

NUTRITIVE POTENTIAL OF SOME BROWSE PLANTS GROWN UNDER THE EGYPTIAN DESERT CONDITIONS

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ABSTRACT

Browse plants leaves and stems from *Kochia indica*, *Suaeda vera*, *Atriplex halimus*, *Tamarix mannifera*, *Halocnemum strobilaceum*, *Lygos raetam*, *Artemisia monosperma*, *Hammada elegans*, *Thymalaea hirsuta*, *Peganum harmala* and *Zygophyllum album* were evaluated for nutritive potential (chemical composition and degradability characteristics). Crude protein (CP), crude fiber (CF), ash, ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined (on dry matter basis). Mean values of CP, CF, EE, ash, NFE, NDF, ADF and ADL for shrub species tested were 9.8%, 23.23%, 2.95%, 22.71%, 41.53%, 50.07%, 32.65% and 10.46%, respectively. Crude protein content ranged from 5.9% (*Z.album*) to 20.0% (*P.harmala*). *Kochia indica* and *L.raetam* had moderate CP content 14.0% and 10.5%, respectively). *Zygophyllum album* had lowest NDF, ADF and ADL (30.2%, 18.3% and 3.5%), respectively comparable to *A. halimus* (63.5%, 43.9% and 13.8%), respectively.

The content of macrominerals such as phosphorus (P), sodium (Na), calcium (Ca) and potassium (K) was also determined. In addition, manganese (Mn), Zinc (Zn), copper (Cu), iron (Fe) and magnesium (Mg) were measured as microminerals content. The shrubs showed varied values of macro and micro minerals content.

In Vitro dry matter (DM) and organic matter (OM) degradability showed that *K. indica*, *S. vera* and *H. strobilaceum* had the highest values of DM and OM degradability (67.87% and 65.37%; 65.53% and 61.0%; 64.27% and 62.73%, respectively), compared with *Z. album*, *T. hirsuta* and *P. harmala* that had the lowest values (47.27% and 45.50%; 47.13% and 44.50%; 44.33 and 46.87%, respectively).

The secondary metabolites, which are considered anti-nutritional defenses against grazing animals such as saponins, alkaloids, flavonoids, sterols, tannins and coumarine were analyzed qualitatively and were expressed as an indicator to their presence in these plants. The results showed that the tested plants varied in their contents of anti-nutritional factors.

Keywords: Browse plants, Chemical composition, Degradability characteristics, Anti-nutritional factors.

INTRODUCTION

Egypt is classified as a semi-arid country since it is characterized by winter rain fall varies from less than 150 to 250mm year and dry summer. The irrigated valley represents 4% of its land while the rain fed desert represents 96%. In these desert regions halophytic plants often dominate, few of them plants are palatable (30% - 40%). Unpalatable halophytes are distribute and represent about 60% - 70% of natural rang land vegetation in Egyptian desert. These plants are resistant to salinity and drought conditions. The name halophyte does not designate a number of any particular taxon or any specific geographic or physiographic area. The word literally means "salt plant" and is used to referee to any plant that is capable of growing and

reproducing in areas subject to high salinity is somewhat subjective, but most people consider a salinity equivalent to about 0.5% NaCl in the soil water as a rough approximation of the lower of the salinity range. This corresponds to a concentration of around 85m M NaCl. Thus, it may appear easy to designate these plants that deserve the name halophyte (James and Edward, 1994).

Halophytes occupy important niches in many (particularly arid) ecosystems. This is due to the ease with which they adapt to many diverse and generally harsh environments (Chapman, 1974). Halophytic plants play a significant role in ruminant nutrition. Halophytes species because of their resistance to heat, drought, salinity, alkalinity, drifting sand, grazing and repeated cutting, are the major advantage during the dry season (Fagg and Stewart, 1994), However, due to the presence of secondary plant metabolites (particularly tannins) in halophytes, the utilization of protein and organic matter in these feeds is low (Waghorn and Shelton, 1997).

The object of the present study is to evaluate the chemical composition and degradability characteristics of some natural desert range plants.

MATERIALS AND METHODS

This study was conducted at the experimental farm and Laboratories of National Research Centre, Giza, Egypt.

