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Mineral Contents of Weed Crops In Central Anatolian Region

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Abstract

Objective of the research is to determine the mineral contents of weed crops intensively grazed by livestock of Central Anatolian Region. A total of 11 weed crops (*Sinapisarvensis, Lamium album, Malva* spp., *Convolvulus arvensis, Chenepodium album, Alhagi* spp., *Sanguisorba minor*Scop.,*Amaranthus* spp., *Taraxacumofficinale, Polygonumcognatum* and *Sorghum halepense*) collected from pastures and field of Kayseri were used as the material of the research. Plant samples were collected at blooming periods during June of the year 2011. Samples were dried and mineral contents were determined with 3 replications. Statistical analyses were performed based on randomized block design. Phosphorus, Calcium, Potassium, Nickel, Cadmium, Lead, Copper, Manganese, Sodium, Zinc, Iron, Magnesium and Boron were determined in the weed plants in dissimilar numbers. The close analysis indicated that the weed seeds contained Cu 8.115-9.360, Mn 65.905-77.890, Zn 30.405-42.105, Fe 254.0-290.5, Mg 2118.0-2414.0, B 6.385-9.655, Ni 0.2305-0.2945, P 2640.5-3307.5, Ca 8193.0-8965.0, K 10221.51-12332.0, Cd 0.1625-0.2235, Pb 0.3345-0.4160 and Na 1181.51-1475.5 mg kg-1, respectively. Results indicated that weed plants of Central Anatolia were rich in trace elements and there was no need for supplemental trace elements.

Key words

Weed, Mineral Content, Correlation, Biplot

1. INTRODUCTION

Pecora browsing indicates a system of land admin in non-farm marginal fields, but, on grassland pecora browsing indicates the most appropriate terrain use (Jones and Martin 1994). Weeds are important feed source for ruminants grazing over the rangelands of Turkey. However, there are limited studies about nutritional values of these weeds. Alternative feed sources are widely used as regional feed sources without reducing the livestock performance. They can reduce feeding costs through providing a full or partial alternative to forage graminae or concentrate feed (Sallam, 2005). It is usually thought that weeds had low nutritional values and were not grazed by livestock; therefore, expensive and time-consuming methods were used in weed control (Marten and Andersen, 1975). Some of these weeds are poisonous and toxic to farm animals and some others result in decreasing feed consumption. Several weed species have thorns and hard leaves, so may injure animal mouths and they even cause eye diseases ending up with blindness. Some weeds may cause to have undesired odor or taste in meat and milk. Weeds mostly contest with culture products and forage crops for water, sunlight and nutrients. On the other hand, some weeds have quite high nutritional values and digestibility (Lewis and Green, 1995). This research was carried out to detect nutritional values of common weeds in range lands of Turkey (Bosworth et al., 1985).

