EVALUATION OF CHEMICAL COMPOSITION AND *IN VITRO* DRY AND ORGANIC MATTER DIGESTIBILITY OF SOME FORAGE PLANT SPECIES DERIVED FROM EGYPTIAN RANGELANDS

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ABSTRACT

The objective of the study was to evaluate wild forage plant species derived from Egyptian rangelands based on the determination of their chemical composition, *in vitro* digestibility and gross energy value. Twenty four wild palatable forage plants were identified and analyzed for crude fiber, ether extract, crude protein, nitrogen free extract, ash, neutral detergent fiber and acid detergent fiber, acid detergent lignin, cellulose, hemi-cellulose, silica, *in vitro* dry matter digestibility (IVDMD) and In vitro organic matter digestibility (IVOMD) and gross energy. The differences among species were significant in the same group of plants and among different groups (grasses, legumes and forbs). Significant differences were observed between grasses in all factors evaluated, except acid detergent lignin. In legumes the differences among species in values of acid detergent fiber, acid detergent lignin and cellulose were not significant. Contrary, all tested factors among forbs species were significantly different. IVDMD and IVOMD showed a significantly higher trend for grasses compared to legumes and forbs. Contrary, forbs showed a higher trend in gross energy compared to grasses and legumes. It can concluded that the high protein, moderate fiber contents and high *in vitro* digestibility found in *Ammophila arenaria, Trigonella maritime* and *Vicia monantha, Vicia sativa*, *Ononis vaginalis*, *Atriplex nummularia* and *Lycium shawii* make them good quality wild forage plant species that can be used in ruminants' nutrition under Egyptian rangelands conditions.

Key words: Grasses, legumes, forbs, fiber, silica and energy.

INTRODUCTION

The issue of animal feed supply and its quality is aggravated in arid, semi-arid and tropical regions with scarce and erratic rainfall that limits the growth of herbaceous species and biomass yield (Boufennara *et al.*, 2012). Egyptian deserts covered by native palatable plants can provide continuous forage supply for domestic grazing animals and support the national economy. Although the natural plant cover of Egyptian deserts is quite low and scattered, the flora in the North West coast is relatively rich and diverse. The Western Mediterranean Coastal land is one of the richest phyto-geographical regions in Egypt because of its relatively high rainfall. The natural vegetation includes many annuals species, mostly herbs and a few grasses, perennial herbs, shrubs, sub-shrubs, and a few trees. These species represent 50% of the total flora of Egypt (UNESCO, 2003). Heneidy (2004) found that the most representative plant families in North West Coastal region of Egypt were *Asteraceae*, *Fabaceae*, *Poaceae* and *Chenopodiaceae*. Other families were represented by less than 2 % of total, *e.g.*, *Aizoaceae*, *Apiaceae*, *Brassicaceae*, *Caryophyllaceae*, *Liliaceae*, *Plantaginaceae*, *Ranunculaceae*, *Solanaceae* and *Thymelaceae*. Täckholm (1974) and Boulos (1995) reported that *Fabaceae* and *Asteraceae*are are the largest families in Egypt with the greatest number of plant species. Indigenous shrub and bush species have also a potential to (i) prevent desertification, (ii) mitigate the effects of droughts, (iii) allow soil fixation, (iv) enhance the restoration of the vegetation and the recuperation of rangelands. Hence, there is an increasing interest in the rational utilization of potential livestock feed resources such as browse species that are adapted to these environments (Robles *et al.*, 2008). Obviously, the plant species selected for the present study grow throughout the Western Mediterranean Coastal of Egypt and are commonly used as range plants and feed supplements for grazing animals in many regions. In spite of their limited nutritional value, these forage resources are indispensable as feeds for herbivores in such kind of when production systems which are based on grazing rangelands (Papanastasis *et al.*, 2008). Also, chemical composition of pasture vegetation is crucial, particularly in combination with *in vitro* digestibility, to evaluate the nutritive value of browse species that are not known previously (Laudadio *et al.*, 2009). Consequently, a detailed analysis of browse species is important to identify the most proper shrub species for ruminants, in terms of nutrient content and digestibility (Tufarelli *et al*., 2010). Boufennara *et al.* (2012) reported that all the chemical, *in vitro* and *in situ* measurements are useful tools in initial screening studies to rank the forages according to their nutritive quality. Keeping in view these facts, this study designed to evaluate the chemical composition, *in vitro* digestibility and gross energy value of some wild forage plant species derived from Egyptian rangelands.