Range plants naturally grown in with relatively high biomass in Sinai Peninsula, Nubaria desert and North Western Cost of Egypt were collected during the green season of each plant, chemically analyzed. Investigated plants were *Kochia indica*, *Suaeda vera*, *Atriplex halimus*, *Tamarix mannifera*, *Halocnemum strobilaceum*, *Lygos raetam*, *Artemisia monosperma*, *Hammada elegans*, *Thymalaea hirsuta*, *Peganum harmala* and *Zygophillum album*.

Samples of succulent parts (leaves and stems) of each plant were air dried separately on thin plastic sheet to avoid mechanical losses or sand contamination.

Proximate analysis and minerals were determined according to A.O.A.C. (1996) procedures. Goering and Van Soest (1970) methods were used to determine cell wall constituents (CWC).

In vitro DM and OM disappearance

In vitro dry matter (IVDMD) and organic matter (IVDMD) disappearance were determined for the halophytic plants according to Tilley and Terry (1963) modified by the method of Norris *et al.* (1976) in triplicate dried and ground samples. Animals were maintained on berseem hay (*Trifolium alexandrinum*) for a period of at least 3 weeks before collecting the rumen liquor. Hay was offered to animals at the rate of 150 % of maintenance requirements in two equal meals mainly at 08:00 a.m. and 17:00 p.m.

Qualitative phytochemical screening

The phytochemical screening of some secondary metabolites was carried out on the dried plants.

The experimental plants used in this study contained variable secondary metabolites according to their species. The results of qualitative analysis was expressed by (-, +, ++, +++) signs. The materials have (-) sign express nil values, while the (+, ++, +++) signs expressed the presence of these materials. The number of (+) signs detect the expected amounts of these materials.

Tannins

About 5g sample was extracted with diluted ethanol (50%) and filtered. To 5 ml of each extract, ferric chloride (T.S) was added. An olive green colour was developed in case of positive tannin (Wall *et al.*, 1954).

Saponins

Froth test: About 2.5 g sample of each material were extracted with boiling water. After cooling the extract was shaken vigorously until froth was obtained then allowed to stand for 15-20 minutes (No froth = negative (-), froth less than 1cm high = weakly positive (+), froth 1-2 cm high = positive (++) , froth greater than 2cm high = strongly positive (+++)) (Gihad *et al.*, 2003).

Alkaloids

The alcoholic extract of 2.5g plant material was concentrated, taken up with 0.5 ml 10% hydrochloric acid and filtrated. The filtrate was tested for presence of alkaloids using Mayer's and Wanger's reagents (Wall *et al.*, 1954).

Coumarins

About one gram sample of each plant material was placed in test tube covered with filter paper moistened with diluted sodium hydroxide. The tube was placed in a boiling water bath for few minutes. The filter paper was then removed and examined in UV light (Kingham and Evans, 1974).

Glycosides and/ or carbohydrates

About one gram sample of each material was separately extracted with 5 ml of ethanol (50 %). About 0.5 ml of alcoholic α -naphthol solution was added to each of the alcoholic extracts and sulfuric acid was carefully poured on the wall of test tube to form a separate lower layer. A violet zone was developed at the junction of the two liquids indicating the presence of carbohydrate and or glycosides (Vogel, 1956).

Unsaturated sterols and/ or triterpenes

The alcoholic extract of 1 g plant material of each sample was evaporated. Residue was treated with anhydrous chloroform (10 ml) and filtered. The filtrate was divided into 2 portions and tested by Libermann Burchardt and Salkowski's reactions (Schmidt, 1964).

Libarmann-Burchard test

To the first portion, 1ml of acetic anhydride was added followed by 2ml of H₂SO₄ down the walls of the test tube. Reddish-violet ring was produced at the junction of the two layers and then the solution become bluish-green in colour in the acetic layer, indicating the presence of unsaturated sterols and or triterpenes.

Salkowski's test

To the second portion one equal volume of sulfuric acid was added, a red colour was produced, indicating the presence of unsaturated sterols and or triterpenes (Schmidt, 1964).

Flavonoids (Shinoda test)

Five ml of alcoholic extract of each sample were treated with 0.5 ml of 10 % hydrochloric acid and magnesium turning (0.5 gm), (Willstatter, 1914). A red colour was observed in case positive flavonoids test.