Both warm- and cool-season weeds contained enough calcium for moderate producing cattle. Warm-season broadleaf weeds were high in calcium. In contrast, sicklepod, tall morningglory, cutleaf evening primrose, wild rye, and little barley were down in P and suboptimum for superior-producing cattle. Magnesium content of warm-season weeds was adequate. Most cool-season weeds tested were low enough in magnesium to be considered possible inducers of grass tetany if used as the sole source of feed. Henbit at 0.4% and primrose at 0.3% were unusually high in magnesium. Potassium levels of both weeds and cultivated forages were well above nutrient requirements (Hoveland, 1995). There are some literatures about our studied plants for some quality properties. Akubugwo et al. (2008) have stated that elements in *S. nigrum* but only for Sodium, Calcium, Iron and Magnesium in *Amaranthushybridus* L. Sodium/Potassium and Calcium/Phosphorus rates varied between 0.13 and 0.14, and 1.24 and 1.28 in *Amaranthus* h. L., while amounts for *Solanum nigrum* L. were 0.70 and 0.80, and 0.21 and 0.24, respectively, in all the treatments. Sultan et al (2008) detected macro (Calcium, Phosphorus, Potassium and Magnesium) and micro (Copper, Zinc, Manganese and Cobalt) nutrients in plant samples taken from 10 different freely-grazed rangelands. Early-blooming period Ca, P, K and Mg contents were respectively observed as 0.26±0.022, 0.025±0.004, 0.69±0.113 and 0.044±0.006. Early-blooming Cu, Zn, Mn and Co contents were respectively observed as 22.75±2.671, 14.70±2.065, 10.12±1.770 and 0.023±0.003. Ripening period Ca, P, K and Mg contents were respectively identified as 0.30±0.049, 0.031±0.006, 0.68±0.108 and 0.028±0.004. Ripening period Cu, Zn, Mn and Co contents were respectively observed to be 29.8±2.962, 8.96±2.0701, 6.14±1.034 and 0.029±0.005. Krishnaiah et al. (2008) have pointed that the element content of some weed plants Eucheuma, Sargassum,Caulerpa, Gracilaria, Gelidiella, Kappaphycus and Ulva was examined. The Fe content was rich in the line of Gelidiella>Caulerpa>Sargassum>Eucheuma and its interval was identified to be 6.6-10.9 mg/100g dry weight. The large etesian variation was determinate to be 9.3% Magnesium, 6.4% Calcium and 5.3% Iron. There a few studies performed to determine the mineral contents of weed crops. Therefore, aim of the research was set as to detect mineral contents of weed crops with a significant role in ruminant livestock feeding.

2. MATERIAL AND METOD

2.1. Plant Materials

A total of 11 weeds were used as the plant material of this research. Plant samples were collected from pastures and field of Kayseri Province and analyzed in laboratories of Biology department of Erciyes University Natural Sciences Faculty. Surface area of Kayseri is 16.917 km^2 with an altitude of 1050 meters. Cold terrestrial climate is dominant in Kayseri. Summer is hot and dry and winter is cold and snowy. The province has an annual precipitation of 366 mm with the highest precipitation in March, April and May and the lowest in June, July and August. Extreme temperatures were recorded as between –32.5 °C and +40.7 °C. Experimental year generally had similar temperatures and to precipitations long-term averages. Relative humidity levels of the experimental year was generally lower than the long-term averages.Soils of the experimental site are classified as sandy- loamy sampled at 0-30 cm depths. Calcareous and salt were low while potassium and phosphorus were rich in the soil. Soil pH was slightly alkaline but organic matter content was quite low. Plant samples were taken in June during the flowering periods of the plants. Samples were dried at 70 ^{o}C for 48 hours, granulated in crusher with 1mm screen and arranged for chemical analysis.

2.2. Mineral Analysis

The weed samples were run across wet-ashing continuum with hydrogen peroxide (2:3) in 3 dissimilar paces (First paces: at 145 ºC 75% microwave force for five minutes, second paces: at 80 ºC 90% microwave power for ten minutes and third paces: at 100 ºC 40% microwave force for ten minutes) in a wet-ashing monad (speed wave MWS/2 Berg. prod. + Instru. Harres.1. 72800 E. Gernmany) durable to 40 bar compression (Mertens, 2005a). Then macro and micro nutrient (Phosphorus, Potassium, Calcium, Magnesium, Sodium, Iron, Manganese, Zinc, Nickel, Cadmium, Copper, Lead and Boron) content of weed plants were detected by using ICP/OES spectrophotometer (Perkin-Elmer, Opt. 2100/DV, ICP-OES, Shel., CT/06484/4794, USA) (Mertens, 2005b).

2.3. StatisticalAnalysis

SAS (SAS Inst., 1999) was used to perform variance analysis on experimental data and Duncan testing was usage to test the importance of variations among means.Biplot Analysis was performed using mineral content as variables and *Astragalus* species as classification criterion (Yan and Kang, 2003).