MATERIALS AND METHODS

The experiments were conducted at the Experimental Laboratories of the Natural Resources Department, Institute of African Research and Studies, Cairo University, Animal Production Department, Faculty of Agriculture, Cairo University, Egypt and Department of Animal Nutrition and Feed Management, Poznan University of Life Sciences, Poznan, Poland during period 2015-2017.

Plant materials: Ten samples of twenty-four wild palatable forage plants were collected from different sits of Egyptian Rangelands in Mediterranean coast region (Marsa Matrouh area) and shoot parts of annual plants were clipped and new sprouts of perennials were cut during spring seasons (Table 1). Plant species were firstly identified at the field, collected and prepared as herbarium sheets after being pressed. All collected and preserved plants were taken to the Cairo University herbarium for accurate identification. Floristic identifications were performed according to Täckholm (1974) and the scientific names of species were updated by Boulos (1999, 2000, 2002 and 2005).

Chemical composition of feeds: Samples of feeds were analyzed according to A.O.A.C. (2007, Table 1) for dry matter (method no. 934.01) and ash (method no. 942.05). Crude protein was determined by Kjel-Foss Automatic 16210 analyzer (method no. 976.05), crude fat by Soxtec System HT analyzer (method no. 2003.05), and crude fiber by Tecator Fibertec System I (method no. 978.10). Nitrogen-free-extractives (NFE %) was calculated using the difference method by subtracting the sum of crude protein, crude fiber, ether extract and total ash from 100.

NFE % = 100 – (CP % + CF % + EE % + TA %)

Batch culture fermentation: The rumen inoculum was obtained 3 h after the morning feeding from three rumen cannulated Polish Holstein-Friesian dairy cows (mean body weight 600 ± 23 kg) fed the diet (kg/day) containing alfalfa silage, 46.0; meadow hay, 1.80; corn meal, 0.90; dry brewer's grains, 0.60; protein concentrate (35% crude protein), 1.50; wheat bran, 0.60; and commercial concentrate (19% crude protein), 5.50. Ruminal content was squeezed through four layers of cheesecloth into a Schott Duran® bottle (SCHOTT North America, Inc. Corporate Office, Elmsford, NY 10523, USA) with an O_2 – free headspace and immediately transported to the laboratory in a water bath preheated to 39 ± 0.5˚C. Each substrate (wild palatable forage plants) was grounded through a 0.15–0.4 mm screen, bulked and stored in sealed plastic containers. The ground substrates (400 ± 1 mg) were weighted into each individual batch culture fermentation bottle (100 mL). The batch culture fermentation was carried out according to Szumacher-Strabel *et al.* (2004). Briefly, rumen fluid was diluted with a buffer (mg/L; K_2HPO_4 292, KH_2PO_4 240, $(NH_4)_2SO_4$ 480, NaCl 480, $MgSO_4 \cdot 7H_2O$ 100, $CaCl_2 \cdot 2H_2O$ 64, Na_2CO_3 4, and cysteine HCl 600) in ratio 2:3. Then aliquots of 40 mL were transferred into incubation bottles. The bottles were filled with CO_2 and then closed with a rubber stopper and aluminum-sealed.

***In vitro* dry and organic matter digestibility:** After incubation, the bottles content was transferred to the previously weighed crucible. The residues of incubation was washed with 50 ml distilled water and dried at 105°C for 3 days. *In vitro* dry matter digestibility (IVDMD) was calculated after 24-h incubation using the following equation:

IVDMD (%) = [(initial DM input - (Residue - Blank) / initial DM input) ×100].

