Proximate and elemental analysis of five selected medicinal plants of family Solanaceae

Ishfaq Hameed and Farrukh Hussain
Department of Botany, University of Peshawar, KPK, Pakistan

Abstract: The proximate analysis revealed the presence of ash, moisture, protein, fiber, fats and carbohydrate. ANOVA showed that ash and moisture contents was non significant between the plant parts and phenological stages. Crude protein was non significant between the plant parts and phenological stages except for *Datura innoxia* parts but not for its phenolgical stages, while crude fats were non significant between the plant parts and phenological stages except for *Solanum nigrum* and *Solanum surattense* parts but not for their phenolgical stages. Crude fiber was non significant between the plant parts and phenological stages except for *Datura innoxia* parts but not for its phenolgical stages. And carbohydrates was non significant between the plant parts and phenological stages except for the phenolgical stages of *Solanum surattense* and *Withania coagulans*. The mineral analysis showed the presence of Cr, Zn, Cu, Mn, Fe, Ca, K, Mg and Na in the roots, stems, leaves, flowers and fruits of the plants in three different phenological stages. Only the micro-minerals were present in traces while the macro-minerals were present high quantities as compared to the micro-minerals.

Keywords: Proximate analysis, microelements, macro elements, Solanaceae.

INTRODUCTION

Family Solanaceae has 84 genera and 3000 species worldwide and in Pakistan it is represented by 14 genera and 52 species (Nasir, 1985). This family has wide range of medicinal plants of commercial and local importance. Five most common species with varied local uses were selected for the present study to find the scientific base for their medicinal value. *Datura innoxia* leaves cure cough and asthma (Hussain *et al*., 2006), swollen limbs (Khan *et al.,* 2009a) and also used as repellant and vermicide. Fruits and seeds are used to heat-up the buffaloes. Powdered seeds cure scabies (Ajaib *et al*., 2010). *Solanum nigrum* is narcotic, antispasmodic, diuretic, and laxative (Evans, 2009). Warmed leaves are applied to cure painful and swollen testicles. Fresh leaves extract mixed with pulp of *Cassia fistula* is used as gargle for diphtheria, tonsillitis and inflammation of the tongue. Extract from leaves is given orally for treating jaundice and inflammation of the liver (Qureshi *et al*., 2010) and for treating painful joints. Shoots are used as pot herb. Roots of *Solanum surattense* cure for phlegmatic cough, asthma and chest pain. Fruits cure bronchial asthma, headache and migraine. Powdered ripe fruits cure cough and asthma (Qureshi *et al*., 2010). Roots serve as expectorant. Seeds are used as blood purifier and improve blood level (Manan *et al*., 2007). Fresh stems cure fever, cough and ingestion. Leaves are used as vegetable (Abbasi and Khan, 2010).*Withania somnifera* is helpful in combating chronic fatigue, weakness, dehydration, bone weakness, loose teeth, thirst, impotency, premature ageing, and emaciation, debility, and muscle tension. The leaves are used for the treatment of tumors, inflammation, psoriasis, bronchitis, asthma, ulcer, scabies, insomnia, hypnosis, alcoholism, anathematic and as hepato-protective (Kar *et al*., 2010). *Withania coagulans* is used for purification of blood (Tareen *et al*., 2010), treating gastric and abdominal disorders and face pimples.

Proximate and mineral composition of plants provides valuable information its medicinal and nutritional quality. Many aspects of such as moisture content, ash content, volatile matter content, ash and fixed carbon can be determined. Ash is the inorganic residue that is a measure of total amount of minerals within the food and plant. Minerals are not destroyed by heating and they have a low volatility as compared to other food components. Total ash contents may vary widely among the plants and plant parts. The determination of ash contents is important because mineral contents may be the cause of a pharmacological effect (Lee, 2005).

Folarin and Igbon (2010) reported moisture, ash, crude protein, crude fiber, oils and carbohydrate, Na, Ca, Mg, Fe, Cu and Zn from *Enterolobium cyclocarpum* seed. Nzikou *et al.* (2007) stated that oil from seeds of Solanum *nigrum* were rich in protein and carbohydrates. It had 7.18% ash and 3.86±0. 97% moisture contents.Sultan *et al*., (2010) determined the nutritive value of *Indigoferra gerardiana, Myrisine africana, Impatiens bicolor* and *Adhatoda vasica.* They observed maximum crude protein (14.7%) for *Myrisine africana* and minimum (15.6%) for *Impatiens bicolor* and *Adhatoda vasica.* Higher ash contents (14.7%) were observed for *Myrisine africana*. Hameed and Dastagir (2009) determined the proximate composition of *Rumex hastatus*, *Rumex dentatus* and *Rumex nepalensis.* Aliero *et al.* (2007) reported Al, K, Na

**Corresponding author:* e-mail: pakoonlco@gmail.com

and Si contents in the leaves of *Solanum pseudocapsicum.* Rehman and Iqbal (2008) evaluated Fe, Pb, Cu, Cr and Zn mineral composition of *Prosopis juliflora, Abutilon indicum* and *Senna holosericea.* They observed that the level of Cu and Cr was highest in the foliage of *S. holosericea.* The Cu was high in foliage of *A. indicum.* The foliage of *S. holosericea had* highest concentration of Zn. Ozcan (2005) determined mineral contents in various parts of *Capparis ovata.*All parts contained Ca, K, Mg, Na, P, Pb, and Zn. Ba, Cd, Cr, Cu, Li, Ni, Pb, and Se contents were found to be very low. The review suggests that no reference on the proximate and mineral composition of these five selected plants, therefore the present study was conducted to envisage the neutraceutically important compounds in three different phenological stages. The findings will help in understanding the cause of medicinal utility and provide a base for future investigation by scientists.

MATERIALS AND METHODS

Fresh mature plants of *Datura innoxia* Miller, *Solanum nigrum* Linn, *Solanum surattense* Burm. f, *Withania somnifera* L. and *Withania coagulans* (Stocks) Dunal were collected at different phenological stages from Peshawar and its surrounding during 2009-2011. The plants were identified with help of Flora of Pakistan (Nasir, 1985). The voucher specimens were deposited in the Herbarium, Department of Botany, University of Peshawar, for future reference. Plant materials were washed with water, separated and dried in shade for 15 days and powdered. The proximate composition at four phonological stages was determined for different parts of plants following AOAC (2000). The mineral composition was determined for different parts of plants at different phenological stages following Sucman *et al.,* (2007) and AOAC (2000).

The data was statistically analyzed using ANOVA to see the significance levels among the phenological stages and plant parts (Choudhary and Kamal, 2004).

RESULTS

Ash contents

The ash content varied from 2.08-9.37% in vegetative stage to 2.94-14.00% in reproductive stage and 1.92-7.00% in post reproductive stage. The overall highest (9.37%) ash content was recorded in leaves followed by (9.27%) stems of *Withania coagulans* and (6.93%) roots of *Withania somnifera* in vegetative stage. At reproductive stage, it was highest (14.00%) in stems followed by (10.00%) roots of *Withania somnifera* and leaves of *Solanum surattense* (9.00%). In post reproductive stage it was highest (7.00%) in roots followed by (6.00%) leaves of *Datura innoxia* and (5.20%) fruit of *S. surattense* and stems of *W. coagulans*. The results revealed that the ash content increased from vegetative stage to reproductive and decreased in the post reproductive stage (table 1). ANOVA showed that ash contents was non significant between the plant parts and phenological stages (table 2).

Moisture contents

The moisture content varied among the species. It varied from 10-44.89% in the vegetative stage, 7.08-48% in the reproductive stage, 4.44-33.3% in the post reproductive stage (table 1). The overall highest (44.89%) moisture contents were recorded in stems of *Withania coagulans* at vegetative stage, followed by stems (32%) and leaves (28%) of *Solanum surattense.* Reproductive stage showed the highest (48.00%) value in *Solanum nigrum* leaves, followed by stems (42.00%) of *Withania somnifera* and stems (32.00%) of *Datura innoxia* and *W. coagulans.* It was highest (33.33%) in fruits of *Datura innoxia* in post reproductive stage followed by stems (22.91%) of *S. nigrum* and leaves (19.23%) of *D. innoxia.* The results revealed that the moisture content increased from vegetative stage to reproductive and decreased at the post reproductive stage (table 1). ANOVA showed non significant differences between the plant parts and phenological stages (table 2). The results revealed that moisture contents not only varied among the species but also between the different phenological stages of the plants.

