Nutritive value of the common grazing plants and their potential asforage resources in the Saudi Arabia eastern

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ABSTRACT

Most of the rangelands in the Kingdom of Saudi Arabia are located in marginal ecosystems with low rainfall and high aridity index. Under these conditions, highly drought and salinity resistance perennial rangeland plant species play an important role in the sustainable livestock production which is highly depending on the nutritive value of the available forage. This study was conducted to evaluate the nutritive value of the common rangeland plants and to assess their potential utilization as livestock feed in the eastern region of Saudi Arabia. Twenty-two Rangel and plants (grasses, forb sand shrubs) were surveyed and collected from the study area. Proximate analysis of the common rangelands plants naturally growing on the study area indicated that rangeland plants contained 15.1 – 49.6 % of their fresh weight as dry matter. (DM) Ash, crude protein, crude fiber, organic matter, ether extract contents on dry matter basis in these plants ranged from 7.9 to 43.8, 5.4 to 15.4, 5.1 to 38.5, 3.4 to 7.9 %, and 56.2 to 94.5%, respectively. The neutral detergent fibers (NDF), acid detergent fiber (ADF) and Lignin contents (DM %) of the examined plants in this study were ranged from 16.3 to 70.4, 10.2 to 44.3, and 2.7 to 10.9%, respectively. Those plants also contained 0.058 to 1.341, 0.153 to 1.384, 0.92 to 10.283 and 0 to 4.2% tannis, nitrates, saponins and oxalates, respectively. Digestion coefficients for DM, ash, OM, crude protein (CP) and ADF% ranged from 22.7 to 75.7, 2.9 to 82.9, 18.4 to 88.1, 26.7 to 76.4, and 11.9 to 51.4 % in that order. In general, the obtained results indicated that most of the evaluated rangeland plants have good nutritive value and represent major livestock forage resources, and they might be cultivated using brackish and saline waters. Also, they are valuable plant resources for cultivation using seawater or a mixture of seawater and fresh water.

Key wards: Grazing plants, Halophytes, crude fiber, lignin, crude protein, Saudi Arabia.

INTRODUCTION

Rangelands are multifunctional resources that provide feed for livestock and wildlife, food for people and other services such as wood for fuel, medicinal plants, soil and watershed protection, recreation and leisure (Hadri and Guellouz, 2011). In Saudi Arabia, rangelands cover an area of 170 million ha which represents about 76 % of the country area, and they provide the largest and least costly portion of the feed needed for domesticated livestock and wild animals and play an important role in the development of livestock production. Rangeland survey of the eastern Saudi Arabia region conducted by Al-Saud *et al.* (2007) indicated that 56 % of the rangelands in the region were in deteriorated condition and 27 % of the area was in poor condition. There was also a shift in plant species composition from palatable to unpalatable and declines in plant productivity of forage plants. These changes would also imply changes in the nutritive value of the rangeland plants. Herbaceous, grasses, and shrub species play an important role in livestock feeding in arid and semi-arid regions. Voluntary consumption and nutrient digestibility are the main determinants of plant fodder value (Mason and Shellford, 1990). These two factors are interrelated and cannot be discussed separately, and they are both influenced by animal and plant characteristics factors (Sanderson *et al.*, 1989).

Physical and chemical plant characteristics are closely related to the degree of palatability, optional consumption and nutrient digestion rates in ruminants (Minson, 1982 and VanSoest, 1965, Buxton and Harnstein, 1986 and Cohen *et al.*, 1989). It has been recognized that the feed value of a plant could be predicted using one or more of the plant characteristics including, 1) nature and percentages of plant cell nutrients contents and their soluble sugars as well as nitrogenous compounds and organic and inorganic (ash / salts) contents; 2) nature and percentages of plant cell wall components of fiber especially (NDF), (ADF) and lignin 3) the presence / absence of anti-nutritional factors content in plant cell such as tannins, nitrates and saponins (Majak *et al.* ,1980, Metrens and Ely,1982 and Basden and Dalvi,1987).

VanSoet and Wine (1967) and Obsourn, *et al.* (1974) found negative relationship between the feed content of the fibers and the digestibility of these feeds in the animal rumen and the degree of palatability of the ration by the animal. They also found that the nitrogen level of 1.44% in the feed represented the minimum for the survival and activity of the rumen microbes and consequently the degree of palatability and digestibility rates (Anninkov, 1982). Mertens and Ely (1982) suggested that the amount of NDF in the plant could be used as an indicator to measure the feed intake into the rumen when ingested. They considered that the level of 35% (NDF) in the dry ration motivates the animal consumption of this feed and that the high percentage of NDF above this level (35%) inhibits the animal consumption of the feed and thus need another one before it can eat the right amount to meet the body needs. They also found that the plant content of crude protein and acid fiber (ADF) could be used as an indicator of the degree of palatability of the feed. It was noted that plants containing less than 7-9% crude protein or more than 25% (ADF) are plants low in palatability and digestibility. Zimmer and Wirck (1986) also observed that feed levels of lignin could be used very efficiently to predict the feed nutrient digestibility.

Several studies have been conducted to evaluate the nutritive value of forage plants. Hassan *et al.* (1979), Pasternak *et al.* (1985), Ariel *et al* (1989) and El-Shaer *et al.* (1995) studied the nutrients and components of the *Atriplex* cell wall and found that these shrubs were high in crude protein, neutral fiber (NDF), lignin and mineral contents and found that it is very poor in sugars and digestible energy. El-Shaer *et al.* (1998) showed that the *Atriplex* feed contains high percentages of crude protein, ash and crude fiber, while it was poor in energy content and concluded that the degree of palatability of this saline shrub could be improved when added to other high-energy feeds such as barley and maize.

Swingle *et al*. (1992) suggests that halophytes feed can be successfully used in mixed rations in proportions related to their ash, energy and crude fiber contents. Wilson *et al*. (1995) indicated that the palatability of halophytes is generally low and their digestion rates are moderate, although their crude protein contents were somewhat high. Swingle *et al.* (1992) studied the effect of mixing *Atriplex*, *Suaeda* and *Salicornia* in traditional rations (cotton and barley) by 30% and found that the consumption of the feed mixtures was higher than that of Cynodon mixed with traditional feeds.

Badri and Hamed (2000) reported that *Tamarix arabica* is the main breeding vegetation cover for grazing animals because of its high fodder content represented by high protein and carbohydrate content. The result of the chemical analysis showed that Tamarix *arabica* contained 9.4% crude protein, 23.13 % ash, and 10.07% crude fiber. Al-Zaid *et al.* (2004) evaluated the production status of the naturally growing *Panicum turgidum* plant in the eastern rangelands of Saudi Arabia. They showed that the dry fodder yield was 57 kg / ha and that the fodder value of the plant species was moderate. The ADF content was 65.4% and lignin content was 11.7%. These values indicated a relative reduction in the fodder value as compared to crops *Medicago sativa* and Rhodes grass (*Chloris gayana*).

Knowledge of the nutritional dynamics of rangeland forage species is important to sustain satisfactory growth and reproduction of livestock without deterioration of rangeland (Ganskopp and Bohnert, 2001). Also information regarding plant nutrient levels is a starting point for exploring its forage value as it provides first-hand and basic indicators of its potential forage and dietary potential. These include dry matter, ash, organic matter, crude protein, crude fiber and ether extract. The quality of halophytes as animal feed is the main determinant of their potentiality to meet the needed animal demands for growth and production. The dietary qualities of halophytes as animal feed differ greatly among plant species. Analysing halophytes for their nutrient content can determine their feeding quality and whether they can adequately meet the animal demands or whether other feed ingredients should have been supplemented in order to supply the animal dietary demands. The main characteristics that influence animal feed quality include nutrient contents as well as the presence of anti-nutritional factors. Plants contain approximately 24,000 of secondary compounds that are not an integral part of the plant and may arise in response to environnemental stresses variables such as salinity, drought, heat, frost, pest, diseases and other competing herbs (Harborne, 1993). Knowledge of the contents of forage plants of antinutritional factors is an important step in determining the fodder value of these unconventional plants. Hence, this study was conducted to determine the nutritive value and anti-nutritional factors of the common native rangeland plant species in the eastern region of Saudi Arabia and to evaluate their utilization as animal feed resources.

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MATERIALS AND METHODS

The study area

This study was conducted in the eastern region of Saudi Arabia. Long term average of relative humidity, annual temperature, and annual rainfall were 82.2%,21.5^{o}C, and104.0 mm, respectively. The mean elevation of the study area was 725 m above sea level.