Then the samples of palatable forage plants, residue and blank samples were ashed at 450 °C and weighed. IVOMD (*In vitro* organic matter digestibility) was calculated according to the following formulas:

IVOMD (%) = [(initial OM input - (Residue - Blank) / initial OM input) ×100].

Energy calculation: Gross Energy (GE) of each palatable forage plant was estimated according to DLG (1982) equation:

GE (MJ/kg DM) = 0.0242CP+ 0.0366 EE + 0.0209 CF + 0.0170 NFE (g).

Statistical analysis: The layout of the experiment was arranged in a randomized complete blocks design, with 3 blocks (replicates), and the resulted data were subjected to statistical analysis, employing F-test for significance at $P \leq 0.05$ and computing of LSD values to separate means in different statistical groups according to the described method by Little and Hills (1978).

RESULTS

Chemical composition of feeds: Crude fiber (CF %) content in grasses was higher than legumes and forbs (Table 2). Among grasses, CF increased from 19.17% (*Ammophila arenaria*), 26.03% (*Lophochloa cristata*), to 38.30% (*Lygeum spartum*). Among legumes, the CF ranged from 15.30% in *Astraglus homosus*to to 30.10% in *Lygos raetam*. Among forbs CF increased from

11.69% (*Atriplex nummularia*), 13.61% (*Tamarix nilotica*), to 28.74% (*Gymnocarpos decandrum*).

The ether extract (EE %) contents of grasses varied between 1.74% (*Hordeum marinum)* and 5.62% (*Phalaris minor)*. In contrast, among legumes, ether extract contents varied between 1.18% (*Vicia sativa)* and 4.49% (*Trigonella maritime)*. While, among forbs ether extract content of analyzed plants varied between 1.17% (*Deverra trotuosa)* and 3.95% (*Tamarix nilotica).*

The highest percentages of crude protein (CP) attained in *Vicia sativa*, *Ononis vaginalis* and *Vicia monantha* were 16.70, 13.98 and 12.72% respectively, among legumes (Table 2). In grasses, the CP contents attained in *Ammophila arenaria* (14.00 %) and *Phragmites australis (13.09 %)*. While, among forbs the highest percentages of CP attained in *Gymnocarpos decandrum (*18.47%) and *Tamarix nilotica (*13.93%).

The values of nitrogen free extract (NFE %) in forbs increased from 49.51% (*Tamarix nilotica),* 56.54% (*Atriplex halimus)* to 63.10% (*Atriplex nummularia)* and ranged from 50.78% in *Astraglus homosus* to 51.59% in *Vicia monantha* as legumes. Among grasses, NFE increased from 43.33% (*Hordeum marinum*), 44.11% (*Phalaris minor*) to 44.75% (*Aegilops kotschyi*) as shown in Table 2.

Total ash (TA %) among legumes increased from 9.70% (*Lygos raetam*), 12.21% (*Vicia sativa*) to 22.05% (*Trigonella maritima*) and 23.24% (*Ononis vaginalis*). In grasses, the TA ranged from 11.48% in *Phragmites australis* to 21.22% in *Lophochloa cristata.* Forbs total ash ranged from 12.01% in (*Deverra trotuosa*), to 18.99% (*Tamarix nilotica).*

The neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), cellulose, hemi-cellulose and silica contents of some wild plants are summarized in Table (3). Among grasses, the highest and lowest values of NDF contents were 66.70 g/kg (*Lygeum spartum)* and 29.56 g/kg (*Ammophila arenaria)*. In legumes, the highest and lowest values of NDF contents were 50.61 g/kg and 33.67 g/kg in *Trigonella maritima* and *Astraglus homosus,* respectively. In forbs, the highest and lowest values of NDF contents were 63.95 g/kg (*Deverrat rotuosa)* and 22.34 g/kg (*Atriplex nummularia).*

Acid detergent fiber contents of grasses varied from 41.23 g/kg *(Lygeum spartum)* to 25.47 g/kg (*Ammophila arenaria)*. In contrast, among legumes, ADF varied between 15.29 g/kg for *Astraglus homosus* and 36.77 g/kg for *Lygos raetam.* While, among forbs ADF content of analyzed plants varied between 16.77 g/kg for *Atriplex nummularia* and 45.80 g/kg for *Deverra trotuosa*.