RESULTS AND DISCUSSIONS

The approximated analysis of forage tests are presented in Table (1). The highest CP content was found in *P. harmala* (20%) followed by *K. indica* (14%). The other tested forages contained fluctuating values of CP which ranged between (5.9-10.5%) and the lowest content of CP was found with *Z. album* plant.

Table (1): Chemical composition of some shrubs grown in Egyptian desert (DM %).

Forage species	DM	CP	CF	EE	Ash	NFE
<i>Kochia indica</i>	31.6	14.0	30.2	2.8	15.1	37.9
<i>Suaeda vera</i>	31.8	8.5	29.5	1.5	20.9	39.6
<i>Atriplex halimus</i>	34.8	8.8	25.7	2.4	31.0	32.1
<i>Tamarix mannifera</i>	40.0	8.9	17.9	1.8	24.7	46.7
<i>Halocnemum strobilaceum</i>	55.0	6.5	14.5	2.5	39.4	37.1
<i>Lygos raetam</i>	61.56	10.5	37.9	2.5	14.4	34.7
<i>Artemisia monosperma</i>	48.5	8.7	16.9	6.3	18.6	49.5
<i>Hammada elegans</i>	24.1	7.8	16.5	3.9	24.6	47.2
<i>Thymalaea hirsuta</i>	42.6	8.2	30.4	4.4	8.2	48.8
<i>Peganum harmala</i>	34.1	20.0	16.9	2.1	19.5	41.5
<i>Zygophyllum album</i>	38.0	5.9	19.1	2.3	33.4	39.3

The herein results agreed with the findings of Wardeh *et al.*, (1990). They found that the preferred plant species of the desert range contained 8.54% to 14.89% crude protein such a high protein content would satisfy most of the protein requirement of consuming animals to performer their physiological functions.

The desert plants tested also contained fluctuation values of CF which ranged between 14.5% - 37.9%. The highest levels of CF were found with *I. raetam*, *T. hirsuta* and *k. indica* compared with *H. strobilaceum*, *H. elegans* and *A. monosperma*, which contain the lowest values.

These results agreed with that obtained by Gihad *et al.*, (2003), who found that the CF content of palatable, less palatable and unpalatable plants ranged between 14% - 33%.

The desert plants contain moderate values of EE, except *A. monosperma* which showed extremely high value (6.3%). The other tested forages showed fluctuating values of EE which ranged between (1.5% - 4.4%). The high EE contents of *A. monosperma* could be attributed to the high ratio of waxes and essential oils to true fats present in this plant (Wardeh, 1982).

The tested forages *T. hirsuta*, *L. raetam* and *k. indica* showed lowest values of ash content being 8.2%, 14.4 and 15.1%, respectively. Meanwhile, *H. strobilaceum*, *Z. album* and *A.halimus* showed highest ash content, being 39.4%, 33.4% and 31.0%, respectively. These high values of ash might be due to their high content of salt which could be predicted from the high Na and Cl content (Mohamed, 1996).

The cell wall constituents of different tested forages are illustrated in Table (2). The highest content of NDF were found with *A. halimus* and *k. indica* while the lowest content were recorded with *Z. album* and *H. elegans*. *A. halimus* and *L. raetam* showed also the highest values of ADF. The level of ADL content of tested forages ranged between 3.5-13.8%. these results were agreed with that obtained by Abd El-Rahman (2003).

Mineral Contents:

Table (2): Cell wall constituents of some shrubs grown in Egyptian desert (DM%).

Forage species	NDF	ADF	ADL
<i>Kochia indica</i>	62.8	39.4	12.0
<i>Suaeda vera</i>	52.7	33.9	13.5
<i>Atriplex halims</i>	63.5	43.9	13.8
<i>Tamarix mannifera</i>	47.7	31.2	12.1
<i>Halocnemum Strobilaceum</i>	61.8	32.9	10.3
<i>Lygos raetam</i>	53.3	42.5	11.6
<i>Artemisia monosperma</i>	42.0	33.9	10.8
<i>Hammada elegans</i>	36.6	18.6	7.1
<i>Thymalaea hirsuta</i>	58.9	35.0	12.3
<i>Peganum harmala</i>	41.3	29.6	8.1
<i>Zygophyllum album</i>	30.2	18.3	3.5

The macro and micro minerals content of the tested plants are shown in Table (3). All shrubs had Na concentration significantly different among species, however, *P. haramala* had the lowest value. While, *A. halimus*, *k. indica* and *H. strobilaceum* had the highest value of Na. Also, all halophytes had Ca concentration, *Z. album*, *T. mannifera* and *H. Strobilaceum* had varied the highest content, while *K. Indica* and *A. halimus* had the lowest contents.