Chemical composition and nutritive values:

Rangelands plant survey was implemented in the communal grazing areas of the region. The common plant species were cut 10 cm above ground and the fresh weight per plant was measured immediately. A representative sub-sample (0.5 kg) of the cut material was dried at 70^{o}C in an oven for 48 h and dry yields per plant were weighted, then ground with a Wiley mill to pass a 1 mm screen and analyzed for nutrients content. All analyses were carried out on triplicate samples. The Nitrogen content of the rangelands plant species was determined by the Kjeldahl Method (AOAC 1997) and crude protein by multiplying N with 6.25. NDF, ADF and ADL were determined using the procedure described by Van Soest (1965). Dry matter digestibility of plants was estimated using Sheaffer *et al.* (1995) procedures by using ADF results: DMD% = 88.9- (0.779 x ADF%). Dry matter digestibility values were used to estimate digestible energy using the regression equation reported by Fonnesbeck *et al*. (1984): DE (Mcal/kg) = 0.27 + 0.0428 x DMD%. Then digestible energy values were converted to ME using the formula reported by Khalil *et al.* (1986): ME (Mcal/kg) = 0.821 x DE (Mcal/kg).

Anti-nutritional factors analysis

Total polyphenols concentration in the samples was determined by Basden and Dalvi (1987). Saponins were determined using the Majak *et al.* (1980) method. Oxalates in the samples were determined using the titration method. Then the oxalate content of each sample was calculated in accordance to Munro and Bassiro (2000). Nitrates in plant samples were determined using Kenny and Nelson (1980) method.

Statistical analysis:

The results were subjected to one-way analysis of variance using MP 5.1 software (JMP, A Business Unit of SAS, Cary, NC, 2003). There were no significant differences between years. Therefore, the data from the two years were pooled. Differences between individual means were evaluated by LSD test at the 0.05 significance level.

RESULTS AND DISCUSSION

Dry matter content

Data presented in Table 1 show the arithmetic mean and the standard deviation of the dry matter of the common rangeland's plants surveyed in the study area. There was some variation in among the sampled plant species in the dry matter and it ranged from 15.1% to 49.6%. Rangeland plants with low dry matter content of less than 25 % included *Suaeda vermiculata, Salsola brynosa, Seidlitzia rosmarinus, Calligonum comosum, and Halocnemum strobilaceum*. Thirteen other plant species were of intermediate dry matter that ranged from 25 to 40 %. Four plant species that are annual and perennial grasses had high dry mater content of more than 40 % and included *Eragrostis barrelieri, Panicum turgidum, Aeluropus lagopoides*, and *Pennisetum divisum*.

The percentage of dry matter in fresh samples of the studied plant species ranged between 15.1% and 49.8%. This means that the water content of these plants (moisture) ranged between 51.2% and 84.9% of the weight of the aerial parts that can be eaten by animals in the pasture. These plant species contained some real salt tolerant species like *Seidlitzia rosmarinus*, *Salsola baryosma* and *Suaeda vermiculata*. These plants had the lowest percentage of dry matter (16.3%) and therefore the highest percentage of moisture (83.5%) due to the use of these species to a mechanism of raising their succulence as a means to alleviate the toxic effect of salinity in their environments (Al-Khateeb 1997). The drought tolerant saline species such as *Panicum turgidum*, *Eragrostis barrelieri* and *Aeluropus lagopoides* had the highest dry matter levels (45.5%) and the lowest moisture content (52.5%).

Ash content

Table 1 shows the ash content of the different plant species that could be classified into four groups according to their ash content %. The first group is the least in its ash content as the mean ash content is not more than

(8.5%) and included *Cyperus conglomerates, Calligonum comosum, Eragrostis barrelieri, Lasiurus scindicus, Leptadenia pyrotechnica, Panicum turgidum, Pennisetum divisum* and *Rhanterium epapposum*. The second group had mean ash content of 19.6% and included Haloxylon *salicornicum, Haloxylon persicum Lycium shawii, Heliotropium bacciferum* and *Tamarix arabica*. The third group had mean ash content of 35.4%. This group included *Zygophyllum coccineum, Seidlitzia rosmarinus,Anabasis setifera*, Suaeda *vermiculata,* and *Atriplex halimus.* The last group had mean ash content of 42.6% and it included *Arthrocnemum macrostachyum, Aeluropus lagopoides,Halocnemum strobilaceum* and *Salsola baryosma*.

Results of this study indicated that *Salsola baryosma, Seidlitzia rosmarinus, Suaeda vermiculata, Zygophyllum coccineum* and *Aeluropus lagopoides* contained 5.9%, 6.6%, 5.3%, 9.2% and 21.3% ash respectively and 43.6%, 35.2%, 36.8%, 35.5%, and 42.9% of dry matter, respectively in their pastoral green matter state. Thus, the dilution may make green saline plants more acceptable to animals than if it was used as hay. Water trapped inside plant cells is an important source of watering and cooling for animals grazing in dry desert areas, especially in hot seasons. Bergen (1972) and Warner and Stacy (1968) found that water contained in feed plays an important role in controlling osmotic levels of the rumen content in ruminants that graze green plants. Mir *et al* (1990) noted that the saturation of saline plants with water is an obstacle to their drying and conservation as hay after harvesting. In this study, we found it was very difficult to dry samples of some salt plants and we did not succeed until we used electric fans for ventilation throughout the drying period under shade.

It is clear from the results of this study that there were great variations in the plant species ash and organic matter content, ash ranged between 7.8% in *Cyperus conglomeratus* and 43.8% in *Salsola baryosma* and this was consistent with the results of Glenn *et al.* (1999). The ash content ranged between 15.0% and 50.0%. It should be noted that saline plants generally accumulate salts as a means of resisting the effects of salinity for the purpose of osmotic control of their cells and thus their ability to absorb water from their reclaimed environments (Flowers and Yeo 1986). As a result, there was an increase in the level of ash in all species with increasing salinity. It should be noted that the saline vesicles present in *A. halimus* are particularly effective in expelling salts outside plant tissues if they exceed the level that the plant could tolerate. Al-khateeb (1997) noted that *Atriplex halimus* excrete approximately 50% of the Na salts through these vesicles. The accumulation of salts in the studied halophytes negatively affected their organic matter content, so they were energy-poor plants (Le Houreoru, 1993).

Organic matter content

Data presented in Table 1 show the arithmetic mean ± standard deviation of the organic matter content estimated in the different plant species present in the study area. Different plant species could be divided into four groups depending on the level of their organic matter content. The first group had the highest organic matter %, with an average of 91.4% and included eight plant species that had the lowest percentage of ash which were *Cyperus conglomerates, Calligonum comosum, Eragrostis barrelieri, Lasiurus scindicus, Leptadenia pyrotechnica, Panicum turgidum, Pennisetum divisum* and *Rhanterium epapposum*. The second group had mean of organic matter content of 80.6% and included *Haloxylon salicornicum, Haloxylon persicum, Lycium shawii, Heliotropium bacciferum* and *Tamarix arabica*. The third group had mean of the organic matter content of 64.6% and included *Suaeda vermiculata, Seidlitzia rosmarinus, Anabasis setifera, Zygophyllum coccineum* and *Atriplex halimus*. The fourth group had the least amount of organic matter with an average of 57.4%, and included *Salsola baryosma, Aeluropus lagopoides, Arthrocnemum macrostachyum* and *Halocnemum strobilaceum*.

The results indicated that the true halophytes such as Zygophyllum *coccineum, Seidlitzia rosmarinus, Anabasis setifera, Suaeda vermiculata, Arthrocnemum macrostachyum, Aeluropus lagopoides, Halocnemum strobilaceum* and *Salsola baryosma* which were high in ash content (35.2– 43.8 %) and low in their organic matter content (56.2 - 64.8%) are less favoured by camels. The results also show that camels preferred xerophytes such as *Haloxylon persicum, Haloxylon salicornicum, Lycium shawii* and *Tamarix arabica* that contain relatively moderate levels of ash (15.1 - 30.0%) and organic matter (50.0 - 83.9%). The camel's preferred xerophytes, such as *Cyperus conglomeratus, Panicum turgidum, Eragrostis barrelieri, Pennisetum divisum, Lasiurus scindicus* and others such as *Rhanterium eppaposum* and *Calligonum comosum*, etc., that had the lowest ash content (5.8 - 10.4%) and the highest organic matter content (89.6- 92.2%) which were similar to their levels in traditional filler diets. It seems that camels do not like species that contain more than 35% ash and consume plant species that contain less than 30% ash.