Among the tested grasses, legumes and forbs, the highest ADL contents (17.24, 16.98 and 14.31 g/kg) were recorded in *Lolium rigidum*, *Hordeum marinum* and *Deverra trotuosa*, respectively. In contrast, the lowest values of ADL contents (2.67, 2.67 and 3.08 g/kg) were recorded in *Phragmites australis*, *Lophochloa cristata* and *Atriplex halimus*, respectively.

Commonly, grasses had more cellulose than legumes and forbs. Within grasses, cellulose content of tested plants varied between 37.03 g/kg *(Lygeum spartum)* and 9.39 g/kg (*Lolium rigidum)*. In legumes, cellulose content varied between 4.39 g/kg (*Astraglus homosus)* and 27.77 g/kg (*Lygos raetam)* whilst among forbs cellulose contents of tested plants varied between 2.75 g/kg for *Atriplex nummularia* and 34.75 g/kg for *Gymnocarpos decandrum.*

Generally, grasses had more hemi-cellulose than legumes and forbs (Table 3). The highest values of hemi-cellulose (35.26, 31.50 and 30.88 g/kg) found in *Lolium rigidum*, *Aeluropus lagopoides* and *Phragmites australis*, respectively whilst the lowest values of hemi-cellulose (4.10, 4.49 and 4.69 g/kg) were found in *Ammophila arenaria*, *Gymnocarpos decandrum* and *Tamarix nilotica*, respectively. In silica contents varied from 7.42 g/kg in *Aeluropus lagopoides* to 10.04 g/kg in *Lolium rigidum*. Among legumes, it ranged from 13.37 g/kg in *Trigonella maritime* to 2.95 g/kg in *Lotus polyphyllus.* Among forbs, silica content ranged from 0.21 g/kg in *Atriplex nummularia* to 5.29 g/kg in *Deverra trotuosa*.

***In vitro* digestibility and gross energy of feeds:** Overall results showed significant differences among different groups (Table 4). IVDMD and IVOMD showed a higher trend for the group of grasses compared to legumes and forbs. Contrary, forbs showed a higher trend in gross energy compared to grasses and legumes.

The highest values of IVDMD were 44.39, 42.91, 40.48 and 40.37% in *Ammophila arenaria*, *Hordeum marinum*, *Trigonella maritime* and *Vicia monantha*, respectively. In contrast, the lowest values of IVDMD were 22.68, 23.51, 27.47 and 27.77% in *Deverra trotuosa*, *Gymnocarpos decandrum*, *Lygo sraetam* and *Panicum coloratum*, respectively.

IVOMD percentages of analyzed plants varied between 37.19% for *Ammophila arenaria* and 61.24% for *Lygeum spartum* among grasses. Among legumes IVOMD varied between 34.07% *(Trigonella maritime)* and 60.57% (*Lygos raetam)* while, among forbs IVOMD of tested plants varied between 64.11% (*Deverra trotuosa)* and 33.66% *(Atriplex halimus).*

Gross energy (Table 4) among forbs fluctuated between 1.76 MJ/kg DM (*Deverra trotuosa)* to 1.61 MJ/kg DM (*Tamarix nilotica)*. Among grasses, it varied from 1.78 MJ/kg DM (*Phragmites australis)* to 1.59 MJ/kg DM (*Lophochloa cristata)*. Likewise, among legumes, GE of tested legumes was ranged from1.56 MJ/kg DM in *Astraglus homosus* to 1.74 in MJ/kg DM in *Vicia sativa.*

Table 1. Botanical composition and life duration of tested forage plants.