3. RESULTS AND DICCUSSION

3.1. Mineral Contests of Weed Crops

Highly significant differences were observed in mineral contents of weed plants (Table 1). While the lowest P (2640.5 mg kg^{-1}), Ni (0.2305 mg kg^{-1}) and B (6.385 mg kg^{-1}) contents were obtained from *Sanguisorba minor*Scop., the highest P content (3307.5 mg kg-1) was seen in *Sorghum halepense*, the highest Ni value (0.2945 mg kg^{-1}) in *Alhagi* spp. and the highest B value (9.655 mg kg^{-1}) in both *Sinapisarvensis* and *Chenepodium album*. The lowest Ca content was obtained from *Convolvulus arvensis*, the highest Ca content (8965.0 mg kg^{-1}) was observed in *Alhagi* spp. Elements of Ca and P are significant in bone, teeth and muscle metabolism (Dosunmu, 1997; Turan et al., 2003). Ca acts as a co-factor for additional celled proteins and enzyme (Krishnaiah et al., 2008).

While the lowest Mg (2118.0 mg kg^{-1}), Cu (7.115 mg kg^{-1}) and Cd (0.1625 mg kg^{-1}) contents were obtained from *Chenepodium album*, the highest Mg value (2414.0 mg kg^{-1}) was seen in *Convolvulus arvensis*, the highest Cu value (9.360 mg kg^{-1}) in *Malva*spp. and the highest Cd (0.2235 mg kg^{-1}) in *Sorghum halepense*. Magnesium plays a significant role in cardiovascular function. Copper-like micro elements exist in structural, regulatory and catalisator functions, nucleic acids and hormones stabilizing membranes. These elements also increase pigmentation in eye, hair and skin, blood-clotting and energy transformation and they have a potential economic significance (Levine 1984; Phillips 1995; Moy and Walday 1996; Krishnaiah et al. 2008). Minson (1990) noticed that growing Mo intromission intercepted Copper toxicity in farm animals. Same researchers also indicated increased Cu concentrations with increasing soil temperatures from 12 to 20°C.

With regard to Na contents, the lowest (1181.5 mgkg^{-1}) and the highest (1475.5 mgkg^{-1}) values were observed respectively in *Alhagi* spp. and *Polygonumcognatum*. Sodium acts as electrolyte balance. Na content of weed plants was considerably lower than that obtained by Krishnaiah et al. (2008). This might be due to differences in plants species. The lowest Mn content (65.905 mgkg^{-1}) was found in *Malva* spp. and the highest (77.890 mgkg^{-1}) in *Sorghum halepense*. The Manganese ingredient in independent grassland grasses was enough to meet the pecora necessities (Perveen 1998).

While the lowest K, Zn and Pb contents were observed in *Amaranthus* spp. (10221.5, 30.405 and 0.3345 mg kg^{-1}, respectively), the highest K content (12332.0 mg kg^{-1}) was seen in *Lamium album*, the highest Zn value (42.105 mg kg^{-1}) in *Alhagi*spp. and the highest Pb value (0.4160 mg kg^{-1}) in *Malva* spp. Humphreys (1984) reported K concentration of tropical graminae plants ranged from 0.6 to 1.2%. Potassium was reported to activate several enzyme system effecting plant growth (Humphreys 1984) (Hussain and Durrani 2007; Khan et al. 2007; Sultan et al. 2007; Sultan et al. 2008a; 2008b; Inam-Ur-Rahim et al. 2008). The lowest Fe content (254.0 mg kg^{-1}) was obtained from *Convolvulus arvensis* and the highest value (290.5 mg kg^{-1}) was observed in *Sorghum halepense*. While zinc exist in regular function of immune system, Fe present in structure of hemoglobin, energy metabolism and regular function of nervous system. (Shills and Young 1988; Adeyeye and Otokiti 1999; Ishida et al. 2000).

Mineral contents may vary based on crop type and species, time of harvest, soil and climate conditions and stress factors (Gralak et al., 2006). Soils of Central Anatolia Plateau are rich in soluble salts and lime. Beside this, boric acid may be accumulated within sedimentary deposits of volcanic sites (Sonmez and Beyazgul, 2012). In present study, Na, Ca and B levels were found to be at desired levels with regard to animal feeding. Mineral contents of the present study were above the values recommended by National Research Council (1985) for ruminants but were below the critical values.