Crude protein

The crude protein contents varied from 2.12-6.31% in vegetative stage, 2.39-6.45% in reproductive stage and 2.36-6.45% in post reproductive stage (table 1). The overall highest (6.31%) crude protein contents was recorded in leaves of *Datura innoxia*, followed by (6.26%) rootss of *Withania somnifera* and (6.14%) roots of *Solanum nigrum* at vegetative stage. In the reproductive stage, roots of *W. coagulans* had the highest (6.45%), followed by leaves (6.21%) of *Withania somnifera* and leaves of *Datura innoxia* (5.68%). At the post reproductive stage, the crude protein contents were maximum (6.45%) in roots of *S. nigrum*, followed by stemss (5.68%) of *S. surattense* and roots (5.64%) of *W. somnifera*. The results showed that the crude protein contents generally increased from vegetative stage to reproductive stage but it declined in the post reproductive stage (table 1). ANOVA showed non-significant differences among the plant parts and phenological stages, except for *Datura innoxia* parts (table 2).

Crude fats and oils

The crude fats varied from 6.50-1.34% in vegetative stage, 3.50-37.05% in reproductive stage and 3.00-26.00 % at the post reproductive stage (table 1). The overall highest concentration (11.34%) of oil was recorded in the stems of *Datura innoxia*. It was followed by stems of *Withania coagulans* (11.11%) and roots of *Datura*

innoxia (10.30%) in vegetative stage. In reproductive stage it was highest (37.05%) roots of *Solanum nigrum* followed by (18.27%) flowers of *Datura innoxia* and (17.00%) leaves of *Solanum surattense*. In post reproductive stage, it was highest (26.00%) in the leaves of *Datura innoxia*, followed by stems (20.50%) of *Datura innoxia* and roots of *Solanum nigrum*, and stems (17.00%) of *Withania somnifera*. The results revealed that the crude fats enhanced from vegetative stage to reproductive stage and then decreased in the post reproductive stage (table 1). ANOVA showed non significant differences between the plant parts and phenological stages except for *Solanum nigrum* and *Solanum surattense* (table 2).

Crude fibers

The data shows that the crude fibers varied from 14-44% in vegetative stages, 6-30% among reproductive stages and 8-28% in post reproductive stages. The overall crude fiber contents were highest (44%) in roots of *Withania somnifera*, followed by (38%) stems of *Solanum nigrum* and (34%) leaves of *Withania coagulans* in the vegetative stages. In reproductive stages, it was highest (30%) in flowers of *Withania coagulans* followed by (26%) stems of *Datura innoxia* and flowers of *Solanum nigrum* (24%). At the post reproductive stage crude fibers were maximum (28.00%) in leaves of *S. nigrum.* It was followed by fruits of *S. nigrum* (16%) and (14.00%) leaves of *Datura innoxia* and fruits of *Withania somnifera*. The results indicated that the crude fiber contents decreased from vegetative stage to post reproductive stages through reproductive stage (table 1). ANOVA showed non significant differences between the plant parts and phenological stages except for *Datura innoxia* parts (table 2).

Carbohydrate

The carbohydrates contents swayed from 12.08-51.43% in vegetative stages, 8.38-67.17% in reproductive stages and 29.32-75.71% in post reproductive stages (table 1). The overall concentration of carbohydrate was highest (51.43%) in leaves of *S. nigrum*. It closely approached by (51.32%) stems of *Datura innoxia* and (50.04%) and leaves of *Withania somnifera* in the vegetative stage. Carbohydrate contents in reproductive stage were maximum (67.17%) in leaves of *Withania coagulans*, followed by (66.94%) flowers of *Withania somnifera* and (65.05%) roots of *Solanum surattense*. In post reproductive stage it was highest (75.71%) leaves of *S. nigrum* followed by (66.71%) roots of *Solanum surattense* and (65.31%) leaves of *Withania coagulans*. The results suggested that there was an increasing tendency from vegetative stage to post reproductive stages (table 1).ANOVA showed non significant differences between the plant parts and phenological stages with the exception of phenolgical stages of *Solanum surattense* and *Withania coagulans* (table 2).

Mineral composition

Micro-elements

Chromium (Cr)

The chromium contents fluctuated from 0.020-0.065 ppm in vegetative stages, 0.048-0.286 ppm in reproductive stage and 0.286-0.373 ppm in post reproductive stage (table 3). The highest Cr contents (0.065 ppm) were recorded in leaves of *Datura innoxia* and in the roots of *Withania somnifera.* They were followed by stems (0.060 ppm) and leaves (0.057 ppm) of *W. coagulans* at the vegetative stage. At reproductive stage, Cr was highest (0.286 ppm) in flowers of *Withania coagulans*, followed by leaves (0.115 ppm) of *Withania coagulans* and flowers (0.110 ppm) of *Withania somnifera*. The post reproductive stage showed highest (0.373 ppm) in fruits of *Withania somnifera*, followed by leaves (0.368 ppm) and fruits of *W. coagulans* and roots and stems (0.363 ppm) of *Withania coagulans*. The results suggest that Cr contents progressively were augmented from vegetative to post reproductive stages (table 3). ANOVA indicated non significant differences among the plant parts. However, the differences were highly significant among the phenological stages of *Datura innoxia, Solanum nigrum, S. surattense* and *Withania somnifera* and significant only *Withania coagulans* (table 4).

Zinc (Zn)

Zinc contents ranged varied from 0.078-0.628 ppm in vegetative stage, 0.025-0.172 ppm in reproductive stage and 0.030-0.314 ppm in post reproductive stage among the tested plants (table 3). The highest (0.628 ppm) Zn contents were recorded in the stems of *Solanum surattense*, followed by stems of *Withania somnifera* (0.245 ppm) and roots (0.221 ppm) of *Solanum surattense* at the vegetative stage. In reproductive stages, Zn was highest (0.172 ppm) in *Withania somnifera* flowers, followed by (0.144 ppm) *Withania coagulans* flowers and roots (0.109 ppm) of *Withania coagulans*. At post reproductive stages, the maximum (0.314 ppm) Zn contents were obtained in roots of *Withania coagualns*, followed by stems (0.188 ppm) of *Withania coagulans* and roots (0.155 ppm) of *Withania somnifera*. The results revealed that the zinc contents gradually decreased from vegetative stage to post reproductive stages (table 3). ANOVA showed that differences for zinc contents were non significant between the plant parts and phenological stages of all tested plants (table 4).

Copper (Cu)

Copper contents ranged in between 0.033-0.278 ppm in vegetative stages, 0.062-0.161 ppm in reproductive stages and 0.116-0.213 ppm in post reproductive stages among the plants (table 3). The highest recorded (0.278 ppm) was in *Withania coagulans* stems, followed by roots (0.125 ppm) of *Withania somnifera* and leaves (0.095 ppm) of *Withania coagulans* in the vegetative stage. During reproductive stages, Cu was highest (0.161 ppm)

in flowers of *Solanum surattense* that was approached by flowers (0.144ppm) of *Withania coagulans* and stems (0.142 ppm) of *Solanum nigrum*, and roots of *Withania coagulans*. Copper contents were maximum (0.213 ppm) in roots of *S. nigrum* at the post reproductive stage, which wasfollowed by stems (0.207 ppm) of *W. coagulans* and leaves (0.202 ppm) of *W. somnifera*. The results revealed that the copper contents generally increased from vegetative stage to post reproductive stages (table 3). The differences in copper were non-significant between the plant parts and phenological stages except for *Solanum nigrum* phenological stages (table 4).

