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NUTRITIONAL QUALITY OF SIXTEEN TERRESTRIAL WEEDS FOR THE FORMULATION OF COST-EFFECTIVE ANIMAL FEED

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ABSTRACT

Nutritional composition of sixteen weeds was investigated to determine their nutritional potential for livestock consumption in Pakistan. Analysis of dry matter, ash, crude fiber, acid detergent fiber, nutrient detergent fiber and crude protein were conducted in *Dicanthium annulatum*, *Cynodon dactylon, Avena fatua, Convolvulus arvensis, Sorghum halepense* and *Amananthus Viridis.* Most of the species were rich in calcium, zinc, copper, iron, sodium and magnesium with the highest values recorded in *Oxalis debilis, Rumex crispus, Medicago polymorpha, P. oleracea* and *A. viridis.* Overall results indicated that broadleaf weeds possess higher mineral contents than grassy weeds. Results indicate that weeds can be used as a source of nutrients in livestock feeding, which will also help in promoting growth of the major corps. The grasses (*A. fatua, D. annulatum* and *C. rotundus*) could be important sources of fiber while broad leaf weeds (*C. arvensis, A. viridis,* and *R. crispus)* could be good sources of protein and minerals.

Keywords: weeds; feed; livestock, terrestrial; nutrients composition, protein, minerals, energy.

INTRODUCTION

Although weeds are often, thought to be harmful, a large number of weeds are consumed by animals as fodder and by humans as green vegetables and herbal medicines in countries such as Pakistan. Weeds help the poor landless farmers who do not have enough land to cultivate fodders for their animals and weeds consumed as green vegetables play an important role in the house hold economy. Weeds are presently a valuable resource for many people in Khyber Pakhtunkhwa (KPK), the war and flood hit zone of Pakistan This is because the livestock industry in Pakistan is not well developed and the dairy and meat animals are reared in a traditional way in the rural areas to meet the requirement of only the household. Commercial dairying is practiced in periurban areas where majority of the dairy farmers are landless and they have to buy fodders for their animals and depend upon grazing where weeds are available.

Hatim *et al.,* (200l) reported that feed resources for domestic animals in KPKare derived from various resources such as crop residues (45%), cultivated fodder (7%), grazing land (46%), and concentrate (2%). Shortage of quality fodder is a serious problem impeding livestock development. The land devoted to fodder crops in the different districts of KPK ranges from 100 hectare in Kohistan to 3,500 thousand hectare in Bannu.

Herbicides are not widely utilized among the farming community due to small land holdings and low economic status (Khan *et al.,* 2009). Thus, weeds flourish in cropped and non-cropped areas that provide opportunities to the local farmers to collect and use for different purposes. In Pakistan, impoverished farmers cut the mature weeds at the base and carry it to their homes to use as fuel (Khan *et al.,* 2009). Thus the weeds are extensively used by the poor farmers for many purposes including animal feed.

Many weeds are good-quality forage plants as they meet most of the recommended values for cattle maintenance (Dora *et al.,* 2008). Less utilized tropical plants represent a potential food source with high protein content and good nutritive value (Yeoh and Wong, 1992).

Unfortunately, there is little published data of the area under discussion that addresses the nutritional importance of agricultural weeds. Pakistan has unique climate and thus there are hundreds of weeds that are palatable to animals. Farmers collect the weeds from cropped and non-cropped areas and use as feed for the animals without knowing the nutritional quality of these weeds. Before advocating the utilization of these terrestrial weeds for supplementation of animals, there is an urgent need to explore their nutritional quality. Therefore our objective was to evaluate the nutritional value of sixteen weed species commonly found in northwest Pakistan:

MATERIALS AND METHODS

Sample collection and preparation: Sixteen major weed species were randomly collected from agricultural lands at seed production stage during March 2009 from five villages of District Peshawar, Khyber Pakhtunkhwa

(KPK), Pakistan at a distance of 10 km around Peshawar city. Weed species were collected on the basis of their densities; weed species found at higher density and widely distributed were presumed to contribute significantly in animal feeds. Farmers were also observed collecting these weeds in the early spring and using them as animal feed. Plant samples (above ground portion) were collected by cutting the plant at the base with a sickle. Then plants were washed with tap water to remove dust and other particles. The samples were put in paper bags and oven dried at 65^{o}C for 72 hours (WiseVen). All the plant samples were ground in a grinder to make powder and kept in paper bags under room temperature.