Table 1. Mineral contents of weed plants

WeedPlants	**P**	**Mg**	**Ca**	**K**	**Na**	**Mn**	**Zn**	**Fe**	**Cu**	**Ni**	**Cd**	**Pb**	**B**
	mg kg^{-1}												
Sinapisarvensis	2876.5ab	2270.5f	8701.0b	10580.5ı	1261.5h	69.760h	31.465h	270.5d	8.915b	0.2405e	0.1815g	0.3455h	**9.655a**
Lamiumalbum	2956.0ab	2243.5h	8612.5c	**12332.0a**	1430.5b	68.540ı	32.910g	274.5c	9.345a	0.2540c	0.1885e	0.3635f	9.535a
*Malva*spp.	2986.5ab	2394.0b	8321.5h	12125.5b	1405.0d	**65.905l**	36.440de	270.5d	**9.360a**	0.2605b	0.1935d	**0.4160a**	9.360a
Convolvulusarvensis	3111.5ab	**2414.0a**	**8193.0j**	11187.5e	1420.0c	70.685g	38.965c	**254.0h**	7.550g	0.2455d	0.1855f	0.3460g	9.035ab
Chenepodiumalbum	2988.0ab	**2118.0k**	8230.5ı	10363.5k	1267.5g	72.805d	34.320f	271.0d	**7.115j**	0.2355f	**0.1625ı**	0.3685e	**9.655a**
*Alhagi*spp.	3212.0a	2332.5e	**8965.0a**	10783.0h	**1181.5l**	72.255f	**42.105a**	281.0b	8.270e	**0.2945a**	0.2040c	0.4150a	9.140ab
SanguisorbaminorScop.	**2640.5b**	2342.0d	8551.5e	11353.0d	1215.5k	73.035c	35.105ef	265.0e	7.450h	**0.2305g**	0.2145b	0.3915b	**6.385b**
*Amaranthus*spp.	2914.0ab	2192.5ı	8404.0g	**10221.5l**	1218.0j	72.405e	**30.405h**	262.5fg	8.625d	0.2335f	0.1765h	**0.3345ı**	9.325ab
Taraxacumofficinale	3111.5ab	2132.5j	8596.0d	10954.5g	1307.5f	68.105j	37.645cd	254.5h	8.905b	0.2550c	0.1760h	0.3730d	8.715ab
Polygonumcognatum	3236.5a	2384.5c	8232.5ı	11634.5c	**1475.5a**	75.235b	40.515b	264.5ef	7.230ı	0.2550c	0.1945d	0.3855c	9.380a
Sorghumhalepense	**3307.5a**	2266.5g	8412.0f	11084.5f	1355.5e	**77.890a**	36.685d	**290.5a**	7.620f	0.2450d	**0.2235a**	0.3930b	9.570a
Significance Level	***N.S.***	*******	*******	**N.S.**	*******	*******	*******	*******	*******	*******	**N.S.**	**N.S.**	*******

*P<0.05; ** P<0.01; *** P<0.001; N.S: Not Significant

3.2. Correlations among Mineral Content of Weed Plants

As indicated in Table 2, positive and significant correlation between Na-K, Zn-Mg, Ni-Zn, Cd-Mg, Cd-Fe, Pb-Zn and Pb-Cd contents and a negative and significant correlation between Cu-Mn contents of weed plants ($p<0.05$) were observed.

