Mg	K	Ca	Na	Al	Si	P	S	Cl	Cu	Fe
Alopecurus myosuroides	Pre-reproductive stage	47.82	6.09	39.39	0.16	2.05	0.40	-	0.18	1.92	0.17	0.24	1.58	-	-
	Reproductive stage	47.73	5.26	41.08	0.32	1.63	0.34	0.20	0.13	1.45	-	0.11	1.76	-	-
	Post-reproductive stage	50.48	2.37	42.49	0.17	1.09	0.17	-	0.17	2.17	0.23	0.07	0.59	-	-
Brachiaria ramosa	Pre-reproductive stage	51.25	-	20.74	-	4.86	-	0.42	-	8.43	-	0.35	-	13.95	-
	Reproductive stage	50.22	-	25.43	-	3.67	-	o.64	0.13	6.87	-	0.23	-	12.81	-
	Post-reproductive stage	53.45	-	24.68	-	5.45	-	0.56	0.24	4.78	-	0.34	-	10.50	-
Chrysopogon aucheri	Pre-reproductive stage	49.83	5.80	40.25	0.13	0.48	0.35	-	-	2.01	-	0.22	0.30	0.64	-
	Reproductive stage	49.46	-	46.05	0.28	0.80	0.22	-	-	2.59	-	0.27	0.33	-	-
	Post-reproductive stage	50.15	5.21	41.31	0.15	0.17	0.23	-	-	2.32	0.13	0.15	0.18	-	-
Phalaris minor	Pre-reproductive stage	53.57	-	38.84	-	3.31	0.24	0.35	0.22	0.90	0.25	-	1.69	0.64	-
	Reproductive stage	47.28	5.73	39.92	-	3.29	-	0.32	0.26	0.88	0.29	0.11	1.61	-	0.30
	Post-reproductive stage	49.20	5.03	37.60	-	3.80	-	-	0.15	1.03	0.38	-	1.67	0.89	0.24
Pennisetum orientale	Pre-reproductive stage	44.87	2.65	27.65	-	-	0.75	0.67	-	9.98	-	-	5.86	7.57	-
	Reproductive stage	43.22	2.32	26.32	-	-	0.56	0.43	-	7.83	-	-	4.23	15.09	-
	Post-reproductive stage	45.67	3.12	27.79	-	-	0.68	0.45	-	8.75	-	-	7.86	5.68	-
Stipa capensis	Pre-reproductive stage	57.96	-	39.60	-	0.35	0.50	-	0.11	1.48	-	-	-	-	-
	Reproductive stage	51.85	3.13	40.99	0.14	0.52	0.41	-	0.19	1.78	-	0.12	0.22	0.26	0.38
	Post-reproductive stage	56.01	5.53	37.36	-	0.40	0.29	-	-	0.28	-	0.14	-	-	-

in *Alopecurus myosuroides*, *Chrysopogon aucheri* and *Phalaris minor*. High amount of Silicon contents were observed all species especially in *Pennisetum orientale* and *Stipa capensis* with a mean of 0.937 mgL^{-1} and 8.854 mgL^{-1} respectively. In case of *Brachiaria ramosa* the sodium contents increased, while in *Pennisetum orientale* and *Phalaris minor* from pre-reproductive to post-reproductive stages. Khan et al. (1) observed similar increase in sodium contents from pre-reproductive to post-reproductive stages. Potassium contents were found maximum in pre-reproductive stages than reproductive stages with a slight increase in post-reproductive stages. The same phenomenon was also observed by Sultan et al. (14) and Khan et al. (1) during their assessments. Potassium is an essential component of many enzymes and play role in the activation of growth enzymes in plants Khan et al. (1), Sultan et al. (14). The calcium contents were observed

Table 3. Mean proximate composition and cell wall constituents at three phenological stages of six weedy grassy species.