Compositional and mineral analysis: Compositional analysis of weeds was carried out according to prescribed procedures of AOAC (2003). Wet digestion of samples was performed using nitric acid and perchloric acid mixture and then the samples were analyzed for copper (Cu), magnesium (Mg), Zinc (Zn), Iron (Fe), and Calcium (Ca) by atomic absorption spectrometry, while sodium (Na) was determined using Flame photometer according to the prescribed procedure of AOAC (2003). All analyses were carried out in triplicates and the final values were determined by using the following formula.

Mg/100g = Instrumental reading x Dilution x Dilution. Factor/Weight of sample

Statistical analysis: Data are presented as means ± SE. One-way analyses of variance (ANOVA) was performed to compare mean values.

RESULTS AND DISCUSSION

Compositional analysis: Dry matter and ash were nearly identical in all the weeds and the values ranged from 90 – 92.44% and 8.93–13.30%, respectively (Table 1). Hence the analysis indicates these weeds can successfully fulfill the dry matter requirements of animals.

Two major grassy weeds of the study (*Avena fatua* and *Dicanthium annulatum*) had the highest level of crude fiber i.e. 31.32 and 28.91%, respectively while the lowest values occurred in *Cynodon dactylon* (6.21%) and *Bromus tectorum* (6.23%). It is very common for *A. fatua* and *C. dactylon* to be fed to animals as farmers can easily collect more biomass in a short time. Farmers need to be informed that not all the weeds are equally important for fodder use.

Acid detergent fiber has been used to estimate the digestibility of a plant. The highest levels of acid detergent fiber (ADF) occurred with *Cyperus rotundus* (57.77%) and *Amaranthus viridis* (57.73%) while *Phalaris minor* and *Taraxacum officinale* having the lowest levels (34.41 and 38.80%, respectively) (Table 1). *S. halepense* and *P. minor* were rich in NDF compared with *Amaranthus viridus* and *Convolvulus arvensis* . Overall NDF content in grassy weeds was higher than broadleaf weeds. As NDF increases, intake declines. Hussain and Durani (2009) similarly found that grasses generally had higher NDF levels than broadleaves..

Crude protein (CP) content in the weed samples varied among different species. *C. arvensis* (26.62%) and *A. viridis* (26.15%) were rich sources of crude protein while *Portulaca oleracea* (7.87%) and *Oxalis deblis* (7.88%) were low in CP. Daily crude protein requirement of dairy animals is approximately 16% (Mandal *et al.,* 2003) therefore the above mentioned weeds can greatly contribute to the protein requirement of livestock industry. Overall results indicated that grassy weeds had less crude protein as compared to broadleaf weeds. Proteins are an essential nutrient required for the proper nutrition of all animals.

Fiber composition is important to livestock as the process of fermentation in rumen converts fiber into volatile fatty acids which contribute more than 70% energy to ruminants animals. The weed analysis in the present study suggests that the fiber content could fulfill the animal requirement. However, the higher fiber content affects feed intake and digestibility but in present study the higher fiber content was due to mature stage of weeds which increases fiber content. In a similar study it was observed that stage of maturity at harvesting time was the most influential factor affecting CF of forage crops (Collar and Aksland, 2001). The weeds under study were collected and anlysed at seed production stage and literature supports that the ADF and NDF contents increases with plant maturity (Church, 1988). So there is a need to analyse these weeds at different growth stages so that the weeds could be incorporated in the nutrition calendar of forages.