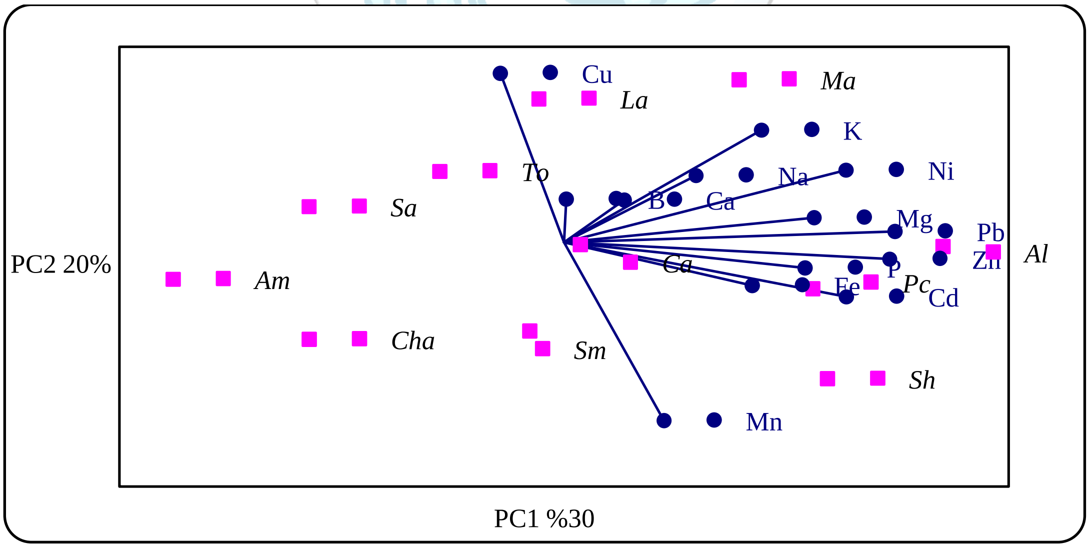
Table 2. Correlations among minerals contents of weed plants

	P	Mg	Ca	K	Na	Mn	Zn	Fe	Cu	Ni	Cd	Pb	B
P	1												
Mg	0.027	1											
Ca	-0.126	0.165	1										
K	-0.014	0.567	0.044	1									
Na	0.361	0.444	-0.380	**0.735**	1								
Mn	0.287	0.227	0.075	-0.176	0.002	1							
Zn	0.572	**0.581**	0.220	0.295	0.295	0.318	1						
Fe	0.283	0.110	0.394	0.125	-0.065	0.466	0.110	1					
Cu	-0.175	-0.181	0.308	0.247	-0.012	**-0.757**	-0.387	-0.039	1				
Ni	0.549	0.193	0.422	0.197	-0.007	-0.209	**0.607**	0.271	0.281	1			
Cd	0.102	**0.648**	0.407	0.430	0.128	0.568	0.467	**0.579**	-0.232	0.145	1		
Pb	0.227	0.553	0.360	0.496	0.145	0.219	**0.723**	0.487	-0.130	0.516	**0.680**	1	
B	0.557	-0.072	-0.033	-0.035	0.370	0.038	0.004	0.327	0.210	0.213	-0.260	-0.109	1

In bold. significant values (except diagonal) at the level of significance alpha=0.050 (two-tailed test)

3.3. Analysis of Biplot

Analysis of biplot was used to contrast the mineral contents of the weeds and to define weed plants and groups (Yan and Kang 2003). Biplot was able to represent 50% of total variation in mineral contents of 11 different weed species. Two perspectives were taken into consideration in biplot application as of (i) the positive relationship among Mn, Fe, Cd, P and Zn; positive relationship among Pb, Mg, Ca, Na, Ni and K; positive relationship between B and Cu, (ii) the negative relationship between Cu and Mn.



Sa:*Sinapisarvensis,* ***La:****Lamium album,* ***Ma:****Malva*spp,***Ca:*** *Convolvulus arvensis,* ***Cha:*** *Chenepodium album,* ***Al:****Alhagi*spp,***Sm:****Sanguisorba minor* Scop,***Am:****Amaranthus*spp,***To:*** *Taraxacumofficinale,* ***Pc:****Polygonumcognatum,* ***Sh:*** *Sorghum halepense,*

Figure 1. Biplot polygon for mineral contents of weed plants

Second, it represents the feature side views of the weed plants, especially those that are established over far from the biplot source. For instance, it represents that *Sinapisarvensis*, *Lamium album*, *Taraxacumofficinale* and *Malva* spp. had extremely high Cu but low Mn; *Polygonumcognatum* had extremely high P but low Cu; and *Sorghum halepense* had extremely high P, Mn, Fe and Cd but lower levels for Mg, Ca, K, Na, Ni and Cu. *Amaranthus* spp. *Chenepodium album* and *Sanguisorbaminor*Scop the poor crops in mineral content, except phosphorus and boron (Table 1 and Figure 1).