Crude protein

Table 1 shows the arithmetic mean and standard deviation of crude protein in the different studied plant species surveyed in the area. Based on the crude protein content rangelands plant species could be divided into three groups. The first group contained enough or more than enough crude protein to feed ruminants, the crude content of this group ranged between 10.4% and 15.4% with an average of 12.5% and included the range shrubs *Arthrocnemum macrostachyum*, *Atriplex halimus*, *Haloxylon persicum*, *Haloxylon salicornicum*, *Lycium shawii*, *Salsola baryosma*, *Seidlitzia rosmarinus* and *Suaeda vermiculata*. The second group had a mean crude protein content of 8.8% and its crude protein content ranged from 8.4% to 9.8% and included *Panicum turgidum*, *Heliotropium bacciferum*, *Leptadenia pyrotechnica*, *Calligonum comosum*, *Halocnemum strobilaceum*, *Pennisetum divisum*, *Tamarix arabica*, *Zygophyllum coccineum* and *Rhanterium eppaposum*. The third group contained a small percentage of crude protein, which is insufficient for ruminant feed with a mean content of 5.7% and ranged from 5.4% to 7.8%. This group included *Cyperus conglomerates*, *Anabasis setifera*, *Eragrostis barrelieri*, *Lasiurus scindicus* and *Aeluropus lagopoides*.

In the sampled saline plant communities, the crude protein (CP) content ranged from 5.4% in *Aeluropus lagopoides* to 15.4% in *Arthrocnemum macrostachyum*. Hay and agricultural residues as stated by Perry *et al* (1999) contain between 2.0-6.0% and 6–13% on mean basis in cultivated cereal forages. Bean forage branes contain 14.0-20.0% of the raw protein in dry matter. The crude protein level of the legume plant species tested in this study falls within the range (4.0 - 22.0%) for salt plants found by Glenn *et al* (1999) in USA. The level of crude protein in the plants recorded in this study is similar to that of traditional cultivated forage cultivars. It was also similar to that reported by Mureillo *et al.* (1987) in *Suaeda vermiculata* hay, by Cohen *et al.* (1989) and Mir *et al.* (1990) in the hay of *Kochia spp* and Riley *et al* (1992) and Le Houerou (1995) in hay of a variety of true halophyte plants.

According to the aforementioned literature and to the results of this study it can be said that the crude protein levels ranged from 10.4 to 15.4% in *Arthrocnemum macrostachyum, Atriplex halimus, Haloxylon persicum, Haloxylon salicornicum, Lycium shawii, Salsola baryosma, Seidlitzia rosmarinus* and *Suaeda fruticosa* hay is sufficient for the survival of rangeland animals in addition to low production levels without the need for any treatments or the use of supplementary protein feed, it can also be said that *Cyperus conglomeratus* and *Anabasis setifera* and *Aeluropus lagopoides* and *Lasiurus scindicus* in addition to *Eragrostis barrelieri* hay is poor in its crude protein contents (5.4 - 5.8 %).This level may not be sufficient to meet rumen microbes needs of nitrogen required for their survival and activity as well as meeting the needs of animal cells. The use of such types of diets to feed ruminants requires chemical treatments to increase the level of crude protein (Non-Protein Nitrogen) or provide supplementary protein ration. The rest of the tested plant species in this study can be found to contain critical levels of crude protein (8.4 - 9.8%) sufficient and may be more than required to meet the needs of rumen microbes, but the willingness of ruminants to such rations may not be enough and thus complementary rations might be important if not especially necessary for ruminant's productivity.

Crude Fiber

Table 1 shows the mean and standard deviation of crude fiber content of the plant species in the study area. According to the crude fiber content of the range species, plants were category zed into four distinct groups. The first group contained the lowest crude fiber contents with an average of 7.8% and included *Anabasis setifera*, *Arthrocnemum macrostachyum*, *Halocnemum strobilaceum*, *Salsola baryosma*, *Suaeda vermiculata*, *Seidlitzia rosmarinus* and *Zygophyllum coccineum*. The second group had an average of crude fiber content of 15.5%. The crude fiber content for this group ranged from 13.4% to 17.8%, and it included *Calligonum comosum*, *Atriplex halimus*, *Haloxylon persicum*, *Haloxylon salicornicum*, *Aeluropus lagopoides* and *Tamarix arabica*. The third group had mean crude fiber content of 24.4 % on dry matter basis, and it included *Heliotropium bacciferum*, *Lycium shawii,Rhanterium eppaposum,Cyperus conglomerates*, and *Lasiures scindicus*. The last group with the highest crude fiber content had a mean of 37.1% and ranged from35.9 to38.5%, and included *Leptadenia pyrotechnica*, *Eragrostis barrelieri*, *Panicum turgidum* and *Pennisetum divisum*.

Crude fiber levels ranged from 5.1% in *Arthrocnemum macrostachyum* to 38.5% in *Eragrostis barrelieri*. By comparing the results of this study with the results obtained by Abdallah *et al.* (1995). It was clear that the crude fiber levels obtained in the different plant communities tested in their study were higher except for *Haloxylon persicum, Atriplex halimus, Pennisetum divisum, Lycium shawii* and *Zygophyllum coccineum*, which had similar crude fiber content as shown io our results. The levels obtained in this study were similar to those observed by Al-Ani *et al.* (1971b) in the hay of *Atriplex halimus, Haloxylon salicornicum, Salsola baryosma* and*Zygophyllum coccineum*. The observed increase of crude fiber levels in the hay of *Cyperus conglomeratus, Lasiurus scindicus, Leptadenia pyrotechnica, Panicum turgidum, Pennisetum divisum* and *Lycium shawii* may be due to the small size, small number of leaves, roughness and thick stems of these species. The lower crude fiber level in *Arthrocnemum macrostachyum, Salsola baryosma, Seidlitzia rosmarinus, Suaeda fruticosa* and *Zygophyllum coccineum* may be attributed to the large size and number of leaves, the tenderness and thin stems and the high level of ash in their dry matter.

American standards as described by Perry *et al* (1999) filler forages are defined as those containing dry matter content of about 18% or more crude fibers. Concentrated feeds are defined as those containing less than 18% crude fibers. According to this definition and the crude fiber levels detected in this study (Table 1). The hays of *Cyperus conglomeratus* (25.2%), Eragrostis *barrelieri* (38.5%), *Heliotropium bacciferum* (18.3%), *Lasiurus scindicus* (30.8%), *Leptadenia pyrotechnica* (35.9%), *Lycium shawii* (22.1%), *Panicum turgidum* (35.3%), *Pennisetum divisum* (36.6%), *Rhanterium eppaposum* (23.6%) were qualified to be fodder fillers. These specifications describe fillers feeds as those which have crude fiber percentages of more than 34.0% and they were considered poor forages, such as the hay and residues of agricultural crops, and therefore, most of the species mentioned above can be considered poor rations.

Dulphy *et al* (1980) reported that increasing the crude fiber level above 34.0% in hays by one percentage reduces its consumption and grazing period for sheep by about 38 g of the dry matter and 4.1 minutes, respectively. This will also increase the rumination period by 6.1 minutes. According to these specifications, the hays of *Atriplex halimus* (16.5%), *Haloxylon salicornicum* (16.8%), *Tamarix arabica* (13.5%), *Calligonum comosum* (14.4%) and *Zygophyllum coccineum* (11.3%) were qualified to be used as concentrated feed with a relatively high content of crude fiber. The true halophytes such as *Arthrocnemum macrostachyum* (5.1%), *Suaeda fruticosa* (8.9%), *Seidlitzia rosmarinus* (6.5%), *Salsola baryosma* (5.9%) and *Halocnemum strobilaceum* (5.8%) were qualified to be used as concentrated feed with low crude fiber content. The use of such feed in ruminants feeds will result in their soft stool, incidences of diarrhea and low fat content in the milk. However, such real halophytes can be used as a softener for crude fiber levels in poor coarse feed such as crop residues and can be used as an ingredient in salt licks.

Ether extract

Table 1 shows that the ether extracts content range was very narrow as compared to the other nutrients reviewed earlier and the ether extract ranged between 3.4 and 5.9%. However, the studied plant species could be classified only into two main groups. The first group had an average ether extract of 4.6% and the members of this group had ether extract contents ranging between 3.4 and 5.4%. It included *Atriplex halimus*, *Calligonum comosum*, *Heliotropium bacciferum*, *Lycium shawii*, *Rhanterium eppaposum*, *Seidlitzia rosmarinus*and *Tamarix arabica*. The second group had mean ether extract content of 6.5% and ranged from 5.6 to 7.9%. It included Anabasis *setifera*, *Cyperus conglomerates*, *Aeluropus lagopoides*, *Eragrostis barrelieri*, *Haloxylon persicum*, *Haloxylon salicornicum*, *Lasiures scindicus*, *Leptadenia pyrotechnica*, *Panicum turgidum*, *Pennisetum divisum*, *Halocnemum strobilaceum*, *Salsola baryosma*, *Suaeda vermiculata* and *Zygophyllum coccineum*.