Botanical name	Phenological stages	Cell wall constituents					Proximate composition							
		NDF (%)	ADF (%)	Lignin (%)	Hemi cellulose (%)	Cellulose (%)	DM (%)	Moisture (%)	Ash (%)	CP (%)	CF (%)	Fat (%)	OM (%)	NFE (%)
Alopecurus myosuroides	Pre-reproductive stage	65.34	43.22	25.35	22.76	8.42	91.64	8.36	14.68	13.94	35.00	7.39	90.43	31.46
	Reproductive stage	58.23	22.62	34.56	24.63	5.94	92.12	6.88	12.37	11.32	28.95	10.64	89.75	24.94
	Post-reproductive stage	62.71	40.86	24.57	13.19	6.05	91.85	8.15	15.14	8.12	31.53	9.11	87.21	21.39
Brachiaria ramosa	Pre-reproductive stage	30.65	32.96	19.39	23.63	7.87	89.21	10.79	12.45	15.05	26.30	12.43	92.64	26.44
	Reproductive stage	56.67	17.74	26.75	8.95	5.34	90.34	9.66	10.34	9.95	23.54	10.86	88.43	28.34
	Post-reproductive stage	60.84	29.43	34.64	19.83	4.78	90.76	9.24	13.21	7.53	21.43	4.78	88.21	22.84
Chrysopogon aucheri	Pre-reproductive stage	70.43	45.76	18.43	40.08	3.24	94.14	5.86	10.84	8.94	38.48	5.98	89.82	30.18
	Reproductive stage	37.92	41.52	19.85	12.57	4.65	93.87	6.13	12.94	7.23	25.76	8.32	89.34	31.65
	Post-reproductive stage	63.73	33.46	36.57	23.21	4.26	92.43	7.57	8.12	4.42	21.96	12.67	88.76	26.12
Phalaris minor	Pre-reproductive stage	72.11	43.21	29.44	38.56	5.04	93.15	6.85	13.42	14.77	37.26	5.86	86.31	26.07
	Reproductive stage	42.84	34.56	12.54	18.76	7.34	94.23	5.77	11.23	9.11	40.32	4.64	91.75	22.53
	Post-reproductive stage	68.06	45.10	23.75	36.22	3.86	94.93	5.07	18.03	6.21	31.34	8.32	89.64	21.18
Saccharum bengalense	Pre-reproductive stage	40.96	22.56	17.47	8.23	4.33	93.72	6.28	8.29	7.32	34.22	10.32	80.35	19.45
	Reproductive stage	36.86	29.04	19.06	2.67	3.54	94.34	5.66	4.67	4.93	36.03	8.21	86.94	17.84
	Post-reproductive stage	68.45	74.34	37.80	10.34	5.32	95.13	4.87	6.85	3.43	29.74	12.87	88.21	22.59
Stipa capensis	Pre-reproductive stage	64.55	33.23	25.64	13.22	8.75	91.98	8.02	9.91	6.34	33.01	8.36	90.04	34.75
	Reproductive stage	23.45	34.65	19.92	18.49	5.98	92.56	7.44	5.75	4.66	27.62	11.41	89.74	32.55
	Post-reproductive stage	56.87	54.95	30.57	28.60	4.85	94.43	5.57	8.22	3.24	28.21	4.54	88.57	28.76

to decrease from pre-reproductive to post-reproductive stages. Deficiency of micro elements has effects on the digestibility and can reduce cattles productivity as well as macro elements contents (16).

Proximate composition

Proximate analysis of all grass species showed essential variation in dry matter, organic matter, fat content, ash content, moisture content, crude fiber, crude protein and NFE values both phenologically and species to species (Table 3). Generally moisture contents were observed high in pre-reproductive stages (Figure 1). *Brachiaria ramosa* had higher moisture contents in all three phenological stages especially in pre-reproductive stage (10.79%). Moisture contents of all six species were low which indicates higher dry matter yield as observed by Bamigboye et al. (17) and their long storage capability as it not flavour the growth of microorganisms (18). Dry matter analysis resulted in maximum values in post-reproductive stages and *Saccharum bengalense* has high dry matter yield in post-reproductive stage (95.13%) followed by reproductive (94.34%) and pre-reproductive stage (93.73%). Percentage ash content has high values in pre-reproductive stages and varied between 14.68% for *Alopecurus myosuroides* in pre-reproductive stage and *Saccharum bengalense* 4.67% in reproductive stage (Table 3). Kramberger and Klemmencic (19) reported that in herbaceous and woody plants the dry matter contents are increased with advancing in phenological stages. The crude protein content was within a range 15.05% (*Brachiaria ramosa*) and 3.24% (*Stipa capensis*). Storeheier et al. (20) reported that winter green grass parts had high contents of crude proteins than other parts of plants. Crude proteins are important for animals growth and tissue repair (21). Deficiency of crude proteins could result in reduced appetite, low feed intake and poor efficiency of food, which cause lower growth and reduced development of cattle (13). Crude fats contents were found high and usually maximum at post-reproductive and reproductive stages. High fats contents shows suitability of as species as a food and also level of palatability as their essential role in production of energy (18). The organic matter contents were observed to decrease from pre-reproductive to post-reproductive stages all grass species. Hussain and Durrani (22) reported similar results during assessment of forage plants of Harboi range lands where they found that OM decreased with maturity. Sultan et al. (14) also observed opposite trend that OM increased in with age in some grasses. Highest value for nitrogen free extract was observed *Stipa capensis* (34.75) in pre-reproductive stage. Daccord et al. (23) also reported decrease in NFE values from pre-reproductive to advanced stages supporting the current results.