Manganese (Mn)

The manganese lied in between 0.144-19.63 ppm in vegetative stages, 0.031-3.079 ppm in reproductive stages and 0.026-0.583 ppm in post reproductive stages (table 3). The highest Mn contents (19.63 ppm) were recorded in leaves of *Datura innoxia* that was approached by roots (3.364 ppm) of *Datura innoxia* and stems (1.203 ppm) of *S. nigrum* in the vegetative stage. During reproductive stages, Mn was highest (3.079 ppm) in leaves of *Datura innoxia* followed by stems (1.781 ppm) of *S. surattense* and roots (1.293 ppm) of *S. surattense*. At post reproductive stage, Mn was maximum (0.583 ppm) in stems of *S. surattense* followed by fruits (0.541 ppm) of *W. somnifera* and fruits (0.521 ppm) of *W. coagulans*. The results revealed that the manganese generally had declining tendency from vegetative stage to post reproductive stages (table 3). The differences were non significant among the plant parts and phenological stages in all the treatments, except for *S. surattense* parts (table 4).

Macro-elements

Iron (Fe)

During vegetative stage iron contents varied from 1.797-36.39 ppm; 0.379-17.66 ppm in reproductive stage and 0.253-7.253 ppm in post reproductive stage. The overall concentration of iron was highest (36.39 ppm) in leaves of *Datura innoxia* followed by (11.93 ppm) stems of *Withania somnifera* and (11.06 ppm) stems of *Withania coagulans* in the vegetative stages. At reproductive stages, the maximum iron contents (17.66 ppm) were in leaves of *Datura innoxa* that was approached by roots (15.76 ppm) of *Solanum surattense* stems (6.779 ppm) of *Datura innoxia*. At post reproductive stage it was highest (7.253 ppm) in fruits of *Datura innoxia*, followed by flowers (6.128 ppm) of *Withania somnifera* and stemss (2.782 ppm) of *Datura innoxia*. The results revealed that the iron decreased from vegetative stage to reproductive and post reproductive stage (table 3). ANOVA showed non significant differences among the plant parts and phenological stages of all the analyzed plants (table 4).

Calcium (Ca)

The calcium contents swung varied from 1.749-2.510 ppm in vegetative stage, 1.844-5.823 ppm in reproductive stage and 0.039-3.548 ppm in post reproductive stage. The overall concentration of calcium was highest (2.510 ppm) in stems of *Solanum surattense* followed by roots (2.371 ppm) of *Datura innoxia* and stems (2.116 ppm) of *Withania somnifera* in the vegetative stage. At reproductive stages it was highest (5.823 ppm) in leaves of *Withania coagulans* followed by (5.705 ppm) of *Withania coagulans* flowers and stems (3.398 ppm) of *Datura innoxia*.At post reproductive stages, Ca was highest in stems (3.548 ppm) followed by leaves (2.981 ppm) and roots (2.535 ppm) of *Datura innoxia*. The results revealed that the calcium increased from vegetative stage to reproductive but decreased at post reproductive stage (table 3). ANOVA showed that differences calcium contents were significant for *Datura innoxia* parts only. For the phenological stages, the differences were significant for of all the, except *Datura innoxia* (table 4).

Potassium (K)

The K contents varied from 4.961-9.710 ppm in vegetative stage, 4.985-6.351 ppm in reproductive stage and 0.014-5.127 ppm in post reproductive stage. The overall K concentration recorded maximum (9.710 ppm) in roots of *Datura innoxia*, followed by stems (8.707 ppm) of *Withania somnifera* and stems (7.927 ppm) of *S. surattense* in the vegetative stage. In reproductive stage, it was highest (6.351ppm) in stems of *S. nigrum* that was approached by (6.056 ppm) flowers of *D. innoxia* and (5.923 ppm) stems of *S. surattense*.During the post reproductive stage stems of *Datura innoxia* had the maximum concentration (5.127 ppm), which was followed by roots (5.020 ppm) and fruits (4.717 ppm) of *D. innoxia*. The results indicated that the potassium contents gradually declined from vegetative stage to post reproductive stages (table 3). The differences were non significant in all the plants parts and phenological stages. However, *Solanum nigrum*, *S. surattense* and *W. coagulans* showed significant differences (table 4).

Sodium (Na)

The concentration of sodium varied from 28.62-47.67 ppm in vegetative stage; 46.39-119.3 ppm in reproductive stage and 0.161-109.00 ppm in post reproductive stage. The overall Na contents were highest (47.67 ppm) in leaves followed by roots (45.32 ppm) and stems (43.67 ppm) of *Withania coagulans* in the vegetative stages. At reproductive stages, Na was highest (119.3 ppm) in flowers and leaves (98.50 ppm) of *W. somnifera* and flowers (89.21 ppm) of *S. nigrum*. Sodium contents at post reproductive stage were maximum (109.0 ppm) in roots followed by leaves (96.41 ppm) and stems (62.80 ppm) of *Datura innoxia*. The data indicated that sodium contents generally improved from vegetative stage to reproductive and thereafter dwindled at post reproductive stage (table 3). ANOVA provided non significant differences among all the plants parts. The differences were significant for phonological stages among all species, except *Datura innoxia* (table 4).

Table 1: Proximate composition of five selected medicinal plants of family Solanaceae

Plant name	Plant parts	Ash (%)	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
	Vegetative stage						
Datura innoxia Miller.	Roots	4.95	22	3.47	10.30	18	41.28
	Stems	2.08	10	5.26	11.34	20	51.32
	Leaves	4.95	18.75	6.31	8.76	22	39.23
Solanum nigrum Linn.	Roots	6.12	20.40	6.14	6.56	30	30.78
	Stems	6.06	20.83	2.56	7.77	38	24.78
	Leaves	4.08	20.40	2.95	7.14	14	51.43
Solanum surattense Burm.f.	Roots	5.94	20.40	3.12	7.10	18	45.44
	Stems	6.18	32	5.46	6.5	12	37.86
	Leaves	6	28.57	4.52	10.10	26	24.81
Withania somnifera Linn.	Roots	6.93	15.68	6.26	6.89	44	20.24
	Stems	5	14.58	2.98	6.63	22	48.81
	Leaves	5.82	12.5	5.64	9.64	16	50.04
Withania Coagulans (Stock) Dunal.	Roots	4.04	25.91	3.98	7.57	28	30.59
	Stems	9.27	44.89	4.65	11.11	18	12.08
	Leaves	9.37	22.24	2.12	10	34	22.27
	Reproductive stage						
Datura Innoxia Miller.	Roots	2.94	13.87	5.41	7.44	20	50.34
	Stems	5	32	5.23	11.61	26	20.16
	Leaves	7	26	5.68	9.23	22	30.09
	Flowers	5.76	16	4.95	18.27	14	41.02
Solanum nigrum Linn.	Roots	4	12	4.26	37.05	16	26.69
	Stems	3.09	14	3.26	10.05	6	63.60
	Leaves	9	48	5.62	13	16	8.38
	Flowers	4	18	4.89	5.5	24	43.61
Solanum Surattense Burm.f	Roots	7	8	3.45	4.5	12	65.05
	Stems	6	22	2.39	5.5	7.84	56.27
	Leaves	7	16	5.64	17	9.80	44.56
	Flowers	8	20	2.95	4	20	45.05
Withania Somnifera Linn.	Roots	10	14	4.61	10	12	49.39
	Stems	14	42	5.23	8.5	15.68	14.59
	Leaves	8	17.5	6.21	4	6	58.29
	Flowers	4	13.95	5.61	3.5	6	66.94
Withania Coagulans (Stock) Dunal.	Roots	8	34	6.45	7.5	12	32.05
	Stems	5	32	5.42	8	8	41.58
	Leaves	4	7.08	3.25	8.5	10	67.17
	Flowers	5	28	5.49	7.5	30	24.01
	Post reproductive stage						
Datura innoxia Miller.	Roots	7	15.68	5.23	8.5	12	51.59
	Stems	4.08	12.5	2.68	20.5	8	52.24
	Leaves	6	19.23	5.45	26	14	29.32
	Fruit	4.12	33.33	2.36	9.5	10	40.69
Solanum nigrum Linn.	Roots	3.12	10.41	6.45	20.5	8	51.52
	Stems	4.16	22.91	2.36	7.5	12	51.07
	Leaves	2.04	4.44	4.54	10	28	50.98
	Fruit	4.12	10.20	4.65	5	16	60.03
Solanum surattense Burm.f.	Roots	3.12	6.55	5.62	8	10	66.71
	Stems	4.12	16	5.68	9	8	57.20
	Leaves	3.96	12.5	3.64	8.5	14	57.40
	Fruit	5.20	12.24	3.58	6.5	12	60.48
	Fruit	4.21	14	4.65	5	12	60.14