The ether extract in the studied halophytes which ranged from 3.4% to 6.7%, recorded that data were not significantly different from that obtained by Perry *et al* (1999) for traditional filler forages, but were significantly higher than that reported by Abdallah *et al* (1995) for eight pastoral halophytes tested in their study. Their data for the ether extract in *Panicum turgidum,Pennisetum divisum* and *Lycium shawii* were comparable to our data for this study. It is well known that the ether extract contributes in doubling (X 2.25) the potential energy (PE) content of the feed. Therefore, it is possible to say that *Aeluropus lagopoides* (5.9%), *Halocnemum strobilaceum* (5.1%), *Haloxylon persicum* (6.5%), *Haloxylon salicornicum* (6.4%), *Salsola baryosma* (6.4%), *Zygophyllum coccineum* (6.3%), *Suaeda fruticosa* (6.1%), *Lasiurus scindicus* (6.0%), *Eragrostis barrelieri* (5.9%), *Cyperus conglomeratus* (5.6%) and *Panicum turgidum* (5.6%) had more potential energy in organic matter than other species, that qualify them to participate in providing ruminants with their energy demands.

Analysis of cell wall components

Samples of the plant species collected from different sites in the study area were analyzed for the following cell wall components: neutral detergent fibers, acid detergent fibers and lignin.

Neutral detergent fibers

Table (2) shows the mean ± standard deviation of cell wall contents of neutral detergent fibers (NDF) in the rangelands and halophytes plants present in the study area. Plant species have been divided into four groups based on their content of NDF. The first group had the lowest content of NDF with a mean of 15.9% and included *Zygophyllum coccineum* and *Anabasis setifera* .The second group had a mean NDF content of 24.8% and ranged from 20.9% to 29.3% on dry matter basis. It included *Seidlitzia rosmarinus, Halocnemum strobilaceum, Salsola baryosma,Tamarix Arabica, Arthrocnemum macrostachyum, Suaeda vermiculata* and *Calligonum comosum.* The third group had a mean NDF content of 35.4± 3.48% on dry matter basis and the least content of 30.4% NDF in this group was recorded by *Haloxylon persicum*. The highest NDF content of 38.4 % was recorded by *Haloxylon salicornicum*, while the rest of plant species in this group were *Lyciumshawi* and *Atriplexhalimus* that had 36.9% and 35.5% NDF contents, respectively. The last group comprised nine species and had a mean NDF of 58.5 ± 10.54%. Therefore, it is the richest group in neutral detergent fibers, and included *Cyperus conglomerates*, *Aeluropus lagopoides*, *Eragrostis barrelieri*, *Heliotropium bacciferum*, *Lasiures scindicus*, *Leptadenia pyrotechnica*, *Panicum turgidum*, *Rhanterium eppaposum* and *Pennisetum divisum*.

Results in Table (2) show that the level of neutral fiber (NDF) in the tested plant species ranged from 16.3% to 69.2% on dry matter basis. The data recorded for *Cyperus conglomeratus*, *Pennisetum divisum*, Rhanterium *eppaposum* and *Zygophyllum coccineum* were in agreement with those recorded by Abdallah *et al* (1995) in the southern United Arab Emirates. Van Soest (1965) found that the amount consumed by ruminants from the neutral fibers was quantitatively constant and was estimated by Mertens (1983) as 11 g / kg live weight. Mertens and Ely (1982) and Perry *et al.* (1999) indicated that the minimum neutral fiber in filler feeds should be at least 28-35% on dry matter basis to avoid malfunction and digestion functions of the rumen.

The decrease in neutral fiber content (Table 2) in the Lesser palatable true halophytes such as *Anabasis setifera*, *Salsola baryosma*, *Seidlitzia rosmarinus* and *Zygophyllum coccineum* as well as the hay of *Tamarix arabica* would not make them suitable as filler forages as they cause rumin malfunctioning and reduce milk fat contents if provided for milking or lactating ruminants. Hays of the most palatable grass species, such as *Aeluropuslagopoides*, *Cyperus conglomeratus*, *Eragrostis barrelieri*, *Lasiurus scindicus*, *Leptadenia pyrotechnica*, *Panicumturgidum* and *Pennisetumdivisum* contain high levels of neutral fibers that may limit their consumption enough to meet the animal energy needs.The results shown in Table (1) suggest that the hays of *Haloxylonpersicum*, *Haloxylonsalicornicum*, *Halocnemumstrobilaceum*, *Rhanteriumeppaposum*, *Lycium shawii*, *Atriplex halimus*, *Heliotropiumbacciferum*, *Calligonumcomosum*, and *Arthrocnemum macrostachyum* are situable in terms of the natural fiber levels as these levels would not affect the consumption or digestion of nutrients rate, including energy of these plant species.

Acid detergent fiber

Table 2 shows the acid detergent fiber (ADF) mean content of the different plant species surveyed in the study area. Range plants and halophytes species had been classified into four groups depending on their ADF content. The first group was the poorest group in ADF with a mean content of 13.5 ± 2.40%, but it had the most numerous with nine species including *Anabasissetifera*, *Arthrocnemum macrostachyum*, *Calligonum comosum*, *Haloxylon persicum*, *Halocnemum strobilaceum*, *Salsola baryosma*, *Seidlitzia rosmarinus*, *Suaeda vermiculata* and*Zygophyllum coccineum*. The second group was the second least group in the ADF content with a mean content of 22.3 ± 1.26%, and it included *Lycium shawi*, *Atriplex halimus*, *Aeluropus lagopoides* , *TamarixArabica* and *Haloxylon persicum*. The third group had a mean ADF content of 36.5 ± 2.12% on dry matter basis, and it included *Cyperus conglomerates*, *Eragrostis barrelieri*, *Lasiures scindicus*, *Panicum turgidum*, *Pennisetum divisum*, *Heliotropium bacciferum*. The fourth group was the most favoured group in ADF with a mean of 42.5 ± 2.33% on dry matter basis. It included *Leptadenia pyrotechnica* and *Rhanterium epapposum*.

ADF are often composed of cellulose and lignin, which are slow and indigestible (Minson, 1982). It turns out that the percentage of ADF was as expected - less than the ratio of neutral detergent fibers in each of the tested species, and ranged between 10.2 - 44.3% on dry matter basis and is consistent with what Perry *et al* (1999) recorded for many filling traditional feed. The levels of ADF obtained in this study were very close to those obtained by Abdalla *et al* (1995) for *Atriplexhalimus*, *Cyperus conglomeratus*, *Haloxylon persicum*, *Leptadenia pyrotechnica*, *Panicum turgidum*, *Pennisetumdivisum*, *Rhanterium eppaposum* and *Zygophyllumcoccineum*. The difference in the results of the two studies were found in the data obtained for *Calligonum comosum*, *Heliotropium bacciferum* and *Lycium shawii* which recorded significant differences, this may be due to the differences in plant species or growth stages, or the differences in sampling, preservation and samples treatment method as noted by Jung *et al* (1995).

In addition, Minson (1982), Aiple *et al*. (1996) and Jung and Allen (1995) reported that the filler feeds ADF contents have negative effects on dry matter digestion rates and have no direct relation to feed consumption, but Grobber *et al.* (1992) and Wilson and Mertens (1995) reported that dry matter consumption and digestion rates are more related to the quality and shape of cell wall components than to their quantity or proportion in fillers feeds. The lowest levels of ADF were recorded in *Anabasis setifera*, *Salsola baryosma*, *Seidlitzia osmarinus*, *Suaeda fruticosa* and *Zygophyllum coccineum* which were also the lowest in their neutral detergent fibers (NDF) contents.*Calligonum comosum*, *Haloxylon persicum* and *Halocnemum strobilaceum*, which have medium / ideal levels of NDF, which means that these species have good levels of soluble and digestible hemicellulose. The highest levels of ADF were recorded in the same grassy species that had the highest levels of neutral fibers (NDF) with the exception of the palatable *Aeluropus lagopoides*. The plant species that contained an average percentage of ADF such as *Haloxylon salicornicum*, *Atriplex halimus*, *Lycium shawii* and *Tamarix arabica* h ad the highest palatability, It is noted that the level of NDF was high in *Aeluropus lagopoides* and low in *Tamarix arabica* which indicated that the first species had the higher and the second species had the lower soluble hemicellulose contents.