Family Name	Scientific Name	Life Duration
	Aegilops kotschyi	Annual
	Aeluropus lagopoides	Perennial
	Ammophila arenaria	Perennial
	Hordeum marinum	Annual
Poaceae	*Lolium rigidum*	Annual
(*Gramineae)*	*Lophochloa cristata*	Annual
	Lygeum spartum	Perennial
	Panicum coloratum	Perennial
	Phalaris minor	Annual
	Phragmites australis	Perennial
	Astraglus homosus	Annual
	Lotus polyphyllus	Perennial
	Lygos raetam	Perennial
Fabaceae	*Ononis vaginalis*	Perennial
(*Leguminosae*)	*Trifolium tomentosum*	Annual
	Trigonella maritima	Annual
	Vicia monantha	Annual
	Vicia sativa	Annual
Asteraceae	*Anacyclus alexandrinus*	Perennial
Chenopodiaceae	*Atriplex halimus*	Perennial
Chenopodiaceae	*Atriplex nummularia*	Perennial
Apiaceae	*Deverra trotuosa*	Perennial
Caryophyllaceae	*Gymnocarpos decandrum*	Perennial
Solanaceae	*Lycium shawii*	Perennial
Tamaricaceae	*Tamarix nilotica*	Perennial

Table 2. Chemical composition of tested feeds (on DM basis).

Plant Species	Chemical Composition %					
	CF	**EE**	**CP**	**NFE**	**Ash**	**OM**
Grasses						
Aegilops kotschyi	29.97	2.50	8.95	44.75	13.83	86.17
Aeluropus lagopoides	28.42	3.53	9.97	40.34	17.74	82.26
Ammophila arenaria	19.17	5.22	14.00	41.69	19.92	80.08
Hordeum marinum	29.65	1.74	7.27	43.33	18.01	81.99
Lolium rigidum	30.25	2.39	10.82	39.96	16.58	83.42
Lophochloa cristata	26.03	3.20	12.63	36.92	21.22	78.78
Lygeum spartum	38.30	1.92	7.64	41.22	10.92	89.08
Panicum coloratum	34.80	3.24	9.05	37.88	15.03	84.97
Phalaris minor	29.07	5.62	5.89	44.11	15.32	84.68
Phragmites australis	32.82	2.57	13.09	40.05	11.48	88.52
Mean	29.85	3.19	9.93	41.03	16.01	84.00
$LSD_{0.05}$	1.95	2.13	0.37	3.35	1.42	1.42
Legumes						
Astraglus homosus	15.30	2.52	11.84	50.78	19.57	80.43
Lotus polyphyllus	26.56	2.76	10.79	42.95	16.95	83.05
Lygo sraetam	30.10	2.75	11.79	45.66	9.70	90.30
Ononis vaginalis	22.47	4.03	13.98	36.27	23.24	76.76
Trigonella maritima	26.72	4.49	11.25	35.49	22.05	77.95
Vicia monantha	20.34	2.26	12.72	51.59	13.09	86.91
Vicia sativa	25.72	1.18	16.70	44.20	12.21	87.79
Mean	23.89	2.86	12.72	43.85	16.69	83.31
$LSD_{0.05}$	0.28	2.63	0.11	2.88	0.73	0.73

Forbs						
Anacyclus alexandrinus	26.61	2.79	8.99	45.19	16.41	83.59
Atriplex halimus	13.97	2.48	13.03	56.54	13.97	86.03
Atriplex nummularia	11.69	3.29	9.00	63.10	12.92	87.08
Deverra trotuosa	35.02	1.17	13.90	37.91	12.01	87.99
Gymnocarpos decandrum	28.74	3.50	18.47	33.34	15.94	84.06
Lycium shawii	26.21	3.85	15.34	39.36	15.23	84.77
Tamarix nilotica	13.61	3.95	13.93	49.51	18.99	81.01
Mean	22.26	3.00	13.24	46.42	15.07	84.93
$LSD_{0.05}$	1.47	1.23	0.11	4.58	4.21	4.21
Collective-Mean	25.90	3.04	11.71	43.42	15.93	84.07
Collective-$LSD_{0.05}$	1.46	1.89	0.27	3.77	2.66	2.66

Table 3. Fiber fractions and silica content of tested feeds (on DM basis).