Continued…

Table 1: Continued…

Plant name	Plant parts	Ash (%)	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
Withania somnifera Linn.	Roots	3.09	14.58	5.64	3	11.66	62.03
	Stems	4.08	16.32	4.95	17	8.33	49.32
	Leaves	3.15	14.58	2.68	6.5	12	61.09
	Fruit	4.16	14.28	4.56	4.5	14	58.50
Withania coagulans (Stock) Dunal.	Roots	1.92	8.16	2.95	5.5	5.76	75.71
	Stems	5.20	31.25	3.64	5	10	44.91
	Leaves	3.26	13.72	2.95	3	11.76	65.31
	Fruit	4.21	14	4.65	5	12	60.14

Table 2: Statistical analysis (ANOVA) for proximate analaysis among the plant parts and phenological stages of the some selected medicinal plants of Family Solanaceae

	Datura innoxia	*Solanum nigrum*	*Solanum surattense*	*Withania somnifera*	*Withania coagulans*
	Ash content				
Plant parts	0.130270NS	0.288382NS	0.338288NS	0.068095NS	0.235311NS
Phenological stage	0.364625NS	0.721509NS	0.397702NS	0.087825NS	0.6591NS
	Moisture content				
Plant parts	0.519266NS	0.26437NS	0.128435NS	0.088781NS	0.07033NS
Phenological stage	0.593882NS	0.522759NS	0.520353NS	0.282527NS	0.650638NS
	Crude protein				
Plant parts	0.026988S	0.138019NS	0.067412NS	0.207269NS	0.2988816NS
Phenological stage	0.469551NS	0.534062NS	0.602314NS	0.657334NS	0.348643NS
	Fats & oils				
Plant parts	0.291864NS	0.02985S	0.024317S	0.07034NS	0.129946NS
Phenological stage	0.374125NS	0.155732NS	0.691154NS	0.810751NS	0.447674NS
	Crude fiber				
Plant parts	0.027996S	0.593498NS	0.401169NS	0.172415NS	0.670117NS
Phenological stage	0.202819NS	0.876411NS	0.899164NS	0.387861NS	0.601484NS
	Carbohydrates				
Plant parts	0.17334NS	0.52711NS	0.079569NS	0.469174NS	0.127234NS
Phenological stage	0.767304NS	0.41873NS	0.009246HS	0.449111NS	0.002195HS

DISCUSSION

Proximate analysis

Hameed *et al*., (2008) reported highest contents of ash in *R. australe, R. hastatus, R. dentatus, Polygonum maculosa* and *P. plebejum*, which differ from the present results. Hussain *et al.*, (2010) also reported that ash contents progressively decline towards maturity in some plants and this is in the line with the present study. Hussain *et al*., (2010) also stated that moisture contents varied in different species investigated by them. Das *et al*., (2009) and Hanif *et al*., (2006) concluded that green leafy vegetables had higher moisture content and this parallel with the present findings.Saidu and Jideobi (2009) also recorded highest moisture contents at reproductive stages in leaves. Hussain *et al.,* (2009) reported high moisture contents in *Allium sativum* (67.66 %) and *Valeriana officinalis* (6.82 %) which are higher than in the present findings. Adnan *et al.,* (2010) reported high moisture contents in *Bupleurum falcatum, Forsskalea tenacissima, Lavendula angustifolia, Valeriana officinalis* and *Otostegia limbata* and their results strengthen the present results. As for as crude protein concerned, Hanif *et al*., (2006) recorded 0.9 % to 2.1 % protein contents in the selected vegetables. Protein contents vary according to climatic and habitat conditions. Cheema *et al.,* (2011) reported high concentration of CP in leaves of *Morus alba*, which is a best source of protein in ruminant feeding. They also stated that differences in CP are due to differences of capability of plants to accumulate protein. This is true in our case whereby there were differences in amount of protein among the plants. Yao *et al*., (2000) also stated that *Morus alba* is a best source of protein for ruminants. Adenipekun and Oyetunji (2010) observed little differences between *Vigna unguiculata* (23%) and *Arachis hypogea* (24%) and this agrees with our findings in some cases. Hussain *et al*., (2010) also found that *Sonchus asper* and *Melia*

azadrichta had the highest concentration of protein. The present findings vary from above mentioned workers. Hussain *et al.,* (2009) observed 6.4 % protein in ginger. Shah *et al*., (2009) stated that protein rich plants had 23% -33% protein, whereas the present investigation reported moderate level of protein in analyzed plants. The results also differ from those of other workers (Hameed *et al.,* 2008; Adnan *et al*., 2010; Hussain *et al.,* 2010) in this respect. Crude fats and oils is the part of a complex organic material that is soluble in ether consists chiefly of fats and fatty acids. It is a measure of the fat or oil (lipid) of plant which is considered as medicinal or nutritious feed and extremely rich sources of energy. Oils impede microbial fermentation, ruminant diets should be limited to about 4% fat.Our results are in line with Hussain and Durrani (2009), Coskun *et al.,* (2004), Cherney and Cherney (2005).Ayuba *et al*., (2011) reported crude lipid content was 6% in roots and 15.52% in the seed of *Datura innoxia* that agree with the present study.

The crude fiber is the organic residue remaining after digesting with acid and base. The compounds removed are predominantly protein, sugar, starch, lipids and portions of both the structural carbohydrates and lignins. It is an important constituent of balance diet that decreases blood cholesterol level, heart risks, colon cancer and diabetes (Ishida *et al.*, 2000). The RDA values of fibers for children are 19-25% and for lactating mother is 29 %. Belewu and Babalola (2009) stated that crude fibers can be used for useful purposes if treated with microorganisms. Hussain *et al.,* (2010) estimated fibers varied from 9.5 % to 12.12% in selected medicinal plants. This range is similar to the results in the present case. Hameed and Dastagir (2009) reported moisture, ash, crude fiber, proteins, fats and oils, and carbohydrates contents in *Rumex. hastatus*, *R. dentatus* and *R. nepalensis* (Family Polygonaceae). Their findings support the present results. Aberoumand (2012) reported that *Solanum indicum* contained 8.00% crude fiber showing difference in value from the present study. Carbohydrate is a group of organic compounds that includes sugars, starches, cellulose, and gums. It serves as a major energy source in the diet of animals. These compounds are produced in the photosynthetic plants and contain only carbon, hydrogen and oxygen usually in the ratio 1:2:1. Carbohydrates perform numerous important roles in human and animal bodies. Polysaccharides serve for the storage of energy (e.g. starch and glycogen) and as structural components (e.g. cellulose in plants and chitin in animals). Lee and Lim (2006) isolated new glycoprotein (150 KDa) from *Solanum nigrum,* which consist of carbohydrate content (69.74%) and protein content (30.26%). Audu *et al.* (2007) reported carbohydrate from leaves of *Lophira lanceolata.* Hameed and Dastagir (2009) reported carbohydrates contents in *R. hastatus*, *R. dentatus* and *R. nepalensis*. Folarin and Igbon (2010) reported carbohydrate from *Enterolobium cyclocarpum* seed. Aberoumand (2012) reported that *Solanum indicum* contained 40.67% carbohydrate. All these studies agree with the present findings.