Nonetheless, preliminary results suggest that weeds can play a significant role in livestock industry if the chemical composition is known to formulate a nutritive feed as the present feed resources provide 40% CP to the livestock (Younas and Yaqoob, 2005). Farmers usually collect the weeds on the basis of weed biomass rather than on nutritional value therefore our results suggest that the weeds that provide balanced nutrition should be popularized among the farming communities. Using weeds as fodder will not only satisfy the farming community but will also keep the weed population low due to prevention of seed production as the weeds are collected before seed production.

Mineral Analysis: There was large variation in the copper (Cu) content in different weed species (Table 2). The Cu content ranged from 0.005 – 0.268 mg/100g. *O. debilis*, *C. rotundus* and *C. arvensis* contained the highest CU values; respective values were 0.268, 0.171, 0.095 mg/100g. Weed species having the lowest Cu content included *Dicanthium annulatum*, *A. fatua* and *Medicago polymorpha*. Other studies also found that many weeds contained high amounts of mineral elements required for healthy growth and development of animals (Kalita *et al.,*

2007; Dora *et al.,* 2008). As mineral deficiencies (including Cu defiency) are frequently encountered in livestock in developing countries (Mandal *et al.,* 2003), several weeds in our study would be very good candidates for eliminating Cu deficiency in many situations.

Zn is the second most abundant trace element in mammals and forms a structural component of over 300 enzymes, where it may also be a key to catalytic and regulatory activity (Underwood and Suttle, 1999). Zinc (Zn) content of weeds were in the range of 0.010 - 0.199 mg/100g with higher values recorded in *Rumex crispus* (0.199 mg/100g), *P. annua* (0.186 mg/100g) and *A. varidis* (0.175 mg/100g) and lower values found in, and in *Cynodon dactylon* ((0.010 mg/100g) and *P. minor (*0.079 mg/100g) (Table 2). Overall results indicate that the Zn content of *R. crispus, P. annua* and *A. viridus* are comparable to the normal feeds and fodder used in ruminant animals (Underwood and Suttle, 1999)**.**

Weeds having the highest iron (Fe) content included *Portulaca oleracea* (3.692 mg/100g) and *O. debilis* (2.435 mg/100g). Low Fe contents were found in *A. fatua* (0.208 mg/100g) and *Bromus tectorum* (0.382 mg/100g). Results indicated that broadleaf weeds contain higher amount of Fe as compared to grassy weeds. Therefore consumption of *P. oleracea* and *O. debilis* can be very useful in successfully meeting the livestock requirements in developing countries like Pakistan. Abbasi *et al.,* (2009) similarly reported that Fe content was greater in broadleaf than in grass species.

Great variation was observed in the Ca content of weeds in our study (Table 2). Broadleaf weeds such as *Medicago polymorpha, Amaranthus viridis* and *Taraxacum officinale* contained high Ca contents (10.203, 7.458 and 7.343 mg/100g, respectively) while grasses had lower Ca contents Farmers in Pakistan prefer *P. minor* as compared to *M. polymorpha* because they can collect more biomass of fresh *P. minor* in a short period of time. There is a need for farmers to place more consideration on the basis of their nutritional value and not just on the basis of fresh biomass.

Mg plays role in body metabolism as an essential part of a range of enzymes that are involved in bone growth and egg-shell formation, carbohydrate and lipid metabolism, immune and nervous function, and in reproduction. Magnesium (Mg) content of weeds ranged from 0.925 to 4.752 mg/100g (Table 2) with broadleaf weeds again containing higher Mg content as compared to grassy weeds. For example, *A. viridis* (4.752 mg/100g), *P. oleracea* (3.112 mg/100g) and *R. crispus* (2.725 mg/100g) had higher Mg contents than *P. minor* (0.925 mg/100g), *A. fatua* (1.105 mg/100g) and *S. halepense* (1.335 mg/100g). Our results are contrary to Bakshi *et al.,* (2005) who reported that most of the grasses were rich in Ca and Mg.

Sodium (Na) content in the weed species ranged from 0.006-0.030 mg/100g with the highest values being recorded in *P. oleracea, Cichorium intybus* and *C. rotundus,* (Table 2). *S. halepense*, *C. arvensis*, *P. minor* and *D. annulatum* were among species having the lowest Na content.

