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Potential Use of *Atriplex halimus* L. Shrubbery as Fodder in Arid Zones of Saudi Arabia

Fahad M. Alzuaibr

Biology Department, Faculty of Science, Tabuk University, Tabuk, **Kingdom of Saudi Arabia**.

***Correspondence:** falzuaiber@ut.edu.com **Accepted:** 30 July 2019 **Published online:** 26 Aug 2019

Atriplex halimus L. (Chenopodiaceae) is one of the most abundant perennial halophytes found in many arid and semi-arid regions of the world. The aim of this study was to evaluate the phytochemical analysis and nutritive values of *A. halimus* shrubbery as fodder producing plant for domestic livestock in arid lands. *A. halimus* aerial parts were collected from Al-Jouf region of northern Saudi Arabia during the period of May 2018. In the present study, *A. halimus* attained appropriate quantities from crude protein (134.45 g/kg), crude lipid (22.5 g/kg), glucose content (2.72 g/kg), sucrose (19.32 g/kg) and polysaccharides (84.63 g/kg). In the present study, the nutritive value attained 241.77 Cal/100g and TDN is about 54.37% DM. The sequence of macro-minerals in *A. halimus* is: N> K> Ca> P> Mg> Na, while the sequence of micro- minerals is: Fe> Zn> Mn> Cu. Therefore, in arid areas, saltbush could be used as feed for livestock and is considered to be a partial solution to the problem of feed shortage in the Kingdom of Saudi Arabia.

Keywords: ***Atriplex,*** **Nutritive value, Minerals, Phytochemical, KSA**

INTRODUCTION

Arid zones are a global phenomenon, which they are subject to arid climates tend to lack vegetation, where surface water is often scarce or unreliable and groundwater is also salty (Rockstrom, 2013). Many plant species that provide 90% of the food, feed, fiber and drugs in the world and so on. Thus, desert plants remain interesting for plant ecologists, agronomists, etc. to identify them as non-conventional crops for cultivation under desert environmental conditions (Zahran and El-Amier, 2014). Saudi Arabia is an arid country with inadequate groundwater resources (i.e., limited and non-renewable).

The desert vegetation is by far the most important and characteristic type of natural plant life. It covers extensive areas in the world and is formed mainly of xerophytic shrubs and subshrubs (Galal and Fahmy, 2012; El-Amier and AbdulKader, 2015). Many wild plants serve as fodder for livestock and food supplement for desert inhabitants in the Middle East (Heneidy and Halm, 2009). In addition, they are useful in medicine (El-Amier et al., 2014; Zaki et al., 2017 and 2018), pollution indication (El-Amier and Alghanem, 2018; El-Amier et al., 2018), wood and fibres production (Zahran and El-Amier, 2014), horticulture and agriculture, insect or disease traps, dye making and natural rubber production (Zimdahl, 2018). Halophytes have evolved a range of adaptations to tolerate sea water and higher concentrations of salts (Flowers and Colmer, 2008; Shabala and Mackay, 2011).

Atriplex sp. (saltbushes) is dominant in many arid and semi-arid regions of the world, particularly in habitats that combine relatively high soil salinity with aridity (Le Houerou 2000). *A. halimus* is one of the most abundant perennial halophytes found in Red sea coastal strip, Sinai, Arabia, East Africa, and best suited to Mediterranean climates. It is a small shrub and has a woody stem at the base (1-2 m). It can grow in drought conditions and can provide feed during dry seasons and periods of low grazing resources. It is also tolerant of saline conditions and can excrete salt through hairs on the leaves proving its potential as a desalinization plant, provided that material is periodically removed to prevent salt returning to the land (Flowers and Colmer, 2008), therefore the propagation and utilization of halophytic plants in pasture and fodder production in saline and arid lands is the ideal economic solution presently available (Khan and Duke 2001; Fraser et al., 2017).

In developing countries, efforts have been directed toward the use of renewable resources from cultivated and uncultivated areas to produce more food and feed. These efforts will be more successful and fruitful if they are based on prior knowledge of environmental characteristics, including soil, climate, vegetation and animal and human interference. Several studies carried out by researchers were directed towards introducing and cultivating some of the native wild plants as forage plants (Hassan, 1980; Ashour et al., 1997; Ramachurum et al., 2000; Zahran and El-Amier, 2013). In recent years Atriplex spp. have been studied in relation to their adaptability, productive potential, palatability and nutritive value (Giambalvo et al., 2004; Stringi et al., 2009).

Ecologically, it is well known that the naturally growing plants are the producing elements of all natural ecosystems e.g. desert, salt marshes, reed swamps, sand formation mountainous, etc., the other components are consumers. Thus, to throw lights on the role that could be played by these plants in the sustainable development of their ecosystems for the welfare of the people as renewable resources for various products e.g. drugs, fodders, oil, etc., (Zahran and El-Amier, 2014). Therefore, the objectives of this study were to evaluate the phytochemical analysis and nutritive values of *A. halimus* shrubbery as fodder producing plant for domestic livestock in arid lands.

MATERIALS AND METHODS

Plant material

A. halimus L. aerial parts were collected from wild populations in the Al-Jouf region of northern Saudi Arabia during the period of May 2018. The identification of species was done according to Boulos (1999). It was dried at room temperature and ground into a powder using a blender.

Phytochemical analysis

The moisture content (MC), dry matter (DM), crude fibre (CF), ether extract (EE), ash and crude protein (CP) of *A. halimus* sample were analyzed according to AOAC (1995). The total nitrogen was determined by the Kjeldahl method (Pirie, 1955). Glucose was determined based on the method of Feteris (1965). Sucrose was determined according to Handel (1968). Polysaccharides were estimated by the method of Thyumanavan and Sadasivam (1984).