Mineral composition

Micro-elements

Narendhirakannan *et al*. (2005) found marginal levels of Cr in the leaves of *Murraya koenigii, Mentha piperitae, Ocimum sanctum*, and *Aegle marmelos*, which were within permissible limits. Ozcan (2005) also reported very low Cr contents in *Capparis ovata*. The present study also reported low levels of Cr in the investigated plants and this is in the line with above mentioned studies. However on the contrary, Rehman and Iqbal (2008) reported high concentration of Cr in *Prosopis juliflora, Abutilon indicum* and *Senna holosericea*.Zn is found in traces in all the living organisms. It is important as some 200 enzymes dependent for its activity. Human body on the average needs 2–4 g Zn for RNA and DNA metabolism.The permissible limit of Zn is 50 ppm in medicinal plants (Khuda *et al*., 2012). Okwu and Josiah (2006) stated that *Aspilia africana* and *Bryophyllum pinnatum* were good sources of Zn. Demirezen and Aksoy (2006) after evaluating zinc contents of various vegetables reported that the concentrations of Zn were within the permissible limit and same is true for the present findings. Copper is essential trace element, which found in mono and divalent forms in human, animal and plant body. The permissible limit of Cu is 10 ppm in plants (Khuda *et al.,* 2012). Demirezen and Aksoy (2006) reported copper contents of various vegetables within the recommended international standards. The results also show that onion (0.97μg/g) and peppermint (76.5μg/g) had greater the ability to accumulate Cu.Narendhirakannan *et al*., (2005) reported Cu in trace amounts in *Murraya koenigii, Mentha piperitae, Ocimum sanctum*, and *Aegle marmelos*. Yusuf *et al*., (2003) reported significant variation of copper in *Talinum triangulare, Celosia trigyna, Corchorus olitorus, Venomia amygydalina* and *Telfaria accidentalis*, and the soils in which they were grown. *Corchorus olitorus* was more efficient to accumulate elements other than copper. Garg *et al*., (2007) reported that *Nordostachys jatamansi* had high concentration of Co, Cr, Cu, Na, Mn, Fe, Rb and Zn. Said *et al*., (1996) reported Cu, Mg, Zn, Fe, Cr and Mn in *Rheum emodi*. Hameed *et al*., (2008) reported C, O, Na, Mg, Al, Si, S, P, Cl, K, Ca, Ti, Fe and Br and Mn was absent from *Rumex hastatus, R. dentatus, R. nepalensis, Rheum australe, Pplygonum plebejum* and *P. maculosa*. These all findings agree with the present study. Hussain and Durrani (2008) reported K, P, Cu, Mn, Fe and Zn in the three phenological stage of the grasses and shrubs and stated the concentration of the Cu was higher in the grasses while that of the Mn was higher in the shrubs. Our findings distract from their results. Microelements are important source of medicinal activity in minor quantity. However, high concentration is injurious in many cases.

Table 3: Micro and macro-elements concentrations of the five medicinal plants of Family Solanaceae at different phenological stages

Species	Parts	Micro elements				Macro elements				
		Cr (ppm)	Zn (ppm)	Cu (ppm)	Mn (pp)	Fe (ppm)	Ca (ppm)	K (ppm)	Mg (ppm)	Na (ppm)
	Vegetative stage									
Datura innoxia Miller.	Roots	0.038	0.126	0.056	3.364	5.486	2.371	9.710	10.01	29.54
	Stems	0.022	0.129	0.066	0.260	2.880	1.807	7.211	15.46	28.62
	Leaves	0.065	0.146	0.075	19.63	36.39	1.871	6.452	14.32	29.31
Solanum nigrum Linn.	Roots	0.020	0.203	0.033	0.144	3.324	1.768	5.193	12.29	33.46
	Stems	0.031	0.091	0.053	1.203	1.995	2.034	5.743	16.76	41.45
	Leaves	0.036	0.109	0.084	0.420	6.514	1.765	7.594	15.36	42.05
Solanum surattense Burm.f.	Roots	0.035	0.221	0.088	0.570	3.208	1.749	6.227	14.19	36.74
	Stems	0.033	0.628	0.068	0.706	1.797	2.510	7.927	19.28	36.20
	Leaves	0.045	0.092	0.053	0.321	2.987	1.931	7.322	15.68	36.40
Withania somnifera Linn.	Roots	0.065	0.099	0.125	0.715	7.586	1.835	7.595	11.15	42.54
	Stems	0.049	0.245	0.087	0.378	11.93	2.116	8.707	16.53	41.91
	Leaves	0.040	0.086	0.091	0.729	2.827	2.010	7.174	9.25	39.68
Withania coagulans (Stock) Dunal.	Roots	0.036	0.078	0.053	0.151	2.070	1.791	4.961	15.28	45.32
	Stems	0.060	0.096	0.278	0.349	11.06	1.913	5.102	8.35	43.67
	Leaves	0.057	0.135	0.095	0.409	2.899	1.953	6.936	8.65	47.67
	Reproductive stage									
Datura innoxia Miller.	Roots	0.068	0.078	0.063	0.279	2.489	2.139	5.438	12.37	46.39
	Stems	0.056	0.059	0.062	0.246	6.779	3.398	4.985	14.25	53.51
	Leaves	0.058	0.098	0.067	3.079	2.441	1.844	5.493	8.64	49.20
	Flowers	0.058	0.054	0.082	1.103	0.464	1.865	6.056	6.66	58.81
Solanum nigrum Linn.	Roots	0.048	0.025	0.065	0.041	0.600	2.459	5.852	14.92	50.69
	Stems	0.054	0.102	0.142	0.349	0.657	1.846	6.351	15.64	46.47
	Leaves	0.057	0.043	0.064	1.145	0.514	2.393	5.250	19.25	73.37
	Flowers	0.064	0.038	0.075	0.343	3.242	2.079	5.248	20.26	89.21
Solanum surattense Burm.f.	Roots	0.091	0.097	0.112	1.293	15.76	2.259	5.268	6.37	52.15
	Stems	0.067	0.039	0.076	1.781	1.787	2.186	5.923	19.52	69.47
	Leaves	0.100	0.088	0.116	0.617	17.66	1.958	5.869	20.38	79.76
	Flowers	0.077	0.073	0.161	0.144	1.191	2.511	5.576	10.23	85.35
Withania somnifera Linn.	Roots	0.090	0.041	0.089	0.031	0.379	2.363	5.768	9.34	67.34
	Stems	0.101	0.075	0.112	0.241	3.767	2.694	5.798	5.45	82.94
	Leaves	0.096	0.054	0.110	0.974	0.470	2.497	5.273	12.93	98.50
	Flowers	0.110	0.172	0.128	0.173	1.048	2.669	5.892	25.34	119.3
Withania coagulans (Stock) Dunal.	Roots	0.107	0.109	0.142	0.100	0.620	2.645	5.349	10.87	70.88
	Stems	0.106	0.063	0.141	0.126	3.951	2.759	5.446	10.89	74.66
	Leaves	0.115	0.058	0.136	0.201	1.506	5.823	5.554	12.94	65.69
	Flowers	0.286	0.144	0.144	0.220	1.657	5.705	5.783	4.67	81.20
	Post reproductive stage									
Datura innoxia Miller.	Roots	0.286	0.052	0.139	0.123	0.409	2.535	5.020	15.97	109.0
	Stems	0.300	0.045	0.134	0.236	2.782	3.548	5.127	15.36	62.80
	Leaves	0.293	0.055	0.116	0.383	0.359	2.981	4.467	25.64	96.41
	Fruit	0.319	0.044	0.142	0.399	7.253	0.061	4.717	29.87	31.01
Solanum nigrum Linn.	Roots	0.303	0.112	0.213	0.361	0.821	0.079	0.796	16.72	30.84
	Stems	0.309	0.092	0.178	0.264	0.832	0.097	0.738	16.75	0.253
	Leaves	0.318	0.140	0.159	0.137	1.277	0.041	0.697	16.92	0.206
	Fruit	0.319	0.042	0.131	0.035	0.258	0.040	0.231	14.86	0.225