Lignin

Table 2 shows the mean and standard deviation of lignin content of the rangeland plant species in the study area. The plant species had been classified into three groups depending on their lignin content. The first group had a mean content of lignin of 4.10 ± 0.64%, and included *Arthrocnemum macrostachyum*, *Anabasis setifera*, *Cyperus conglomerates*, *Aeluropus lagopoides*, *Haloxylon persicum*, *Lasiures scindicus*, *Salsola baryosma*, *Seidlitzia rosmarinus*, *Suaeda vermiculata* and *Zygophyllum coccineum*. The second group had a mean lignin content of 6.1 ± 0.60%, and included *Calligonumcomosum*, *Eragrostisbarrelieri*, *Haloxylonsalicornicum*, *Lycium shawii*, *Panicum turgidum*, *Pennisetumdivisum* and *Halocnemumstrobilaceum*. The last group included the rangeland plants that had the highest lignin content with a mean of 9.6 ± 1.02% and included *Atriplex halimus*, *Heliotropium bacciferum*, *Leptadenia pyrotechnica*, *Rhanterium eppaposum* and *Tamarix Arabica*.

The levels of lignin had a very narrow range between 2.7% (*Anabasis setifera*) and 10.9% (*Rhanterium eppaposum*), which is in line with the data recorded by Perry *et al* (1999) for a group of traditional fillerfeeds and falls within the range recorded by Glenn *et al* (1999) for a group of halophytes in the United States. *Atriplex halimus* lignin content recorded in this study were not different from those reported by Pasternak *et al* (1985) and Arieli *et al* (1989) in other halophytes. The levels of lignin observed by Abdallah *et al* (1995) for *Panicum turgidum*, *Pennisetum divisum*, *Leptadenia pyrotechnica*, *Rhanterium eppaposum*, and *Zygophyllum coccineum* were similar to those recorded in this study, but the legnin contents recorded for *Tamarix arabica*, *Atriplex halimus* and *Calligonum Conglomeratus*, *Haloxylon persicum* and *Heliotropium bacciferum* were significantly higher than those in our study.

The results of this study are consistent with those reported by Morrison (1980) who claimed that leafy plants with smaller branches have lower lignin content than non-leafy plants with coarse branches. We can observe that the hays of leafy *Aeluropus lagopoides,Cyperus conglomeratus,Anabasis setifera,Lasiurus scindicus*, *Salsola baryosma*, *Seidlitzia rosmarinus*, Suaeda fruticosa and Zygophyllum coccineum had lower percentages of lignin than those of non-leafy species with relatively coarse branches, such as *Tamarix arabica*, *Rhanterium eppaposum*, *Pennisetum divisum, Panicum turgidum,Lycium shawii* and *Haloxylon persicum*.

Anti-nutritional factors

Rangelands plant samples were analyzed for some anti-nutritional factors that included total polyphenols, nitrates, saponins and oxalic acids.

Total polyphenols

Table 3 shows the mean ± standard deviation of the total polyphenols in the different plant species in the study area. The plant species had been classified into three groups according to their total polyphenols content. The first group had 1% or more of the total polyphenols and the mean of the group was1.266 ± 0.0536%. This group included *Haloxylon persicum, Eragrostis barrelieri, Cyperus conglomerates, Calligonum comosum, Lasiures scindicus*and *Lycium shawii*. The second group had a mean of total polyphenols of 0.519 ± 0.150%. It included *Halocnemum strobilaceum, Haloxylon salicornicum, Leptadenia pyrotechnica, Panicum turgidum, Pennisetum divisum, Salsola baryosma, Seidlitzia rosmarinus,* and *Zygophyllum coccineum*. The third group contained less than 0.5 of the total polyphenols with an average of 0.388±0.153. It included *Anabasis setifera, Atriplex halimus, Arthrocnemum macrostachyum, Heliotropium bacciferum, Rhanterium eppaposum, Suaeda vermiculata* and *Tamarix Arabica*.

Tannins (Polyphenols) are not toxic plant secondary compounds, and are found in different concentrations in many plant species, especially in legumes such as red clover, lucerne, sainfoin and birds foot at concentrations of 5.0-12.5% on dry matter basis (Broderick and Albercht, 1997). Holecheck *et al* (1990) and Waghorn *et al* (1998) have found that higher levels of tanins (5% or more) in conventional legume feeds have negative effects on feed consumption, protein digestion and energy levels. They also noticed that the incidence of bloat in ruminants increases with increasing levels of tanins in the feed. Table (3) shows the tanins content of the studied halophytes and shows that its levels ranged between 0.058% and 1.34%. The low levels of tanins have no negative effects on the consumption rates of tested halophytes or their crude protein and energy digestion rates. These low levels of tanins may increase the feed value of the tested halophytes as tanins react with crude proteins and protect it from excessive breakdown in the rumen (Egan and Ulyatt, 1980 and Chalupa, 1975) and assist in achieving positive nitrogen and energy balance.

Nitrates

Table 3 shows the mean and standard deviation of nitrate content in the rangelands plant species in the study area. The data showed no significant differences at the 0.05 probability level in nitrate content with the exception of *Heliotropium Bacciferum* Which had a nitrate content of 1.34%. Nitrate levels in the rest of the plant species were low. These levels were not close to ruminants' toxicity level.In general, the nitrate content of the tested halophytesin on this study was low (0.152 - 1.384% on dry matter basis) and less than the toxic level for ruminants which was estimated by Harris and Rhodes (1969) as 1.5% or more on dry matter basis.In a study of the natural vegetation in Sinai desert, Bayoumi and Ahmed (1983) found that the plant species belonging to *Chenopodiaceae, Compositae* and *Zygophyllaceae* had high and toxic levels ranging from 1.65 to 1.98% on dry matter basis of nitrates, which is not consistent with what was found for these families in the present study where low and non-toxic levels ranging between 0.15 and 0.54% were recorded. It was noted that the *Heliotropium bacciferum* of the *Baraginaciceae* family contained a relatively high level of nitrate (1.384%) which was much closer to the toxicity level for ruminants (Harris and Rhodes, 1969).

Saponins

Table 3 shows the mean ± standard deviation of the saponins content in halophytes in the study area. These species can be divided according to their saponins content into three main groups. The first group had a mean saponin content of 1.32 ± 0.314%. This level was not significantly different for those reported in most known plant species in the kingdom (less than 3.0%). The group included *Anabasis setifera, Aeluropus lagopoides, Eragrostis barrelieri, Haloxylon salicornicum, Lasiures scindicus, Leptadenia pyrotechnica, Salsola baryosma, Seidlitzia rosmarinus* and *Heliotropium bacciferum*. The second group had saponin content of more than 3.0% to less than 6.0% with a mean of 5.015 ± 1.108% (the level that adversely affects non-ruminants) on dry matter basis. It included *Rhanterium eppaposum, Pennisetum divisum, Halocnemum strobilaceum, Suaeda vermiculata, Tamarix Arabica,* and *Zygophyllum coccineum*. The third group had saponin content of 6% or more on dry matter basis and ranged between 6.126 and 10.283%. This group included *Atriplex halimus,* *Arthrocnemum macrostachyum*, *Calligonum comosum*, *Cyperus conglomerates*, *Haloxylon persicum* and *Panicum turgidum*.

The levels of saponins in the tested halophytes ranged from less than 1.0% to more than 10% on dry matter basis. Also the level of saponins in *Rhanterium eppaposum*, *Pennisetum divisum*, *Halocnemum strobilaceum*, *Suaeda fruticosa*, *Tamarix arabica*, *Zygophyllum coccineum*, *Atriplex halimus*, *Arthrocnemum macrostachyum*, *Calligonum comosum*, *Cyperus conglomeratus*, *Cyperus conglomeratus* and *Cyperus conglomeratus* were greatly lower than the values recorded by Majack *et al* (1980) for some varaities of alfalfa (less than 3%).In light of the absence of adequate information on the quality of saponins and proteins in the studied halophytes It is difficult to discuss the toxicity the levels of saponins recorded in this study. However, caution is required when feeding the above-mentioned species to farm animals because it may reduce their consumption levels, especially when they are fresh and green.

Oxalates

Table 3 shows the mean ± standard deviation of the oxalate content on dry matter basis of halophytes in the study area. The tested species have been divided into three groups in terms of their oxalate's contents. The first group included plant species with low oxalate content ranging from zero to less than 0.5%.It included *Salsola baryosma*, *Rhanterium eppaposum*, *Heliotropium bacciferum* and *Lycium shawii*. The second group had oxalate contents ranging from 0.5% to less than 1.0% and included *Haloxylon salicornicum*, *Halocnemum strobilaceum*, *Arthrocnemum macrostachyum*, *Calligonum comosum*, *Pennisetum divisum*and *Suaeda vermiculata*. The third group included plant species that had oxalate content ranged between 1.0% to less than 4.5%. It included *Atriplex halimus*, *Anabasis setifera*, *Aeluropus lagopoides*, *Panicum turgidum*, *Leptadenia pyrotechnica*, *Cyperus conglomerates*, *Haloxylon persicum* and *Seidlitzia rosmarinus*.