Plant Species	Fiber Fractions (g/kg)					Silica (g/kg)
	NDF	ADF	ADL	Cellulose	Hemi-cellulose	
Grasses						
Aegilops kotschyi	59.81	31.70	4.14	27.57	28.11	4.44
Aeluropus lagopoides	64.64	33.14	4.72	28.42	31.50	7.42
Ammophila arenaria	29.56	25.47	5.19	20.28	4.10	3.44
Hordeum marinum	61.13	32.64	16.98	15.66	28.48	7.23
Lolium rigidum	61.89	26.63	17.24	9.39	35.26	10.04
Lophochloa cristata	52.70	30.22	2.67	27.56	22.48	4.61
Lygeum spartum	66.70	41.23	4.20	37.03	25.47	3.69
Panicum coloratum	64.16	40.70	4.61	36.09	23.46	2.70
Phalaris minor	53.07	32.13	5.07	27.06	20.94	1.82
Phragmites australis	65.95	35.07	2.67	32.40	30.88	4.29
Mean	57.96	32.89	6.75	26.15	25.07	4.97
$LSD_{0.05}$	1.54	0.63	NS	0.63	1.79	1.45
Legumes						
Astraglus homosus	33.67	15.29	10.90	4.39	18.38	9.01
Lotus polyphyllus	40.55	34.12	9.45	24.67	6.43	2.95
Lygosraetam	50.52	36.77	9.00	27.77	13.75	4.07
Ononisvaginalis	35.90	25.43	3.65	21.78	10.47	3.87
Trigonella maritima	50.61	26.83	8.83	18.00	23.78	13.73
Vicia monantha	40.16	25.22	4.90	20.33	14.94	4.22
Vicia sativa	42.66	28.64	6.45	22.18	14.02	3.89
Mean	42.01	27.47	7.60	19.87	14.54	5.96
$LSD_{0.05}$	2.91	NS	NS	NS	2.91	0.64
Forbs						
Anacyclus alexandrinus	42.22	34.52	7.62	26.90	7.70	2.90
Atriplex halimus	31.20	22.03	3.08	18.96	9.17	2.48
Atriplex nummularia	22.34	16.77	14.02	2.75	5.57	0.21
Deverra trotuosa	63.95	45.80	14.31	31.49	18.15	5.29
Gymnocarpos decandrum	49.00	44.52	9.77	34.75	4.49	1.40
Lycium shawii	31.43	23.67	6.85	16.82	7.76	0.78
Tamarix nilotica	23.32	18.63	6.37	12.25	4.69	0.79
Mean	37.64	29.42	8.86	20.56	8.22	1.98
$LSD_{0.05}$	3.72	0.61	0.40	0.67	3.65	1.02
Collective-Mean	47.38	30.30	7.61	22.69	17.08	4.39
Collective-$LSD_{0.05}$	1.20	0.62	0.20	0.63	2.50	1.05

Table 4. *In vitro* dry, organic matters digestibility and gross energy of tested feeds.