4. CONSLUSION

It was observed in this study that some weeds had quite high nutritional values and even higher than some culture crops. In general, the greatest Mn, Fe, Cd and P contents were observed in *Sorghum halepense* plants, the greatest Pb and Cu contents in *Malva* spp. plants, Ca, Ni and Zn contents in *Alhagi* spp. plants, Mg content in *Convolvulus arvensis* plants, K content in *Lamium album* plants, Na content in *Polygonumcognatum* plants and B content in *Sinapisarvensis* and *Chenepodium album* plants. It was concluded herein that weeds may constitute a low-cost feed source and may provide several macro and micro nutrients.

REFERENCES

[1]. Adeyeye, E.I. and M.K.O. Otokiti, 1999. Proximate composition and some nutritionally valuable minerals of two varieties of Capsicum annum (Bell and Cherry peppers). Discovery Innovation, 11:75-81.
[2]. Akubugwo, I.E., Obasi, N.A., Chinyere, G.C. and Ugbogu, A.E., 2008. Mineral and phytochemical contents in leaves of Amaranthushybridus L and Solanum nigrum L. subjected to different processing methods. African Journal of Biochemistry Research, 2(2):040-044.
[3]. Bosworth, S.C., C.S. Hoveland, and G.A. Buchanan, (1985). Forage quality of selected cool-season weed species. Weed Science 34:150-154.
[4]. Dosunmu, M.I., 1997. Chemical composition of the fruit of Tetrapleuratetreptra and the physico-chemical Properties of its oil. Global J. Pure and Applied Sci. 3:61-67.
[5]. Gralak, M.A., Bates, D.L., Von Keyserlingk, M.A.G., Fisher, LJ (2006) Influence of species, cultivar and cut on the micro element content of grass forage. Slovak Journal Animal Science (1-2):84-88.
[6]. Hoveland, C.S. (1995). Weeds for Pasture and Hay? The Georgia Cattleman. 20-23.
[7]. Humphreys, L.R. 1984. Tropical pastures and fodder crops. Longman Group U.K. Ltd. Longman House, Burnt Mill, Harlow Essex CM 20 2J. E. England.
[8]. Hussain F. and M. J. Durrani. 2007. Forage productivity of arid temperate Harboi rangeland, Kalat, Pakistan. Pak. J. Bot., 39(5): 1455-1470.
[9]. Inam-Ur-Rahim, J. I. Sultan, M. Yaqoob, H. Nawaz, I. Javed and M. Hameed. 2008. Mineral profile, palatability and digestibility of marginal land grasses of Trans-Himalayan grasslands of Pakistan. Pak. J. Bot., 40(1): 237-248.
[10].Ishida H, Suzuno H, Sugiyama N, Innami S, Todoro T, Maekawa A (2000). Nutritional evaluation of chemical components of leaves, stalks and stem of sweet potatoes (IpomeabetatasPoir).Food Chem. 68:359-367.
[11].Jones, G.E and Martin, S. 1994. Eco zone suite of model, for FAO training service. Eco zone Gough SAC Edinburgh Policy Analysis Division, Rome.
[12].Khan, Z.I., M. Ashraf, K. Ahmad, I. Mustafa and M. Danish., 2007. Evaluation of micro minerals composition of different grasses in relation to livestock requirements. Pak. J. Bot., 39(3): 719-728.
[13].Krishnaiah, D., Sarbatly, R., Parasad, D.M.R. and Bono, A., 2008. Mineral content of some seaweeds from Sabah's South China Sea. Asian Journal of Scientific Research, 1(2): 166-170.
[14].Levine, H.G., 1984. The use of seaweed for monitoring coastal waters. In: Alage as ecological indicators. Schubert, L.F. /Ed.), Academic press, London, pp:189-210.
[15].Lewis, W.M., and J.T. Green Jr. 1995. Weed management. In: Production and utilization of pastures and forages. Raleigh (NC): North Carolina State University, North Carolina Agricultural Research Service; Technical bulletin 305.
[16].Marten, G.C., and R.N. Andersen, (1975). Forage nutritive value and palatability of 12 common annual weeds. Crop Science 15: 821-827.13.
[17].Mertens, D (2005a) AOAC official method 922.02. In: Horwitz, W., Latimer, G.W. (Eds.), Plants Preparation of Laboratory Sample. Official Methods of Analysis, 18th ed. AOAC-International Suite, Gaitherburg, MD, USA, (Chapter 3), pp. 1–2.
[18].Mertens, D (2005b) AOAC official method 975.03. In: Horwitz, W., Latimer, G.W.(Eds.), Metal in Plants and Pet Foods. Official Methods of Analysis, 18th ed. AOAC-International Suite, Gaitherburg, MD, USA, (Chapter 3), pp. 3–4.
[19].Minson, D.J., 1990. The chemical composition and nutritive value of tropical grasses. In: Tropical grasses FAO Plant Production and Protection Series, No: 23. (Eds.): P.J. Skerman and F. Riveros. FAO Rome.
[20].Moy, F.E. and Walday, M., 1996. Accumulation end depuration of organic micro-pollutants in marine hard bottom organisms. Mar. Pollut. Bull., 33:56-63.
[21].NRC 1985. Nutrient requirements of Sheep. Sixth Revised Edition. National Academy Press, Washington D.C.
[22].Perveen, S., 1998. Nutritive evaluation of some fodder tree leaves through In vitro digestibility techniques. Technical Paper, NWFP Agricultural University, Peshawar.
[23].Phillips, D.J.H., 1995. The chemistries and environmental fates of trace metals and organochlorines in aquatic ecosystems. Marine Pollut. Bull., 31:193-200.
[24].Sallam, S.M.A., 2005. Nutritive value assessment of the alternative feed resources by gas production and rumen fermentation in vitro. Res. J. Agric. Biol. Sci., 1(2):200-209.
[25].SAS (1999) SAS User's Guide: Statistic. Statistical Analysis Systems Institute Inc., Cary, NC.
[26].Shills, M.E.G., Young, V.R., 1988. Modern nutrition in health and diseases. In: Nutrition. Nieman, D.C., Buthepodorth, D.E. and Nieman, C.N. (eds). WMc. Brown publishers, Dubugue, USA. pp. 276-282.