The oxalate levels detected in the tested halophytes as shown in Table (3) for *Atriplex halimus* and *Pennisetum divisum* are similar to those recorded by Davis (1982) for 33 species of the *Astragalus* family. The levels of oxalate observed for halophytes in this study sites did not reach the toxicity levels to ruminants which was 10% on dry matter basis as mentioned by Checker and Schull (1985). Alison *et al*. (1981) claimed that rumen microbes in ruminants can tolerate very high levels of oxalate in fast growing and immature range plants.

CONCLUSION

The nutritional value of rangeland plants evaluated in this study with the exception of range shrubs is low because some of these plants contained high levels of indigestible fiber and others have low levels of organic matter and high ash content. The tested halophytes hays could be classified into two types of rations: the first is filler rations which include most of the drought-saline resistant grasses and some range shrubs, and the second is concentrated rations which include the true halophytes that have high levels of ash / minerals and low levels of organic matter.

The levels of anti-nutritional factors such as tannins, nitrates, oxalates and saponins in the tested plant species are low and don't reach the levels that are toxic or harmful to livestock.

The palatability of the tested halophytes is low as the consumption rate of these plants by goats ranged from zero and 35.9% in comparing with the consumption of traditional rations.

The grazing value of the tested plants in the study area is higher than the feed value, and the process of drying these plants as dry rations increased their levels of salts and fibers and negatively affect their nutritional value and the degree of palatability for livestock.

Fillers rations cannot be used alone but it is recommended to be mixed with conventional fillers at 10-55% of the total expected consumption depending on the plant species. The hays of these halophytes can be utilized as a source of salts and minerals with little organic matter to manufacture salt licks as well as to reduce the concentration of fiber levels in coarse rations such as the fodder of corn - rice - wheat - barley ... etc. residues.

REFERENCES

Abdallah, O.M., Ibrahim, A.E.S., AboulEla, M.B., Soliman, A.M., Ahmed, M.A. 1995. Chemical composition of important range plant species in United Arab Emirates: 1. Trees and perennial plants. Emir. J. Agric. Sci., 7: 65-86.

Aiple, K.P., Steingass, H., Droncher, W. 1996. Prediction of the net energy of raw materials and compound feeds for ruminants by different laboratory methods. Archives of Anim. Nutr., 49: 213-220.

Al-Khateeb, S.A. 1997. Effect of NaCl and Na_2SO_4 on growth, ion relations, water relations and

Gas exchange of two *Atriplex* species. Ph.D. Thesis. Reading Univ., U.K.

Allison, M.J., Cook, H.M., Dawson, K.A. 1981. Selection of oxalates-degrading rumen bacteria in continuous cultures. J. Anim. Sci., 53: 810-816.

Al-Saud, T.A., Al-Khateeb, S.A., Al-Rowaily, S.L., Al Arifi, F.S.N., Assaeed, A.M., Al-Qarawi, A.A. 2007. Rangeland of Eastern Region. The International Conference on the Arabian Oryx in the Arabian Peninsula, The 23rd meeting of the Saudi Biological Society, Riyadh, 21-23 April, 2007. pp. 51.

Al-Zaid, A.M., Al-Khatib, S.A., Laila, A.A. 2004.The productivity and quality of tomato feed (Panicum turgidum Forssk) naturally grown in the eastern region of the Kingdom of Saudi Arabia. Damascus Unive. J. for Agric. Sci. – Vol. 20 - Second Issue - Pages: 151-162. (In Arabic)

Anninkov, B.N. 1982. Mineral Feeding of Cattle, pp. 285-320 in V.I. Georgievski, B.N. Annenkov, and V.I. Samokin, ed. Mineral nutrition of Animals. Butterworths, London, U.K.

Ariel, A., Naim, E., Benjamin, R.W., Pasternak, D. 1989. The effect of feeding saltbush and sodium chloride on energy metabolism in sheep. Anim. Production, 49: 451-457.

Badri. M.A., Hamed, A.I. 2000. Nutrient value of plants in an extremely arid environment (Wadi Allaqi Biosphere Reserve, Egypt). J. of Arid Environ., 44: 345 - 356.

Basden, K.W., Dalvi, R.R. 1987. Determination of total phenolics in Acorns from different species of Oak trees in conjunction with Acorn poisoning in cattle. Vet. Hum. Toxicol., 29(4): 305-306.

Bayoumi, M.T., Ahmed, A.M. 1983. Nitrate content of natural vegetation in relation to prospect of animal production in Sinai Peninsula. World Review of Animal Production, 19 (1): 25 - 32.

Benjamin, R.W., Oren, E., Katz, E., Becker, K. 1992. The apparent digestibility of Atriplex barclayana and its effect on nitrogen balance in sheep. J. Anim. Prod., 54: 259-264.

Bergen, W.G. 1972. Rumen osmolarity as a factor in feed intake control in sheep. J. Anim. Sci., 34: 1054-1060.

Broderick, G.A., Albrecht, K.A. 1997. Ruminal In Vitro Degradation of Protein in Tannin- Free and Tannin-Containing Forage Legume Species. Crop. Sci. 37: 1884-1891.

Brokowski, B., Drost, K. 1955. Presence of alkaloids in some species of the genus Kochia L. Acta Pol. Pherm., 22: 181-184.

Buxton, D.R., Harnstein, J.S. 1986. Cell-wall concentration and components in stratified canopies of alfalfa, birds foot trefoil and red clover. Crop Sci., 26: 180-184.

Chalupa, W. 1975. Rumen by pass and protection of protein amino acids. J. Dairy Sci., 58: 1198-1218.

Cheeker, P.R., Schull, L.R. 1985. Natural toxicants in feeds and poisonous plants. Av1 Publishing Co-Inc. Westport, Conn. USA.

Cohen, R.D.H., Iwaasa, A.D., Mann, M.E., Coxworth, E., Kernan, J.A. 1989. Studies on the feeding value of Kochia scoparia L. Scherd): Hay for beef cattle. Can. J. Anim. Sci., 69: 735-743.

Davis, A.M. 1982. Crude protein, crude fiber, tannin and oxalate concentrations of 33 *Astragulus* species. J. of Range Management, 36 (1): 32-34

Dulphy, J.P., Reymond, B., Theriez, M. 1980. Ingestive behaviour and related activities in ruminants. In: Ruckebusch, Y. and Thivend, P. (eds) Digestion Physiology and Metabolism in Ruminents. MTP Press, Lancaster, pp 103-122.

Egan, A.R., Ulyaltt, M.J. 1980. Quantitative digestion of fresh herbage by sheep. VI. Utilization of N in five herbages. J. Agric. Sci. Cambridge, 94: 47-56.

El-Shaer, H.M., Gihad, E.A., Squires, V.R., Ayoub, A.T. 1995. Halophytes as animal feed in Egypt deserts. In: Squires, V.R. (eds): Halophytes as a resource for livestock and for rehabilitation of degraded lands. Proceedings of the International Workshop on Halophytes for reclamation of saline wastelands and as a resource for livestock problems and prospects, Nairobi, Kenya, Nov. 22-25, 1992 and 1994. Kluwer Academic Publishers, Dordrecht, Netherlands.

El-Shaer, H.M., Kandil, H.M., Hamdy, A. Leith, H., Todorovie, M., Moschenko, M. 1998. Potential of Atriplex species as fodder shrubs under the arid conditions of Egypt. In: Hamdy, A.; H. Leith and M. Todorovie (eds): Halophyte uses in different climates. II. Halophyte Crop Development: Pilot Studies, Proceedings of the 3rd Seminar of EM Concerted Action Group. Florence, Italy, 20 July 1998.

Flowers, T.J., Yeo, A.R. 1986. Ion relations of plant under drought and salinity. Australian Journal of Plant Physiology, 13:75-91.

Ganskopp, D., Bohnert, D. 2001. Nutritional dynamics of seven northern Great basin grasses. J. Range. Manage. 54: 640-647.

Glenn, E.P., Wange, E., Coates, E., Riley, J.J., Robert, O.K., Swingle, R.S. 1999. Salicornia bigelovii Torr.: a sea water-irrigated forage for goats. Animal feed Science and Technology, 40 (1): 21-30.

Greimson, R.E., Reimer, G.E., Stilborn, R.R., Volek, R.J., Gummeson, P.K. 1989. Agronomic and chemical characteristics of Kochia scoparia (L.) Scherd. And its value as a silage crop for growing beef cattle. Can. J. Anim. Sci., 69: 383-391.

Grobber, J.H., Jung, G.A., Abrams, M., Howard, D.B. 1992. Digestion Kinetics of parenchyma and sclerenchyma cell wall isolated from *Orchard gram* and *Switch gram*. Crop Sci., 32: 806-810.