Plant Species	*In vitro* Digestibility %		Gross Energy (MJ/kg DM)
	DMD	OMD	
Grasses			
Aegilops kotschyi	36.72	55.04	1.70
Aeluropus lagopoides	30.75	53.96	1.65
Ammophila arenaria	44.39	37.19	1.64
Hordeum marinum	42.91	46.00	1.60
Lolium rigidum	35.58	50.65	1.66
Lophochloa cristata	35.88	47.48	1.59
Lygeum spartum	28.40	61.24	1.76
Panicum coloratum	27.77	60.08	1.71
Phalaris minor	37.02	50.09	1.71
Phragmites australis	34.85	52.85	1.78
Mean	35.43	51.46	1.68
$LSD_{0.05}$	10.82	11.97	0.04
Legumes			
Astraglus homosus	34.23	35.97	1.56
Lotus polyphyllus	30.32	51.60	1.65
Lygos raetam	27.47	60.57	1.79
Ononis vaginalis	39.12	37.95	1.57
Trigonella maritima	40.48	34.07	1.60
Vicia monantha	40.37	45.42	1.69
Vicia sativa	35.40	50.52	1.74
Mean	35.34	45.16	1.66
$LSD_{0.05}$	10.31	10.40	0.05
Forbs			
Anacyclus alexandrinus	30.09	44.90	1.64
Atriplex halimus	34.08	33.66	1.66
Atriplex nummularia	31.80	37.96	1.66
Deverra trotuosa	22.68	64.11	1.76
Gymnocarpos decandrum	23.51	61.64	1.74
Lycium shawii	34.94	44.24	1.73
Tamarix nilotica	33.65	40.43	1.61
Mean	30.11	46.71	1.69
$LSD_{0.05}$	10.72	9.74	0.07
Collective-Mean	33.85	48.23	1.68
Collective-$LSD_{0.05}$	10.42	11.18	0.05

DISCUSSION

Chemical composition: The chemical composition is the first step to evaluate the nutritive value for any tested feed. The present investigation primarily indicated the potential to use the tested plants as a source of nitrogen and carbohydrate in ruminant diets. In our study, crude fiber and ether extract contents increased in the species that contained less protein and decreased in the species with high protein content. Similar findings reported in earlier studies (Abbas *et al.* 2008; El-Morsy, 2002; Ibrahim, 1995). It is reported that due to the increase in temperature, the highest percentage of crude fiber was recorded during summer followed by spring, autumn and winter in descending order (Ibrahim, 1995). Hussain and Durrani (2009) also reported that mature plants usually contained higher CF content than in young plants.

Protein is an important nutrient supplied by forages and plant species belonging to *Fabaceae* family that generally produce higher forage quality than other species because legumes usually have high crude protein and favor higher intake than others. Our results agreed with those of Hussain and Durrani (2009) who showed that shrubs generally contained slightly higher CP than grasses. However, Ammar *et al.* (2004) observed that leguminous forages and trees have been used as a basic feed animal supply in many regions of the world mainly because of their high protein contents throughout the year. Holechek *et al.* (1995) found that leaves of forbs and shrubs are generally higher in protein than leaves of grass. Reiad *et al.* (1996) indicated that it is more likely that perennial plants are often relatively lower in CP. On the other hand, El-Shesheny (2007) reported that there was insignificant effect of plant growth seasons on crude protein and also nitrogen-free extract consisting of carbohydrates, sugars, starches at the North West coastal region of Egypt. In this respect, Holechek *et al*. (1995) indicated that NFE is one of the most important components of forage because it represents the basic source of energy for grazing animals. Baumi (2003) reported that the increase or decrease of any of the mentioned components (carbohydrate or crude protein contents) affect the quality of the foliage of the plant species. Literature explains that there is negative relationship between total ash and organic matter content. Hussain and Durrani (2009) reported that the increase or decrease of ash content with advancing age by different plants might be due to variation in soil and other habitat features that need to be explored. However, El-Kerdawy (1992) in the North West coastal region of Egypt claimed that mineral concentrations of range plants on dry matter basis were greatly affected by plant species and stage of growth but not by plant location except for phosphorus and sodium in case of perennials. Therefore, the highest percentages of ash mean the lowest percentages of OM. Generally, legumes had more ash percentages or less organic matter percentages than grasses and forbs.