Continued…

Table 3: Continued…

Species	Parts	Micro elements				Macro elements				
		Cr (ppm)	Zn (ppm)	Cu (ppm)	Mn (pp)	Fe (ppm)	Ca (ppm)	K (ppm)	Mg (ppm)	Na (ppm)
Solanum surattense Burm.f.	Roots	0.326	0.030	0.122	0.026	0.253	0.039	0.014	14.42	0.268
	Stems	0.331	0.110	0.157	0.583	1.738	0.048	0.272	16.98	0.259
	Leaves	0.341	0.062	0.179	0.263	2.202	0.039	0.812	15.40	0.161
	Fruit	0.341	0.040	0.144	0.060	0.529	0.079	0.422	14.87	0.215
Withania somnifera Linn.	Roots	0.347	0.155	0.194	0.307	1.065	0.084	1.183	16.76	0.274
	Stems	0.354	0.116	0.170	0.209	1.518	0.149	1.536	17.50	0.209
	Leaves	0.356	0.071	0.202	0.350	1.500	0.122	0.615	18.31	0.270
	Fruit	0.373	0.096	0.181	0.541	6.128	0.134	1.413	18.13	0.169
Withania coagulans (Stock) Dunal.	Roots	0.363	0.314	0.152	0.125	0.571	0.054	0.422	17.84	3.601
	Stems	0.363	0.188	0.207	0.140	1.812	0.231	1.441	16.00	0.206
	Leaves	0.368	0.140	0.180	0.352	2.091	0.058	0.305	19.22	0.223
	Fruit	0.368	0.097	0.178	0.521	1.150	0.539	0.663	17.15	0.207

Table 4: ANOVA results for micro and macro-elements concentrations among the plant parts and Phenological stages.

	Datura innoxia	*Solanum nigrum*	*Solanum surattense*	*Withania somnifera*	*Withania coagulans*
	Micro-elements				
	Cr				
Phenological stage	0.004816HS	0.004114HS	0.004864HS	0.007355HS	0.035745S
Plant parts	0.397355NS	0.46395NS	0.383271NS	0.459448NS	0.901351NS
	Zn				
Phenological stage	0.245936NS	0.4031NS	0.29676NS	0.909845NS	0.204481NS
Plant parts	0.051438NS	0.078334NS	0.323041NS	0.483682NS	0.257129NS
	Cu				
Phenological stage	0.087442NS	0.032824S	0.170231NS	0.112147NS	0.504266NS
Plant parts	0.356177NS	0.157441NS	0.53225NS	0.251145NS	0.156031NS
	Mn				
Phenological stage	0.315092NS	0.608882NS	0.051244NS	0.87249NS	0.686318NS
Plant parts	0.288391NS	0.251184NS	0.025047S	0.174938NS	0.52993NS
	Micro-elements				
	Iron (Fe)				
Phenological stage	0.478075NS	0.326472NS	0.112368NS	0.320964NS	0.346754NS
Plant parts	0.547634NS	0.517031NS	0.231195NS	0.424722NS	0.101042NS
	Calcium (Ca)				
Phenological stage	0.304299NS	0.012524S	0.022001S	0.012546S	0.027938S
Plant parts	0.003655S	0.13072NS	0.213979NS	0.157579NS	0.460172NS
	Potassium (K)				
Phenological stage	0.888453NS	0.02754S	0.032746S	0.077105NS	0.038953S
Plant parts	0.14047NS	0.097226NS	0.149137NS	0.174293NS	0.16215NS
	Magnesium (Mg)				
Phenological stage	0.171927NS	0.476039NS	0.791444NS	0.544009NS	0.060225NS
Plant parts	0.299961NS	0.166991NS	0.037128S	0.819366NS	0.029694S
	Sodium (Na)				
Phenological stage	0.074638NS	0.037947S	0.007795HS	0.008662HS	0.007455HS
Plant parts	0. 13708NS	0.309103NS	0.263812NS	0.327767NS	0.188942NS

Macro-elements

Maco elements are important for the growth and development of plant, animal and human beings. Folarin and Igbon (2010) reported moisture, ash, crude protein, crude fiber, oils and carbohydrate, Na, Ca, Mg, Fe, Cu and Zn from *Enterolobium cyclocarpum* seed. James *et al*., (2010) analyzed that *Saba florida* had highest iron content in seeds followed by leaves. Hussain *et al*. (2010)

reported high concentration of iron in *Trianthema potulacastrum.*Rehman and Iqbal (2008) reported that plants growing in polluted areas accumulate more iron in their leaves. Adnan *et al.* (2010) observed high iron contents in plants of humid region than sub humid areas. This supports our results. Like the present Hameed *et al.* (2008) also reported iron content in *Polygonum plebjum, Rumex hastatus* and petiole of *Rumex nephalensis.* Khan *et al*., (2006) discussed that iron content was higher in forage of grazing pastures. Similarly, Kabata-Pendiaus and Pendias (1992) had the view that conditions of soil and climate affect the absorption of iron keeping physiological state of plants. Zafar *et al.* (2010) described that Ca contents were present invariably in plants.Hammed *et al.* (2008) also investigated Ca in *Polygonum plebejum, Rumex hastatus, Rumex dentatus* and *Rumex nepalensisi.* It ranged from 0.99 to 7.68 ppm. Hanif *et al.*, (2006) found Ca high in spinach (76 ppm) while recorded low in potato (8 ppm). This range of Ca content agreed with our findings. Hussain *et al.* (2009) found higher concentration of Ca in *Hypericum perforatum* (192 ppm). James *et al.*, (2010) also reported higher Ca level in *Saba florida.* Bano *et al.*, (2009) determined Ca in *Chrysopogon aucheri* and *Cymbopogon jwarancusa.* Khan *et al.* (2009b) reported seasonal effect on Ca in plants. Hussain *et al.* (2010) stated that plants provide 25 % of Ca in food. Hameed *et al.* (2008) stated that K contents varied from 1.04 to 6.57 ppm in various tested species of Polygonaceae but was absent in the flowers of *Rumex hastatus.* Their findings support our results. The results of Saidu and Jideobi (2009) and Zafar *et al.*, (2010) also strengthen the present findings. Sultan *et al.*, (2008) stated that potassium content in free grazing lands was higher at early bloom than at maturity and this agree with our findings. Minson (1990) said that K contents are poor in grasses than herbs. Potassium is important to activate enzymes that affect the plant growth, development and structure (Sultan *et al*., 2007, 2008*;* Hussain and Durrani, 2007; Khan *et al*., 2007).

Akubugwo *et al.* (2007) revealed that the order of mineral contents lie in order of Mg>K>Ca>Fe> Na>Mn>Zn in the leaves and Mg>K>Fe>Ca>Na>Mn>Zn in the seeds of *Solanum nigrum* var *virginicum*. Availability of Ca and Mg in soil affects the intake of Mg by the plants (Skerman and Riveros, 1990; Rahim *et al.*, 2008). Georgievskii (1982) observed equal amount of Mg in leaves and stems. Its uptake was generally low at low temperature and in water logged soil. The grazing pasture plants generally had usually higher Mg contents (ARC, 1980; Islam *et al*., 2003; Khan *et al.*, 2006). The tested species had higher level of Mg than recommended values and therefore these forages are good for lactating cattle, goat and sheep. Dua and Care (1995) stated that availability of Mg to cattle is affected by other dietary components like K, N, Ca contents.Sodium is associated with body fluid and regulates acid base balance. It is a major electrolyte of blood and help in hydration (Ayoola *et al.*, 2010; Gbolahan, 2001). Its intake is related with hypertension in human. James *et al*., (2010) determined high level of sodium in all parts of *Saba florida*.Similarly sodium is present high amounts in *Dalbergia sisso* (Hussain *et al.*, 2010). Adnan *et al.* (2010) recorded low level of sodium in *Bupleurum falcatum* but high concentration in *Otostegia lambata.* Hanif *et al*., (2006) found high amount of sodium in radish (63.9 ppm) and low level found in bottle gourd (1.7 ppm), this agrees with the present study.