Haddi, M.L., Filacorda, S., Susmel, P., Piva, G. 1999. Comparison of different inocula to describe some halophyte shrubs using gas-test. Recent Progress in Animal Production Science. 1. Proceedings of the A.S.P.A. XIII Congress, Piacenza, Italy, 21 – 24 June.

Harborne, J.B. 1993. Introduction to Ecological Biochemistry. Academic Press, London. pp 318.

Harris, D.J., Rhodes, H.A. 1969. Nitrate and Nitrite poisoning in cattle in Victoria. Australian Veterinary Journal, 45: 590-591.

Hassan, N.I., Abdel-Aziz, H.M. 1983. Effect of barley supplementation on nutritive value of saltbush (Atriplex memmularia). World Review of Animal Production, 15(4): 47-55.

Hassan, N.I., Abdel-Aziz, H.M., El-Tabbakh, A.E. 1979. Evaluation of some forages introduced to newly reclaimed areas in Egypt. World Review of Animal Production, 15(2): 30-35.

Jung, H.C., Allen, M.S. 1995. Characteristics of plant cell walls affecting intake and digestibility of forages by ruminants. J. Anim. Sci., 73: 2774-2790.

Kenny, D.R., Nelson, D.W. 1980. Nitrogen: Inorganic forms. Methods of Soil Analysis. Agronomy Monographs, 9: 643 – 698.

Le Houerou, H.N. 1993. Salt-tolerance plants for the arid regions of the Mediterranean isoclimatic zone. In: Towards the rational use of high salineity tolerant plants. Col. 1. pp 403-422.

Le Houerou, H.N. 1995. Forage halophytes in the Mediterranean basin. In: Le Hourerou, H.N., Choukr-Allah, R., Malcolm, C.N. and Hamdy, A. (eds). Halophytes and Biosaline Agriculture, 115-136 (Abst.).

Majack, W., Howarth, R.E., Frasser, A.C., Goplen, B.P., Pederson, W. 1980. Relationship between ruminant bloat and the composition of alfalfa herbage. II. Saponins. Can. J. Ahim. Sci., 60: 699-708.

Mason, S., Shellford, J.A. 1990. Acomputerized forage feeding system allowing measurement of individual intake, meal patterns and competitive feeding behaviour. J. Dairy Sci., 53 (1): 154-159.

Mertens, D.R. 1983. Using neutral detergent fiber for formulate diary rations and estimate the net energy content of for-ages. Proc. Cornell Nutr. Conf., pp 60-80, Cornell University., NY.

Mertens, D.R., Ely, L.O. 1982. Relationship of rate and extent of digestion to forage utilization: A dynamic model evaluation. J. Anim. Sci., 54: 895-905.

Minson, D.J. 1982. Effects of chemical and physiological composition of herbage eaten upon intake. In J.B. Hacker (ed). Nutritional limits to animal production from pastures. CAB Intern., Farnham Royal, pp 167-182.

Mir, Z., Bittman, S., Townley-Smith L. 1990. Nutritive value of Kochia (Kochia scoparia) hay or silage grown in black soil zone in north eastern Saskatchewan for sheep. Can. J. Anim. Sci., 51: 105-114.

Morrison, I.M. 1980. Changes in the lignin and hemicellulose concentration of ten varieties of temperate grasses with increasing maturity. Grass and Forage Sci., 35: 287-293.

Mureillo, J.M., Barroso, M., Mazuelo, C., Sarmeinto, R. 1987. Nutritional and fertilizer values of *Sueda vera*. J. F. Gmelin. J. of the Sci. of Food and Agric., 41: 115-122.

Osbourn, D.F., Terry, R.A., Quten, G.E., Cammell, S.B. 1974. The significance of a determination of cell walls as the rational basis for the nutritive evaluation of forages. Proceedings of the 12th International Grassland Congress, Moscow, 3, Part 1, 354-380.

Pasternak, D., Danon, A., Aronson, J.A., Benjamin, R.W. 1985. Developing the seawater agriculture concept. Plant and Soil, 89: 335-348.

Perry, W.T., Cullison, A.E., Lowry, S.R. 1999. Feeds and feeding (5^{th} edition) published by Pentice Hall, Upper Saddle Rew, New Jersey, pp 12 – 28.

Riley, J.J., Glenn, E.P., Mota, C.U., Squires, V.R. 1992. In: Ayoub, A.T. (eds): Halophytes as a resource for livestock and Rehabilitation of degraded lands. Proc. International Workshop on halophytes for reclamation of saline waste lands and as a resource for livestock: Problems and prospects. Nairobi, Kenya.

Sanderson, M.A., Hornstein, J.S., Wedin, W.F. 1989. Alfalfa morphological stage and its relation to in situ digestibility of detergent fiber fractions of stems. Crop Sci., 29: 1315 - 1319.

Swingle, R.S., Glenn, E.P., Riley, J.J., Squires, V.R., Ayoub, A.T. 1992. Halophytes in mixed feeds for livestock. In: Squires and A.T. Ayoub (eds): Halophytes as a resource for livestock and for rehabilitation of degraded lands. Proceedings of the International Workshop on Halophytes for reclamation of saline wastelands and as a resource for livestock problems and prospects, Nairobi, Kenya, Nov. 22-25, 1992 and 1994. Kluwer Academic Publishers, Dordrecht, Netherlands.

Van Soest, P.J. 1965. Symposium on factors influencing the voluntary intake of herbage by ruminants: voluntary intake in relation to chemical composition and digestibility. J. Anim. Sci., 24: 834-843.

Van Soest, P.J., Wine, R.H. 1967. Use of detergents in the analysis of fibrous materials. IV. Determination of plant cell wall constituents. J. Ass. Off. Anal. Chem., 50: 50-55.

Waghorn, G.C., Douglas, G.B., Niezen, J.H., McNabb, W.C., Foote, A.G. 1998. Forages with condense tannin- Theis management and nutritive value for ruminants. Proc. Of the New Zealand Grassland Association. 60:89-98.

Warner, A.C.I., Stacy, B.D. 1968. The fate of water in the rumen 2. water balances throughout the feeding cycle in sheep. Por. J. Nutr., 22: 289-410.

Wilson, A.D., Squires, V.R., Ayoub, A.T. 1995. Halophyte's shrubs in semi-arid regions of Australia. In: Squires V. R. and A. T. Ayoub (eds): Halophyte as a resource for livestock and for rehabilitation of degraded lands. Proceedings of the International Workshop on Halophytes for reclamation of saline wastelands and as a resource for livestock problems and prospects, Nairobi, Kenya, Nov. 22-25, 1992 and 1994. Kluwer Academic Publishers, Dordrecht, Netherlands.

Wilson, J.R., Mertens, D.R. 1995. Cell wall accessibility and cell wall structural limitations to microbial digestion of forages. Crop Sci., 35: 251-259.

Zimmer, E., Wirck, M. 1986. Improving the nutritive value of maize. P. 91-100. In O. Dolstra and P. Miedema (ed.) Breeding of Silage maize. Proc. 13th Cong. Maize and Sorghum Section of Eucarpia.Wageningn, 9-12 Sept. Centre for Agric. Pub and Documentation, Wageningen, Netherlands.

Table 1. Approximate Analysis of Nutrients for the native rangelands plant species surveyed in the eastern province of Saudi Arabia