Table1. Compositional analysis of common weed species in northwest Pakistan.

Weed Species	Dry Matter (%)	Ash (%)	% Crude Fiber	% ADF	% NDF	% Crude Protein (DM) Nx625
Cynodon dactylon L	90.85+0.53	13.30+0.37^{a}	06.21+1.40^{o}	47.50+0.77^{d}	76.40+0.19^{b}	13.5 +0.020^{de}
Sorghum halepense L.	91.20+0.62	11.85+1.40^{ab}	26.91+1.80^{c}	55.07+0.03^{b}	79.08+0.07^{a}	14.75+0.021^{cd}
Rumex crispus L.	90.14+0.97	11.24+1.19^{ab}	12.48+0.24^{m}	50.30+1.29^{c}	38.28+0.77^{hi}	22.25+0.013^{b}
Portulaca oleracea L.	91.27+0.52	12.88+0.13^{a}	16.48+1.36^{i}	48.60+0.78^{cd}	40.16+0.20^{hi}	7.87+0.061^{f}
Taraxacum officinale FH Wigg	90.74+0.12	11.28+0.11^{ab}	14.50+1.56^{k}	38.80+1.00^{f}	36.83+0.13^{ij}	15.37+0.008^{cd}
Convolvulus arvensis L.	90.27+1.02	10.33+1.29^{bc}	14.60 + 0.02^{l}	41.16+1.80^{e}	35.33+0.55^{j}	26.62+0.013^{a}
Phalaris minor Retz.	90.87+0.40	08.93+0.49^{c}	20.69 + 0.47^{f}	34.41+1.65 ^{g}	78.32+0.02^{ab}	11.62+0.071^{e}
Avena fatua L.	90.75+1.71	12.36+1.15^{ab}	31.32+1.13^{a}	50.12+1.77^{c}	74.21+1.04^{c}	14.75+0.300^{cd}
Oxalis debilis Kunth L.	91.09+0.82	12.17+0.82^{ab}	19.32+0.32^{g}	54.54+0.33^{b}	71.68+0.03^{d}	07.88+0.015^{f}
Bromus tectorum L.	91.09+0.82	12.49+0.24^{ab}	06.23+1.93^{o}	42.71+0.21^{e}	68.19+0.12^{e}	08.50+0.145^{f}
Dicanthium annulatum	91.09+0.82	11.79+0.85^{ab}	28.91+0.45^{b}	49.24+0.87^{cd}	72.61+0.83^{cd}	16.30+0.010^{cd}
Amaranthus viridis L.	91.09+0.82	13.28+0.52^{a}	10.31+0.66 ^{n}	57.73+0.33^{e}	30.99+0.29^{k}	26.15+0.070^{a}
Poa annua L.	91.09+0.82	12.04+1.44^{ab}	24.84+1.40 ^{e}	42.33+1.40^{a}	72.81+0.01^{cd}	14.12+0.313^{cd}
Medicago polymorpha	91.09+0.82	11.28+1.30^{ab}	18.75+1.01^{h}	53.64+0.02^{b}	42.83+0.13^{g}	21.54+0.011^{b}
Cichorium intybus L.	91.09+0.82	2.83+0.12 ^{ab}	14.67+0.33$_{i}$	49.50+1.40^{cd}	38.73+0.40^{h}	13.51+0.103^{de}
Cyperus rotundus L.	91.09+0.82	12.78+1.77^{a}	26.92+0.52^{d}	57.77+1.58^{a}	64.43+0.58^{f}	16.22+0.094^{c}
LSD	2.37	2.34	0.09	2.31	1.94	2.57
Significance level	NS	*	**	**	**	**

Columns having the same letters within the column are statistically non significant

± indicates the standard error (Mean of 3 values) * indicates significance level (P<0.05) ** indicates significance level (P<0.01)

Table2. Mineral analysis of common used weed species in northwest Pakistan.