Fiber fractions: Results of our study stated that legumes slightly varied (P>0.05) among species in values of acid detergent fiber, acid detergent lignin and cellulose. Contrary, all test factors among forbs species were significantly different. The increased fiber content may be due to plant species, maturity and environmental conditions. Similar results had been reported by Boufennara *et al.* (2012) who found the high level of fiber content (NDF, ADF and lignin) in some of the forage species could be explained partly by the ecological conditions-high temperature and low precipitations. This tended to increase the cell wall fraction and to decrease the soluble contents of the plants. On the other hand, Sultan *et al.*, (2008) indicated that the structural constituents (NDF, ADF, hemi-cellulose and lignin) increased in grasses from early bloom to maturity stage. These results are in agreement with those obtained by Hussain and Durrani (2009) who indicated that NDF concentration of grasses was higher than of shrub. However, Kramberger and Klemencic (2003) reported increase in NDF concentration with maturity of plants. Inline to our findings, Hussain and Durrani (2009) observed that ADF contents of grasses were significantly higher than of shrubs at pre-reproductive and post-reproductive stages. Boufennara *et al.* (2012) reported that monocots had higher NDF and ADF and lower lignin contents than dicots. Cherney *et al.* (1993) reported an increase in all fiber constituents with increasing maturity. Furthermore, Brown *et al.* (1984) reported that the soil fertility could also influence grass lignin concentration.

The values of hemicelluloses recorded in our study agreed with the findings of Ghadaki *et al.* (1975) who indicated the cellulose content of grasses was higher than that of shrubs, fortes, and especially legumes. Similar results had been reported by Hussain and Durrani (2009) who found out those grasses generally had greater hemicellulose contents than shrubs.

***In vitro* digestibility and gross energy:** *In vitro* digestibility considered as the second step of feed evaluation. Variations in the results of IVDMD can be attributed to several factors, such as processing of samples, difference in chemical composition of feed, preparation of buffer solution or handling of equipment (Tufarelli *et al.*, 2010). Furthermore, The CP, fiber contents, DM degradability and IVOMD values are used as indicator to use as feed supplements for ruminant (Andualem *et al.*, 2016).

IVDMD showed a wide range of qualities in the 24 plant materials tested related to their different chemical compositions (Table 4). In this respect, Tufarelli *et al*. (2010) reported that IVDMD and IVOMD showed a higher trend for the forbs group compared to legumes and grasses. In addition, Foguekem *et al.* (2011) suggested that IVDMD is strongly influenced by the amount of fiber represented by the NDF, ADF and cellulose levels in the plant tissues. Furthermore, Badrzadeh *et al.* (2008) reported that crude protein, digestible dry matter in *Vicia narbonensis* L. var. *affinis* were higher than in the other species of vetches; this is due to low amount of acid and neutral detergent fiber. The results of our study were in line with those of Cherney *et al.* (1990) who observed a negative correlation of IVDMD with NDF, ADF and lignin. Sultan *et al.* (2008) and Van Soest (1978) reported poor relationship of NDF and digestibility. On the other hand, Foguekem *et al.* (2011) found that changes in the IVDMD are positively correlated with those of crude protein levels. Also, the feeds (indigenous fodder trees and shrubs in Ethiopia) were shown to decrease their crude protein and IVOMD from the wet to dry season while their cell wall constituents were shown to increase (Girma *et al*. 2015).

Generally, forbs contained slightly higher gross energy than grasses and legumes. These results are in agreement with those obtained by Hussain and Durrani (2009) who observed that shrubs contained slightly higher gross energy than the grasses. Contrary, Cook and Harris (1968) observed that grasses had higher gross energy than shrubs. Khachatur (2006) indicated that the wild growing legume forages were characterized by high nutritive and energy values.

Conclusions: The high crude protein and moderate fiber content, along with high IVDMD found in *Ammophila* *arenaria, Trigonella maritima* and *Vicia monantha, Vicia sativa*, *Atriplex nummularia, Ononis vaginalis* and *Lycium shawii* suggested that these plants have a greater nutritive value than the highly fibrous and of moderate IVDMD species such as: *Lygeum spartum, Lygos raetam, Panicum coloratum, Lolium rigidum, Gymnocarpos decandrum, Deverra trotuosa* and *Aeluropus lagopoides*. Because of the relatively high fiber content the plant species of the greater nutritive value can be used as components of ruminants' diets. However further animal experiment is needed to validate this conclusion.

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