Plant species	Dry matter%	Nutrient on dry matter basis (%)				
		Ash %	Organic matter %	Crude protein %	Crude fiber %	Ether extract %
Aeluropus lagopoides	49.6±6.65	42.9±2.83	57.1±2.83	5.4±1.48	13.4±2.4	7.9±0.49
Anabasis setifera	31.9±3.45	36.1±2.16	63.9±2.16	7.8±0.14	6.8±1.91	6.3
Arthrocnemum macrostachyum	25.5	40.4	59.6	15.4	5.1	3.8
Atriplex halimus	30.3	25.5	74.5	11.9	16.7	4.5
Calligonum comosum	22.6	10.4	89.6	9.8	14.4	3.4
Cyperus conglomerates	30.4±7.2	7.8±2.5	92.2±2.5	7.6*±1.6	27.2*±4.59	5.6±0.67
Eragrostis barrelieri	43.3	11.3	88.7	6.4	38.5	5.9
Halocnemum strobilaceum	23.8*±1.82	42.7±3.26	57.3±3.26	9.1 *±1.5	7.8±1.44	7.1±0.88
Haloxylon persicum	39.1±3.46	19.3±1.56	80.7±1.56	13±1.41	17.8±0.21	6.5±0.42
Haloxylon salicornicum	36.7±3.46	17.3±1.63	82.7±1.63	10.4±0.92	16.8±1.13	6.4±0.14
Heliotropium bacciferum	31.0	23.9±3.11	76.1±3.11	8.4±2.5	18.3±1.48	4.9±1.41
Lasiures scindicus	39.2±2.55	8.5±0.07	91.5±0.7	6.2±0.28	30.8±3.54	6.0±1.48
Leptadenia pyrotechnica	32.4±3.76	8.8±1.13	91.2±1.13	8.5±0.42	35.9±1.63	7.6±1.13
Lycium shawii	26.3	17.1	82.9	12.6	22.1	5.1
Panicum turgidum	47.6*±2.15	8.7*±3.70	92.6*±03.7	9.0±1.0	37.3±2.44	6.7*±1.09
Pennisetum divisum	49.6*±4.18	7.9±1.71	93.1±1.71	8.6±1.05	36.6±1.3	5.7±1.13
Rhanterium eppaposum	32.4	7.9	92.1	9.0	23.6	4.1
Salsola baryosma	16.9±2.02	43.8±4.0	56.2±4.0	13.1±2.95	7.9±1.9	6.2±1.22
Seidlitzia rosmarinus	17.9±8.6	35.2±2.56	64.8±2.58	13.1±1.6	6.7±1.44	5.2±0.93
Suaeda vermiculata	15.1±2.58	36.8±2.72	63.2±2.72	12.7*±4.18	8.9±1.75	6.1±1.65
Tamarix Arabica	32.5±3.52	30±1.3	70±1.3	9.0±2.75	13.7±0.73	5.4±1.07
Zygophyllum coccineum	25.8*±4.18	35.7*±7.7	65.3*±9.07	8.4 *±1.80	11.3±3.81	6.3±1.85

*There is significant difference between means at P 0.05

Table 2. Cell wall components (on dry matterbasis) for the native rangelands plant species surveyed in the eastern province of Saudi Arabia

Plant species	NDF%	ADF%	Lignin%
Aeluropus lagopoides	51.9±1.76	25.0±0.85	4.0±1.56
Anabasis setifera	19.5±2.54	10.2*±1.82	2.7±0.79
Arthrocnemum macrostachyum	28.4	12.4	4.5
Atriplex halimus	36.9	21.8	8.1
Calligonum comosum	29.3	13.7	5.9
Cyperus conglomerates	63.3*±1.76	36.0*±4.07	4.7±1.00
Eragrostis barrelieri	66.6	34.2	5.2
Halocnemum strobilaceum	23.0±4.12	13.9*±2.96	7.0±2.44
Haloxylon persicum	30.4±3.68	16.6±3.96	4.4±0.49
Haloxylon salicornicum	38.2±0.85	23.1±1.70	6.0±1.13
Heliotropium bacciferum	43.1±4.67	34.8±4.31	9.5±0.78
Lasiures scindicus	67.0±2.26	36.7±1.91	3.6±0.78
Leptadenia pyrotechnica	52.4±1.72	41.0±3.44	10.0±0.25
Lycium shawii	35.7	20.9	6.0
Panicum turgidum	70.4±3.12	39.0±4.06	6.2±1.12
Pennisetum divisum	69.2*±5.44	39.9*±4.06	6.7±1.20
Rhanterium eppaposum	44.8	44.3	10.9
Salsola baryosma	22.9±3.35	11.0±4.45	3.6*±2.00
Seidlitzia rosmarinus	20.9*±1.56	11.7±3.32	3.9±1.67
Suaeda vermiculata	26.7*±5.32	13.4*±5.06	4.9*±3.16
Tamarix Arabica	23.8±2.07	20.8±0.68	9.3*±2.54
Zygophyllum coccineum	16.3*±4.37	13.7*±4.80	4.7*±1.76

* There is significant difference between means at P 0.05.

Table 3. Total polyphenols, nitrates, saponins and oxalates (on dry matter basis) for the native rangelands plant species surveyed in the eastern province of Saudi Arabia

Plant species	Total polyphenols	Nitrates %	Saponins %	Oxalates %
Aeluropus lagopoides	0.0	0.337±0.117	1.400±0.00	1.18
Anabasis setifera	0.482±0.000	0.451±0.0	1.856±0.017	1.43±0.01
Arthrocnemum macrostachyum	0.455*±0.033	0.570±0.0	6.766±0.251	0.75±0.02
Atriplex halimus	0.058	0.483	10.283	4.20
Calligonum comosum	1.268	0.416	6.250±0.353	0.57±0.04
Cyperus conglomerates	1.310*±0.112	0.268±0.048	6.126±1.921	1.12±0.35
Eragrostis barrelieri	1.341	0.683	1.266	1.82
Halocnemum strobilaceum	0.523±0.130	0.702±0.271	3.720*±1.287	0.99±0.29
Haloxylon persicum	1.147	0.152	7.016	1.47
Haloxylon salicornicum	0.636	0.267	1.651	0.83
Heliotropium bacciferum	0.428	1.384	0.921	1.08
Lasiures scindicus	1.266	0.362	1.000	0.44
Leptadenia pyrotechnica	0.951	0.195±0.026	1.592	1.33
Lycium shawii	1.386	0.401	7.447	0.47
Panicum turgidum	0.700*±0.193	0.398±0.340	7.477*±2.855	1.03±0.31
Pennisetum divisum	0.655±0.067	0.258±0.136	3.500±0.173	0.75±0.03
Rhanterium eppaposum	0.463	0.185	5.823	0.00
Salsola baryosma	0.566±0.148	0.421±0.001	1.155±0.141	0.00
Seidlitzia rosmarinus	0.944±0.186	0.742±0.030	1.052±0.300	1.66±0.17
Suaeda vermiculata	0.343±0.053	0.411±0.028	5.397*±0.861	0.94±0.15
Tamarix Arabica	0.486	0.182	5.966	0.34
Zygophyllum coccineum	0.768±0.092	0.390±0.041	5.698*±0.813	1.06±0.09

* There is significant difference between means at P 0.05

القيمة الغذائية لبعض النباتات الرعوية في المنطقة الشرقية من المملكة العربية السعودية

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الملخص العربي

تقع معظم المراعي في المملكة العربية السعودية في أنظمة بيئية هامشية ينخفض فيها هطول الأمطار مع ارتفاع عالٍ في مؤشر الجفاف. في ظل هذه الظروف، تلعب أنواع نباتات المراعي المعمرة ذات المقاومة العالية للجفاف والملوحة دورًا مهمًا في الإنتاج الحيواني المستدام الذي يعتمد بشدة على القيمة الغذائية للأعلاف المتاحة. أجريت هذه الدراسة لتقييم القيمة الغذائية لنباتات المراعي في المنطقة الشرقية من المملكة العربية السعودية، ولتقييم استخدامها المحتمل كعلف للماشية. تم مسح وتجميع 22 من نباتات المراعي (الأعشاب والشجيرات) من منطقة الدراسة. أظهرت النتائج ان نباتات المراعي الشائعة التي تنمو بشكل طبيعي في منطقة الدراسة أن نباتات المراعي تحتوي على 15.1 - 49.6٪ من وزنها كمادة جافة. تراوحت محتويات الرماد والبروتين الخام والألياف الخام والمواد العضوية ومستخلص الإيثر على أساس المادة الجافة في هذه النباتات من 7.9 إلى 43.8 و5.4 إلى 15.4 و5.1 إلى 38.5 و3.4 إلى 7.9٪ و56.2 إلى 94.5٪ على التوالي. تراوحت محتويات NDF وADF وDM) Lignin ٪) للنباتات التي خضعت للفحص في هذه الدراسة من 16.3 إلى 70.4، و10.2 إلى 44.3، و2.7 إلى 10.9 ٪ على التوالي. احتوت هذه النباتات أيضًا على DM 0.058 إلى 1.341 و0.153 إلى 1.384 و0.92 إلى 10.283 ومن 0 إلى 4.2٪ من التانيس والنترات والصابونين والأكسالات على التوالي. تراوحت معاملات الهضم لـ DM، والرماد، وOM، وCP، وADF٪ من 22.7 إلى 75.7، ومن 2.9 إلى 82.9، ومن 18.4 إلى 88.1، ومن 26.7 إلى 76.4، ومن 11.9 إلى 51.4٪ بهذا الترتيب. أشارت النتائج العامة لهذه الدراسة إلى أن معظم نباتات المراعي التي خضعت للتقييم لها قيمة غذائية جيدة وتمثل موارد علفية رئيسية للماشية، ويمكن زراعتها باستخدام المياه قليلة الملوحة والمالحة، وقد تكون موارد نباتية قيّمة للزراعة باستخدام مياه البحر أو خليط من مياه البحر والمياه العذبة.

الكلمات الاسترشادية: النباتات الرعوية، النباتات الصحراوية، القيمة الغذائية، الألياف الخام، البروتين الخام، المملكة العربية السعودية