[27]. Sultan, J. I., Inam-Ur-Rahim, Haq Nawaz and Muhammad Yaqoob. 2007. Nutritive value of marginal land grasses of northern grasslands of Pakistan. Pak. J. Bot., 39(4): 1071-1082.
[28]. Sultan, J. I., Inam-Ur-Rahim, M. Yaqoob, H. Nawaz and M. Hameed. 2008a. Nutritive value of free rangeland grasses of northern grasslands of Pakistan. Pak. J. Bot., 40(1): 249-258.
[29]. Sultan, J.I., Inam-Ur-Rahim, Nawaz, H., Yaqoob, M. and Javed, I., 2008b. Mineral Composition, Palability and Digestibility of Free Rangeland Grasses of Northern Grasslands of Pakistan. Pak. J. Bot., 40(5):2059-2070.
[30]. Sönmez B, Beyazgül M. 2012. Türkiye'detuzluvesodyumlutopraklarınıslahıveyönetimi. http://makinecim.com/bilgi_56262_Turkiye'de-Tuzlu veSodyumluTopraklarınIslahıveYonetimi.
[31]. Turan, M., Kordali, S., Zengin, H., Dursun, A. and Sezen, Y., 2003. Macro and Micro- Mineral content of some wild edible leaves consumed in Eastern Anatolia. Acta Agriculture Scandinavia, Section B, Plant Soil Science 53:129-137.
[32]. Yan, W. and M.S. Kang, 2003. GGE-biplot Analysis: A Graphical Tool for Breeders. Geneticists, and Agronomists, CRD Press. Boca Raton.