Diversity in cell wall constituents

The results obtained for cell wall constituents showed that these six grasses are a good source of neutral detergent fiber (NDF), acid detergent lignin (ADL), acid detergent fiber (ADF), cellulose and hemicellulose. The NDF and ADF contents were observed to maximum in pre and post-reproductive stages (Figure 1) and usually lower in reproductive stages. Shah and Hussain (24) also observed similar results during assessment of micro-minerals and proximate composition of some Mastuj Valley forage grasses. Neutral detergent fiber (NDF) used generally to measure fiber used for animals feed analysis (21). ADF were also recorded maximum at pre reproductive or at post reproductive stages by Lal, (21) during his studies on micro-mineral and proximate composition of plant species in District tank, Pakistan. *Phalaris minor* (72.11%) and *Chrysopogon aucheri* (70.43%) had high NDF contents in pre-reproductive stage. Lignin contents varied in a range of 37.80% (*Saccharum bengalense* in post-reproductive stage) and 12.54% (*Phalaris minor* in reproductive stage). Hemicellulose contents were abundant in pre-reproductive and post-reproductive stages. Zhao et al. (25) stated that ADL concentration in grasses usually exhibited high in earlier stages than woody species. *Chrysopogon aucheri* (40.08%) has highest hemicellulose contents in pre-reproductive stage (Table 3). Shah and Hussain (24) reported similar findings from their studies. Phimphachanhvongsod and Ledin (26) observed that herbaceous species contain higher hemicelluloses contents than shrubs. Cellulose contents decreased from pre-reproductive stage to post-reproductive stage and *Alopecurus myosuroides* had maximum cellulose content in pre-reproductive stage. The digestibility of grasses and other plants is inversely related to cellulose and lignin contents (Figure 2).

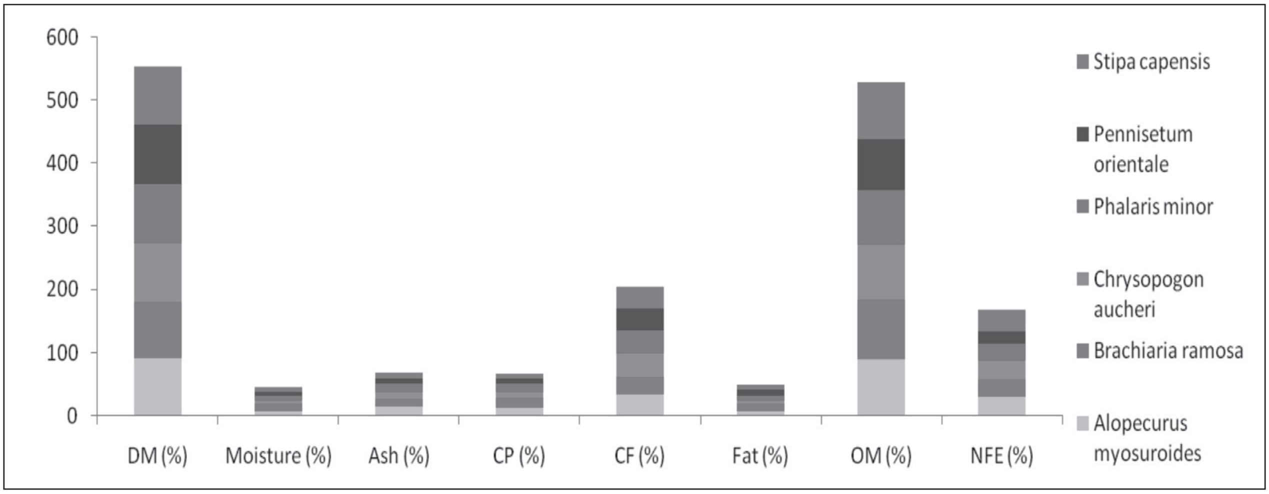

Figure 1. Variation in proximate composition in pre-reproductive stage.