Weed Species	Cu (mg/100g)	Zn (mg/100g)	Fe (mg/100g)	Ca (mg/100g)	Mg (mg/100g)	Na (mg/100g)
Cynodon dactylon L	0.065±0.003^{h}	0.010±0.013^{i}	0.576±0.003$_{k}$	2.664±0.037^{k}	1.667±0.003^{m}	0.010±0.012^{gh}
Sorghum halepense L	0.050±0.001^{j}	0.151±0.019^{f}	0.545±00.07$_{l}$	2.255±0.005^{m}	1.335±0.012^{n}	0.006±0.002^{i}
Rumex crispus L.	0.062±0.002^{i}	0.199±0.033$_{a}$	0.689±0.012$_{h}$	4.675±0.011^{g}	2.725±1.013^{c}	0.015± 0.088^{d}
Portulaca oleracea L.	0.072±0.022$_{k}$	0.172±0.003^{d}	3.692±0.144^{a}	5.289±00.25^{f}	3.112±0.001^{b}	0.030± 0.006^{a}
Taraxacum officinale FH Wigg	0.050±0.052^{m}	0.141±0.040^{h}	1.671±0.024^{c}	7.343±0.008^{c}	2.080±0.055^{i}	0.013±0.033^{ef}
Convolvulus arvensis L.	0.095±0.001^{f}	0.127±0.007^{i}	0.621±0.133^{i}	5.462±0.007^{e}	2.320±0.100^{g}	0.007± 0.008^{i}
Phalaris minor Retz.	0.070±0.003^{c}	0.079±0.033^{m}	0.592±0.005^{j}	1.533±0.005^{p}	0.925±0.005^{e}	0.007± 0.009^{i}
Avena fatua L.	0.020±0.026^{g}	0.068±0.005^{n}	0.208±0.004^{o}	1.808±0.008^{o}	1.105±0.098^{p}	0.016± 0.077^{d}
Oxalis debilis Kunth L.	0.268±0.033^{a}	0.147±0.058^{g}	2.435±0.040^{n}	4.316±0.052^{h}	2.380±0.002^{o}	0.014±0.040^{def}
Bromus tectorum L.	0.073±0.004^{f}	0.109±0.021^{j}	0.382±0.053^{m}	3.575±0 0.92^{i}	1.745±0.007^{l}	0.012±0.077^{fg}
*Dichanthium annulatum*L.	0.005±0.021^{j}	0.106±0.011^{k}	0.468±0.003^{b}	2.151±0.001^{n}	1.857±0.016^{k}	0.007±0.001^{i}
Amaranthus viridis L .	0.088±0.099^{d}	0.175±0.002^{c}	1.493±0.013^{d}	7.458±0.044^{b}	4.752±0.004^{j}	0.013±0.059^{ef}
Poa annua L.	0.083±0.003^{e}	0.186±0.005^{b}	1.193±0.001^{f}	2.861±0.003^{j}	1.982±0.001^{a}	0.008±0.022^{hi}
Medicago polymorpha	0.041±0.007^{i}	0.142±0.002^{h}	1.252±01.001^{e}	10.20±0.003^{a}	2.445±0.033^{d}	0.008±0.036^{hi}
Cichorium intybus L.	0.062±0.055^{l}	0.151±0.013^{f}	0.469±0.155^{m}	6.158±0.006^{d}	2.090±0.057^{h}	0.025±0.004^{b}
Cyperus rotundus L.	0.171±0.006^{b}	0.160±0.027^{e}	0.952±0.004^{g}	2.318±0.004^{l}	2.350±0.009^{f}	0.022±0.099^{c}
$LSD_{0.01}$	2.21	2.31	2.31	2.31	2.31	2.31
Significance level	**	**	**	**	**	**

Columns having the same letters within the column are statistically non significant
± indicates the standard error (Mean of 3 values) ** indicates significance level (P<0.01).

Conclusions: Results indicate that weeds can be used as a source of nutrients in livestock feeding, which will also help in promoting growth of the major corps. The grasses (*A. fatua, D. annulatum* and *C. rotundus*) could be important sources of fiber while broad leaf weeds (*C. arvensis, A. viridis,* and *R. crispus)* could be good sources of protein and minerals.

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