CONCLUSIONS

The present study concludes that all the five tested plant species have adequate levels of various chemicals and minerals required for medicinal activity and benefits. All the investigated parameters are within the permissible range. It was also concluded that ash, moisture contents, crude protein, crude fat and carbohydrate had the tendency to increase from vegetative to reproductive stage and thereafter decreased in the post reproductive stage. Crude fibers decreased from vegetative to post reproductive stage. It was also observed that chromium, calcium and sodium increased from vegetative to reproductive stage, but declined in the post reproductive stage. Zinc and copper contents decreased from vegetative stage to reproductive but enhanced in the post reproductive stages. Manganese, iron, potassium decreased from vegetative stage to post-reproductive stages. Magnesium progressively enhanced from vegetative stage to post reproductive stage. It was concluded that various chemical parameters either increased or decreased with growing age of plant and seasonal changes. It is therefore recommended that harvesting of these plants might be more beneficial at proper stage to get maximum medicinal benefits.

REFERENCES

Abbasi MA and Khan MA (2010). Ethonobotanical survey of Lora valley District Abbottabad (Khyber Pakhtunkhawa), Pakistan. *Hamdard Medicus,* **53**(4): 36-51.

Aberoumand A (2012). Assay of nutritional potential of the fruits of *Solanum indicum* L. in Iran. *J. Agricultural Technology*, **8**: 923-929.

Adenipekun CO and Oyetunji OJ (2010). Nutritional values of some tropical vegetables. *J. Applied Biosciences,* **35**: 2294-2300.

Adnan M, Hussain J, Shah MT, Shinwari ZK, Ullah F, Bahader A, Khan N, Khan AL and Watanabe T (2010). Proximate and nutrient composition of medicinal plants of humid and sub-humid regions in North-West Pakistan. *J. Med. Plant Res*., **4**: 339-345.

Ajaib M, Khan ZD, Khan NU and Wahab M (2010). Ethnobotanical studies on useful shrub of District

Kotli, Azad Jammu & Kashmir, Pakistan. *Pak. J. Bot*., **42**(3): 1407-1415.

Akubugwo IE, Obasi AN and Ginika SC (2007). Nutritional potential of the leaves and seeds of black nightshade- *Solanum nigrum* L. var *virginicum* from Afikpo-Nigeria. *Pakistan J. Nutrition*, **6**: 323-326.

Aliero AA, Asekun OT, Grierson DS and Afolayan AJ (2007). Volatile Components from the roots of *S. pseudocapsicum*. *J. Medicinal Food*, **10**: 557-558.

AOAC (2000). 17th edition. Association of official analytical chemists, Gaithersburg, MD, USA, pp. 87.

ARC (1980). The nutrients requirements of ruminant livestock. 4th edition CAB international, Wallingford, pp.73-310.

Audu SA, Mohammed I and Kaita HA (2007). Phyto-chemical screening of the leaves of *Lophira lanceolata* (Ochanaceae). *Life Science Journal*, **4**:75-79.

Ayoola PB, Adeyeye A and Onawumi OO (2010). Trace elements and major minerals evaluation of *Spondias mombin*, *Vernonia amygdalina* and *Momordica charantia* Leaves. *Pakistan J. Nutrition*, **9**: 755-758.

Ayuba VO, Ojobe TO and Ayuba SA (2011). Phytochemical and proximate composition of *Datura innoxia* leaves, seed, stems pod and roots. *J. Med. Plant Res.*, **5**: 2952-2955.

Bano A, Rehman A and Winiger M (2009). Altitudinal variation in the content of protein, proline, sugar and abscisic acid (ABA) in the alpine herbs from Hunza valley, Pakistan. *Pak. J. Bot.*, **41**: 1593-1602.

Belewu MA and Babalola FT (2009). Nutrient enrichment of waste agricultural residues after solid state fermentation using *Rhizopus oligosporus*. *J. Applied Biosciences*, **13**: 695-699.

Cheema UB, Sultan JI, Javaid A, Akhtar P and Shahid M (2011). Chemical composition, mineral profile and *in situ* digestion kinetics of fodder leaves of four native trees. *Pak. J. Bot.*, **43**: 397-404.

Cherney JH and Cherney DJR (2005). Agronomic responce of cool season grasses to low intensity harvest management and low potassium fertility. *Agron. J.*, **97**: 1216-1221.

Choudhary SM and Kamal S (2004). Introduction to statistical theory. Part 1 & 2 and 250. Murkazi kutub khana, Urdu Bazaar, Lahore. pp.62, 102, 109.

Coskun B, Gulsen N and Umucalilar HD (2004). The nutritive value of *Prangos ferulacea*. *Grass & Forage Science*, **59**: 711-717.

Das P, Devi LP and Gogoi M (2009). Nutrient composition of some regional recipes of Assam, India. *Ethno-Med.*, **3**: 111-117.

Demirezen D and Aksoy A (2006). Heavy metal levels in vegetables in Turkey are within safe limits for Cu, Zn, Ni and exceeded for Cd and Pb. *J. Food Quality*, **29**: 252-265.

Dua K and Care AD (1995). Impaired absorption of magnesium in the etiology of grass tetany. *Brit. Vet. J.*, **151**: 413-426.

Evans WC (2009). *Trease and Evans Pharmacognosy*. W. B. Saunders Publisher, London, New York. 16th ed. P.480.

Folarin OM and Igbon OC (2010). Chemical composition of *Enterolobium cyclocarpum* (Jacq.) Griseb. seed and physiochemical properties of the oil extracts. *Hamdard Medicus*, **53**: 21-26.

Garg AN, Kumar A, Nair AGC and Reddy AVR (2007). Analysis of some indian herbs by INAA. *J. Radio-analytical & Nuclear Chemistry*, **271**(3): 611-619.

Georgievskii VI (1982). Biochemical regions. Mineral composition of feeds. *In*: Mineral nutrition of animals. (Eds.): VI Georgievskii. BN Annenkov and VI Samokhin. Butterworths, London.

Globahan D (2001). Lesson note on medical importance of trace elements. *Centre for Natural Health Studies*, Surulere, Lagos, Nigeria, pp. 8-10.

Hameed I and Dastagir G (2009). Nutritional analyses of *Rumex hastatus* D. Don, *Rumex dentatus* Linn and *Rumex nepalensis* Spreng. *Afri. J. Biotechnol*., **8**: 4131-4133.

Hameed I, Dastagir G and Hussain F (2008). Nutritional and elemental analyses of some selected medicinal plants of the family Polygonaceae. *Pak. J. Bot*., **40**: 2493-2502.

Hanif R, Iqbal Z, Iqbal M, Hanif S and Rasheed M (2006). Use of vegetable as nutritional role in human health. *J. Agric. Biol Sci*., **1**: 18-22.

Hussain F, Badshah L and Dastagir G (2006). Folk medicinal uses of some plants of South Waziristan, Pakistan. *Pak. J. Pl. Sci*., **12**(1): 27-39.

Hussain F and Durrani MJ (2007). Forage productivity of arid temperate Harboi rangeland, Kalat, Pakistan. *Pak. J. Bot*., **39**(5): 1455-1470.

Hussain F and Durrani MJ (2008). Mineral composition of some range grasses from Harboi rangeland, Kalat, Pakistan. *Pak. J. Bot*., **40**: 2513-2523.

Hussain F and Durrani MJ (2009). Nutritional eveluation of some forage plants from Harboi rangeland, Kalat, Pakistan. *Pak. J. Bot*., **41**: 1137-1154.

Hussain J, Rehman NU, Khan AL, Hamayun M, Hussain SM and Shinwari ZK (2010). Proximate and essential nutrients evaluation of selected vegetables species from Kohat region, Pakistan. *Pak. J. Bot.*, **42**: 2847-2855.

Hussain K, Ismail Z, Sadikun A and Ibrahim P (2009).Proximate and qualitative analysis of different parts of *Piper sarmentosum*, and quantification of total amides in various extracts. *Pharmacognosy Research*, **1**: 113-119.