Table (3): Macro and micro minerals content (%) in some browse species grown in Egyptian desert.

Item	P	Ca	Na	K	Mn	Zn	Cu	Fe	Mg
<i>Kochia indica</i>	0.12	0.76	4.77	2.35	0.23	0.11	0.04	0.04	0.30
<i>Suaeda vera</i>	0.10	1.60	2.03	1.69	0.22	0.09	0.03	0.03	1.61
<i>Atriplex halims</i>	0.14	0.81	4.03	2.41	0.19	0.08	0.03	0.02	0.46
<i>Tamarix mannifera</i>	0.11	2.19	3.27	0.88	0.50	0.05	0.02	0.05	1.47
<i>Halocnemum Strobilaceum</i>	0.08	2.16	4.16	1.55	0.13	0.02	0.10	0.13	0.48
<i>Lygos raetam</i>	0.14	0.76	0.19	1.27	0.15	0.01	0.03	0.02	0.27
<i>Artemisia monosperma</i>	0.22	1.15	1.09	2.00	0.12	0.04	0.08	0.03	0.25
<i>Hammada elegans</i>	0.08	1.10	3.79	1.20	1.11	0.08	0.04	0.06	0.70
<i>Thymalaea hirsuta</i>	0.07	1.48	2.28	1.09	0.91	0.06	0.03	0.34	0.32
<i>Peganum harmala</i>	0.15	1.20	0.18	1.95	0.19	0.03	0.03	0.53	0.43
<i>Zygophyllum album</i>	0.01	2.80	2.80	0.76	0.09	0.02	0.03	0.04	1.07

S. vera, *T. mannifera* and *Z. album* had the highest concentration of Mg, while, *L.raetam*, *A. monosperma* and *K.indica* had the lowest contents.

The high K content in evaluated shrubs could reduce Na absorption, because it has been reported that elevated dietary K may decrease ruminal concentration and absorption Na in ruminant animal (Ramirez *et al.*, 2001).

In this study, all evaluated shrubs had high K concentrations except *T. mannifera* and *Z. album*. Similar findings were reported by Ramirez *et al.*, (2001). Moya-Rodriguez *et al.*, (2002) and Carrilla-Soto *et al.* (2004) who evaluated K content in browse species growing in arid and semi-arid regions of the world.

Browse species had P concentrations that were different between species. *A. monospema* had the highest content. However, *Z. album*, *H. elegans* and *T. hirsuta* had the lowest contents. In this study, high Ca and low P content in shrubs resulted in an unusual wide range Ca: P ratios. However, it appears that browsing small ruminants can sustain these high ratios without being affected on the P metabolism (Ramirez, 1999).

All browse plants showed low Cu concentration. Low Cu levels are also reported in shrubs from semi-arid regions (Barnes *et al* 1990 and Ramirez – Orduna *et al.* 1998 and 2005).

All tested shrubs contained Fe levels in substantial amount to meet ruminant requirements. Similar findings were reported by Ramirez *et al.* (2001) and Carrilla- Soto *et al* (2004).

H. elegans and *T. hirsuta* had the highest Mn content and *Z. album* had the lowest content, it seems that all shrubs had fluctuating values of Mn. Exception of *K. indica*, all evaluated shrubs contained trace amount of Zn. These levels of Zn were substantial amount to meat ruminant requirements.

Table (4) showed the values of IVDMD and IVOMD of different plants. The results indicated that the highest values were obtained by *K. indica*, *S.vera* and *H.strobilaceum*, while, the lowest values were recorded with *P.harmala*, *T.hirsuta* and *Z. album*. The other shrubs recorded fluctuating values.

Table (4): In vitro DM and OM disappearance of some shrubs grown in Egyptian desert.