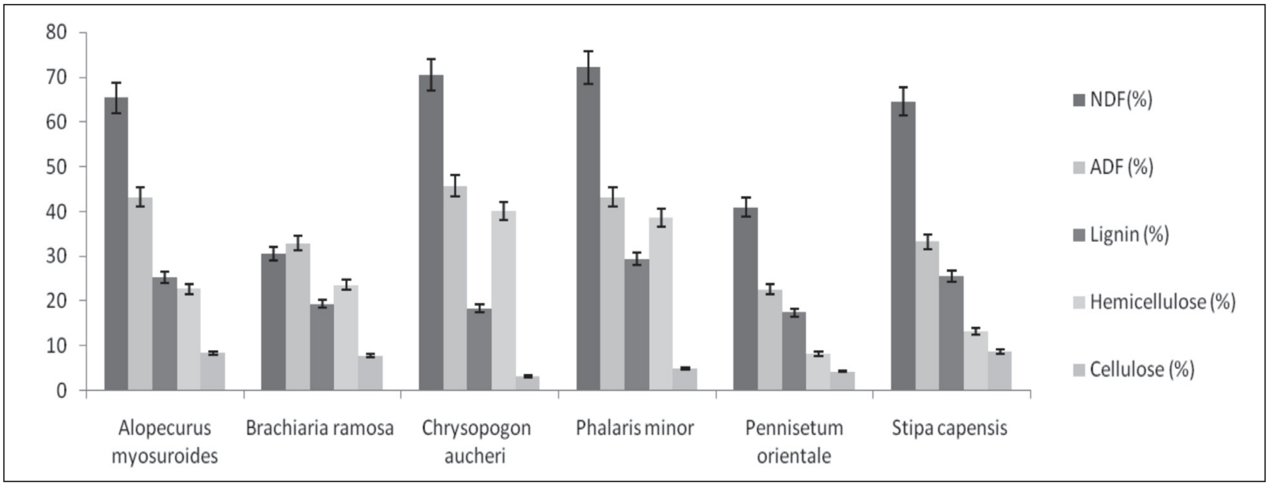

Figure 2. Cell wall constituents in Pre-reproductive stage

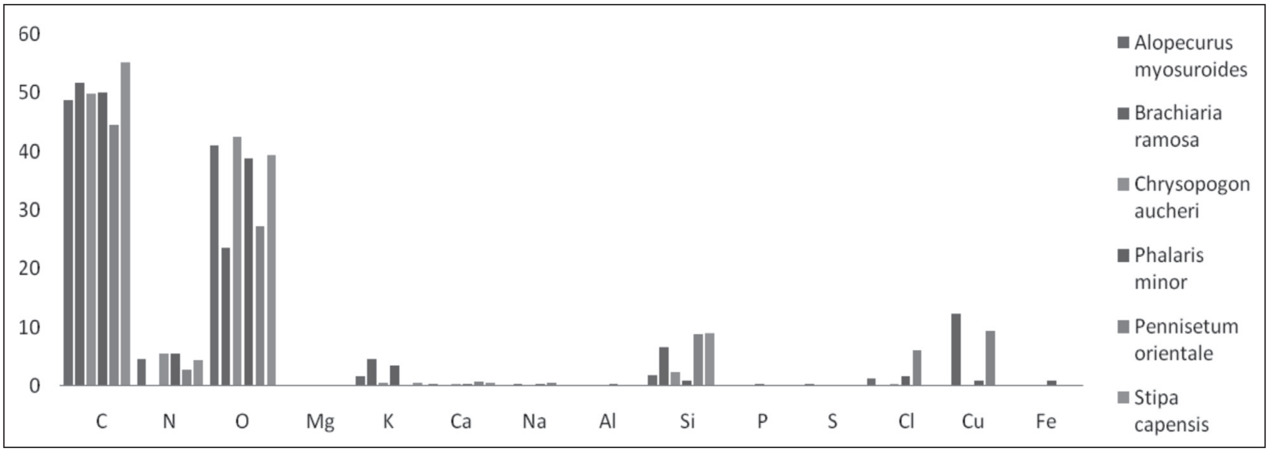

Figure 3. Mean mineral contents (mg/L) variation.

Conclusion

Due to low production of fodder and high grazing pressure on pastures and rangelands there is an instant need of alternative forage grasses. Similarly some medicinally and threatened species are extensively used for forage that results in the extension of those species. Currently only few plant species are used as fodder with low nutrients that results in the deficient growth, low productivity and diseases. There is a instant need for more highly nutritional fodder species that are produced abundantly and wide distribution. In the present study six wild weedy grasses that are produced in abundant throughout the country and world widely were evaluated for their proximate and mineral composition. The results showed that all six species were found to be a good source of nutrients and minerals in all phenological stages. Thus on the basis of current findings we suggest that these grasses possess a great potential for their utilizations as fodder and forage and will be very helpful to overcome the current shortage of fodder in the country as well as globally.

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