Ishida H, Suzuno H, Sugiyama N, Innami S, Todokoro T and Maekawa A (2000). Nutritional evaluation of chemical component of leaves, stalks and stemss of sweet potatoes (*Ipomoea batatas* poir). *Food Chem*., **68**: 359-367.

Islam MR, Saha CK, Sharkar NR, Jahilil M and Hasan-unz-Zaman M (2003). Effect of variety on proportion of botanical fraction and nutritive value of different

Napier grass (*Pennisetum puporeum*) and relationship between botanical fraction and nutritive value. *Asian-Australian J. Anim. Sci.*, **16**: 177-188.

James O, Rotimi AA and Bamaiyi BOJ (2010). Phyto-constituents, proximate and nutrient investigations of *Saba florida* (Benth.) from Ibaji forest. *Intern. J. Nutrition & Metabolism*, **2**: 88-92.

Kabata-Pendias A and Pendias H (1992). *Trace Elements in Soils and Plants.* CRS Press Inc., Boca Raton, FL.

Kar DM, Nanda BK, Rout SP, Deb L, Panchawat S and Jain A (2010). Study of anti-ulcer of hydro-alcoholic extract of leaves of *Withania somnifera* Linn. *Hamdard Medicus*, **53**(2): 81-87.

Khan SU, Wazir SM, Subhan M, Zahoor M, Kamal M and Taj S (2009a). Some of the ethnobotanical important plants of F. R. Bannu, NWFP, Pakistan. *Pak. J. Pl. Sci.*, **15**(1): 81-85.

Khan ZI, Ashraf M, Ahmad K, Ahmad N, Danish M and Valeem EE (2009b). Evaluation of minerals composition of forages for grazing ruminants in Pakistan. *Pak. J. Bot*., **41**: 2465-2476.

Khan ZI, Ashraf M, Ahmad K, Mustafa I and Danish M (2007). Evaluation of micro minerals composition of different grasses in relation to livestock requirements. *Pak. J. Bot.*, **39**: 719-728.

Khan ZI, Ashraf M and Valeem EE (2006). Forage mineral status evaluation: The influence of pastures. *Pak. J. Bot.*, **38**: 1043-1054.

Khuda F, Iqbal Z, Ullah Z, Khan A, Nasir F, Muhammad N, Khan JA and Khan SM (2012). Metal analysis, phytotoxic, insecticidal and cytotoxic activities of selected medicinal plants of Khyber Pakhtunkhwa. *Pak. J. Pharma. Sci.*, **25**: 51-58.

Lee S (2005). Encyclopedia of Chemical Processing, Lee Lee. CRC Press, NY, USA, pp. 1243.

Lee SJ and Lim KT (2006). 150 kDa glycoprotein isolated from *Solanum nigrum* Linn stimulates caspase-3 activation and reduces inducible nitric oxide production in HCT-116 cells. *Toxicology in vitro*, **20**: 1088-1097.

Manan Z, Sirajuddin, Razaq A, Islam M and Ullah I (2007). Diversity of medicinal plants in Wari Subdivision District Dir, Pakistan. *Pak. J. Pl. Sci.*, **13**(1): 19-26.

Minson DJ (1990). The chemical composition and nutritive value of tropical grasses. *In*: *Tropical grasses FAO Plant Production and Protection Series*, (Ed.): P. J. Skerman and F. Riveros. No.23. FAO Rome.

Narendhirakannan RT, Subramanian S and Kandaswamy M (2005). Mineral content of some medicinal plants used in the treatment of diabetes mellitus. *Biol. Trace Elem.Res.*, **103**: 109-115.

Nasir YJ (1985). Flora of Pakistan, Solanaceae. No.168. *In*: S.I. Ali and M. Qaiser (ed.). Flora of Pakistan. Pakistan Agriculture Research Council, Islamabad.

Nziko M, Mvoula-Tsieri M, Matos L and Matouba E (2007). *Solanum nigrum* L. Seeds as an alternative source of edible lipids and nutriment in congo brazzaville. *Journal of Applied Science*, 7(8): 1107-1115.

Okwu DE and Josiah C (2006). Evaluation of the chemical composition of two Nigerian medicinal plants. *Afri. J. Biotechnol*., **5**: 357-361.

Ozcan M (2005). Mineral composition of different parts of *Capparis ovata* Desf. var. canescens (Coss.) Heywood growing wild in Turkey. *J. Med. Food.*, **8**: 405-407.

Qureshi RU, Bhatti GR, Memon RA. 2010. Ethnomedicinal uses of herbs from northern part of Nara Desert, Pakistan. *Pak. J. Bot*., **42**(2): 839-851.

Rahim I, Sultan, JI, Yaqoob M, Nawaz H, Javed I and Hameed M (2008). Mineral profile, palatability and digestibility of marginal land grasses of Trans-Himalayan grasslands of Pakistan. *Pak. J. Bot.*, **40**: 237-248.

Rehman SAU and Iqbal MZ (2008). Level of heavy metals in the foliage of naturally growing plants collected from Korangi and Landhi industrial areas of Karachi city, Pakistan. *Pak. J. Bot*., **40**: 785-789.

Said HM, Saeed A, D,Silva LA, Zubairy HM and Bano Z (1996). Medicinal herbal a textbook for medical students and doctors. Hamdard Foundation Pakistan, Nazimabad, Karachi, Pakistan.

Saidu AN and Jideobi NG (2009). The proximate and elemental analysis of some leavesy vegetables grown in Minna and Environs. *J. Appl. Sci. & Environ. Management*, **13**: 21-22.

Shah MT, Begun S and Khan S (2009). Pedo and Biogeochemical Studies of mafic and intramafic rocks in the Mingora and Kabal areas, Swat, Pakistan. *Environmental Earth Sciences*, **60**(5): 1091-1102.

Skerman PJ and Riveros F (1990). *Tropical grasses.* FAO plant production and protection series, No. 23. FAO.

Sucman E, Mahrova M, Pac J and Vavrova M (2007). Microwave assisted digestion method for the determination of cadmium, copper, lead and zinc in biological materials. *Electroanalysis*, **20**: 386-389.

Sultan JI, Inam-ur-Rahim, Javaid A, Bilal MQ, Akhtar P and Ali S (2010). Chemical composition, mineral profile, palatability and *in vitro* digestibility of shrubs. *Pak. J. Bot*., **42**(4): 2453-2459,

Sultan JI, Inam-ur-Rahim, Nawaz H and Yaqoob M (2007). Nutritive value of marginal land grasses of northern grasslands of Pakistan. *Pak. J. Bot*., **39**(4): 1071-1082.

Sultan JI, Inam-ur-Rahim, Yaqoob M, Nawaz H and Hameed M (2008). Nutritive value of free rangeland grasses of northern grasslands of Pakistan. *Pak. J. Bot*., **40**: 249-258.

Tareen RB, Bibi T, Khan MA, Ahmad M and Zafar M (2010). Indigenous knowledge of folk medicine bythe women of Kalat & Khuzdar regions of Balochistan, Pakistan. *Pak. J. Bot*., **42**(3): 1465-1485.

Yao J, Yan B, Wang XQ and Liu JX (2000). Nutritional evaluation of mulberry leaves as feeds for ruminants. *Livest. Res. Rural Develop*, **12**: 9-16.

Yusuf AA, Arowolo TA and Bamgbose O (2003). Cadmium, copper and nickel levels in vegetables from industrial and residential areas of Lagos City, Nigeria. *Food and Chemical Toxicology*, **41**: 375-378.

Zafar M, Khan MA, Ahmad M, Jan G, Sultana S, Ullah K, Marwat SK, Ahmad F, Jabeen A, Nazir A, Abbasi AM, Rehman Z and Ullah Z (2010). Elemental analysis of some medicinal plants used in traditional medicine by atomic absorption spectrophotometer (AAS). *J. Med. Plant Res*., **4**: 1987-1990.