Item	IVDMD (%)	IVOMD (%)
<i>Kochia indica</i>	67.87	65.37
<i>Suaeda vera</i>	65.53	61.00
<i>Atriplex halims</i>	56.73	51.40
<i>Tamarix mannifera</i>	57.87	52.87
<i>Halocnemum Strobilaceum</i>	64.27	62.73
<i>Lygos raetam</i>	53.00	49.03
<i>Artemisia monosperma</i>	58.77	52.70
<i>Hammada elegans</i>	53.63	45.27
<i>Thymalaea hirsuta</i>	47.13	44.50
<i>Peganum harmala</i>	44.33	46.87
<i>Zygophillum album</i>	47.27	45.50

The low value of IVDMD and IVOMD may be attributed to high level of ADL and NDF or the high concentration of minerals of range plants. These results were agreed with that obtained by Allison and Osbourn (1970), who found that forage characteristics which may affect utilization of these plants are: the content of digestible CWC, the content of indigestible CWC, the structure of CWC and the concentration of ash in plants.

Results of phytochemical screening in Table (5) indicated that *H. elegans*, *L. raetam* and *P. harmala* contained highly intense at alkaloids, however, *K. indica*, *A. monosperma*, *T. mannifera* and *T. hirsuta* were free. Some of alkaloids have a bitter taste to animals and exhibit pharmaceutical action as well as forming drugs such as morphin, codin and atrobin. There were negative correlation exists between total alkaloid content and plants utilization (Marten, 1973).

Table (5): Phytochemical screening of some shrubs grown in Egyptian desert.

Items	Phytochemical Screening					
	Saponins	Alkaloids	Flavonoids	Sterols	Tannins	coumarins
<i>Kochia indica</i>	+	-	+	+	-	-
<i>Suaeda vera</i>	-	+	+	+	-	+
<i>Artemisia monosperma</i>	-	-	+++	+	-	++
<i>Hammada elegans</i>	+	+++	-	++	-	++
<i>Atriplex halims</i>	+	+	+	-	+	+
<i>Thymalaea hirsuta</i>	-	-	++	++	-	-
<i>Tamarix mannifera</i>	-	-	++	++	+++	+
<i>Halocnemum strobilaceum</i>	++	+	+	+	+	+
<i>Zygophillum album</i>	+++	+	++	+	+	-
<i>Lygos raetam</i>	-	+++	+	+	-	++
<i>Peganum harmala</i>	+	+++	+	+	-	-

+++ highly intense ++ moderately intense
 + slightly detected - non detected

Z.album, *T. hirsuta* and *T. mannifera* had a moderately intense of flavonoids. The flavonoids substances as whole are relatively harmless in nutrition, although they may contribute to bitter taste and some of them act as animal toxins.

The highest levels of saponins are showed in *Z.album* and *H. strobilaceum*, however most of evaluated shrubs had low levels. In ruminants, saponins were implicated in causing bloat and inhibit microbial fermentation and synthesis as well as formation calcium salt of saponins in and around the bile duct, also saponins have negative effect on growth rate in livestock (Price *et al.*, 1987).

The highly concentration of tannins was found in *T. mannifera*, however, most of tested shrubs had slightly or non detected tannins. Tannins reduce voluntary feed intake and reduce digestibility of protein and carbohydrate by inhibiting digestive enzymes and by altering the permeability of the gut wall (Reed *et al.*, 1990). Tannins may reduce bacterial enzymes and/ or forming indigestible complex with cell wall carbohydrates (Tanner *et al.*, 1990).

Conclusions

Feeding halophytes is a feasible solution to minimize the problem of feed shortage in developing countries, where desert represent high percentage of the total area. Therefore, proper range management and utilization of halophytes as an animal feed should have the priority of the development plane. Efforts have been directed to identify the most critical problems of livestock nutrition on native range lands and the prospects for better solution.

The present study suggested that the nutritive potential of tested halophytic plants varied from species to other. Moreover, the native range lands as the principle feed resources considerably fluctuate in biomass production; palatability and nutritive value from season to reason and from area to area due to many factors. The green biomass of halophytes may not sustain the nutritional requirements of animals, practically during dry season. Thus supplementary feeding should be practiced in an economic way. In this respect, it is recommended to improve the native range species as well as to cultivate some of high potential shrubs.

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القيمة الغذائية لبعض النباتات الرعوية التي تنمو تحت ظروف الصحراء المصرية
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أجريت هذه الدراسة في معامل قسم الإنتاج الحيواني بالمركز القومي للبحوث ووحدة الأغنام والماعز بمزرعة النوبارية والتابعة لقسم الإنتاج الحيواني. في هذه الدراسة تم تجميع السيقان والأوراق لبعض النباتات التي تنمو في بعض المناطق الصحراوية مثل شبه جزيرة سيناء والساحل الشمالي وكذلك صحراء النوبارية. والنباتات موضع الدراسة هي الكوخيا والسيويده والقطف المحلي والطرفه والحطب الحضادي والرتم والعدار والرمث والمنتان والحرمل والجلام. وكان الهدف من هذه الدراسة هو التقييم الغذائي لهذه النباتات من حيث التركيب الكيماوي ومكونات الألياف الخام والمحتوي المعدني الموجود في هذه النباتات وكذلك المواد المثبطة أو الضارة الموجودة فيها بالإضافة إلى تقدير معدل إختفاء المادة الجافة والمادة العضوية معمليا. وأظهرت النتائج أن متوسط المحتوى من البروتين الخام والألياف الخام ومستخلص الإثير والرماد ومستخلص خالي الأزوت , ADL, ADF, NDF لهذه الشجيرات هو ٩,٨٠% و ٢٣,٢٣% , ٢,٩٥% , ٢٢,٧١% , ٤١,٥٣% , ٥٠,٠٧% , ٣٢,٦٥% , ١٠,٤٦% على الترتيب.

كذلك وجد أن نسبة البروتين الخام كانت متفاوتة في قيمتها حيث تراوحت من ٥,٩٠% في نبات الجلام إلى ٢٠,٠٠% في نبات الحرمل. وكذلك إحتوي نبات الكوخيا ونبات الرتم على قيم معتدلة من البروتين الخام ١٤,٠% و ١٠,٥% على الترتيب أما بالنسبة لمكونات جدر الخلايا فإحتوي نبات الجلام على أقل قيم لكل من ADL, ADF, NDF (٣٠,٢٠% و ١٨,٣٠% و ٣,٥٠%) على الترتيب بالمقارنة بنبات القطف المحلي الذي إحتوي على أعلى قيم (٦٣,٥٠% و ٤٣,٩٠% و ١٣,٨٠%) على الترتيب.

كذلك تم دراسة محتوى هذه النباتات من بعض العناصر المعدنية الكبرى مثل الفوسفور والصدوديوم والكالسيوم واليوتاسيوم وكذلك العناصر الصغرى مثل المنجنيز والزنك والنحاس والحديد والمغنسيوم وأظهرت الدراسة إحتواء هذه النباتات على قيم مختلفة ومتفاوتة من العناصر المعدنية الكبرى والصغرى. على الجانب الآخر تم دراسة معدل إختفاء المادة الجافة والمادة العضوية معمليا حيث أظهرت النتائج أن معدل هدم المادة الجافة والمادة العضوية كان أعلى في نباتات الكوخيا والسيويده والحطب الحضادي ٦٧,٨٧% و ٦٥,٣٧% - ٦٥,٥٣% و ٦١,٠% - ٦٤,٢٧% و ٧٣,٦٢% على الترتيب، وذلك بالمقارنة بنبات الجلام والمنتان والحرمل التي أعطت أقل قيم ٤٧,٢٧% و ٤٥,٥٠% - ٤٧,١٣% و ٤٤,٥٠% - ٤٤,٣٣% و ٤٦,٨٧% على الترتيب.

كذلك تم في هذه الدراسة التقدير الوصفي للمواد الضارة أو المثبطة في هذه النباتات مثل الصابونين والفلويدات والفلافونيدات والأستيرولات والتانين والكومارين. حيث تبين محتوى النباتات تحت الدراسة من هذه المواد، فقد ارتفع محتوى نباتات الرمث والرتم والحرمل من الفلويدات، بينما ارتفع محتوى نبات الطرفه من التانين، وكان نبات الجلام أكثر النباتات احتواءا على الصابونين.