The calculation of nutritive value (NV) and total digestible nutrient (TDN) were estimated according to the equation described by Indrayan et al. (2005) and Abu El-Naga and El-Shazly (1971), respectively. The metabolic energy (ME) and Net energy lactation (NEL) of examined plant species were determined according to Nauman and Bassler (1993) and Baranauskas et al., (1998).

NV (Cal/100g) = 4×CP + 9×EE + 4×carbohydrate

TDN (%) = 0.623 (100+1.25 EE) - P 0.72

ME (MJ/Kg) = 14.07 + 0.0206×EE - 0.0147×CF - 0.0114×CP ± 4.5

NEL (MJ/Kg) = 9.10 + 0.0098×EE - 0.0109×CF - 0.0073×CP

where EE is the percentage of ether extract (crude lipid), CP is the percentage of crude protein and CF is the percentage of crude fiber.

The method of extraction of different elements in the present study was described by Allen *et al*. (1974). Sodium (Na^{+}) and potassium (K^{+}) were determined in sample by Flame Photometer (Model PHF 80 B Biologie Spectrophotometer), while calcium (Ca^{2+}), magnesium (Mg^{2+}), copper (Cu^{2+}), zinc (Zn^{2+}), iron (Fe^{2+}) and manganese (Mn^{2+}) were estimated using atomic absorption spectrometer (Perkin-Elmer, Model 2380.USA). These elements were expressed as mg/g dry weight.

RESULTS AND DISCUSSON

Feed analysis provided information for a farmer to optimize nutrient utilization in animal feeds; feed compounders to prepare feed mixtures suitable for different animal production systems; researcher to relate animal's performance to feed characteristics; and plant breeder to optimize the nutritive value of new varieties (Wrigley, 1999).

Nutrients and carbohydrates

The chemical composition, fibre fractionations and carbohydrates of Atriplex halimus is shown in Table 1. Livestock need to consume a certain amount of dry matter daily to maintain health and production (Shipley and Vu, 2002). Moisture content is one of the most important characteristics of food-consuming animals, and any change in moisture content will dramatically affect flavour and texture as well as physical and chemical properties of food. In addition, ash content also is essential to a food's nutrition and longevity (Sekeroglu et al., 2006; Lewandowski et al., 2003). In the present study, A. halimus attained total ash (255.36 g/kg), moisture content (286.13 g/kg), dry matter (713.87 g/kg) (Table 1). The obtained results from this study are the same as reported in other studies on the same species (Otal et al., 2010; Shawket et al., 2010; El-Amier and Ejgholi, 2014). Comparing the obtained results to those for other forage species, revealed that the proximate composition of A. halimus agrees more or less with that obtained by Stanacev et al., (2010) and Khan et al. (2002).

The crude protein is viewed classically as an indicator of the nutritional value of plants as food for ruminants (Bryant et al., 1983). Although lipids are a concentrated source of energy, they do not constitute a major source of energy from forages (Chesworth, 1996). Nevertheless, forage with high lipid content may be an asset in satisfying the energy requirements of animals when other sources are limited (Phillips, 2018). In the present study, A. halimus attained crude protein (134.45 g/kg) and crude lipid (22.5 g/kg) (Table 1).

Table 1; Chemical composition (g/kg DM) of *Atriplex halimus*.

Constituents analysis	*A. halimus*
Moisture content	286.13±26.79
Dry matter	713.87±64.32
Ash	255.36±23.99
Fibre fractionations	
Crude fibre	168.33±15.88
Hemicelluloses	92.22±11.55
Cellulose	79.53±10.24
Chemical analysis	
Ether extract	22.5±1.73
Crude protein	134.45±10.34
Glucose	2.72±0.21
Sucrose	19.32±1.49
Polysaccharides	84.63±6.51

The obtained results from this study are in harmony with the results of El-Amier and Ejgholi (2014) and Otal et al. (2010) on the same species. Comparing with the other studies, the selected forage species showed relatively comparable percentage of crude protein with the studies of Heneidy and Bidak (2003) and Zahran et al., (1999). While, the lipid contents were quite low similar to that reported by Zahran et al., (1999) and El-Halawany et al., (2002), but not agree with that reported by Heneidy and Bidak (1996) and Omar (2006).

High fibre content is a seminal attribute of plants that exhibit high structural anti-quality. Forage plants with high fibre content are often difficult for herbivores to bite. In herbaceous plants, resistance to chewing can be considerably greater for stems than for leaves during ingestion and rumination (Shipley and Yanish, 2001). The percentage of crude fiber (168.33 g/kg), cellulose (79.53 g/kg) and hemicellulose (92.22 g/kg) for the forage species selected in the present study was similar to the findings of El-Amier and Ejgholi (2014) and El-Waziry (2007), but varies from that of Heneidy and Bidak (1996), Zahran et al., (1999) and Omar (2006).

Regarding glucose content (2.72 g/kg) was determined in A. halimus with sucrose (19.32 g/kg) and polysaccharides (84.63 g/kg) in appropriate quantities in the current study (Table 1). These results are relatively comparable to that obtained by Fernandes and Waditake (2006) on Trifolium alexandrinum and Hafiza et al,. (2002) on Medicago sativa.

Jeroch et al., (1999) reported that optimal content of carbohydrate is 8-10% for producing high-quality silage, accordingly, most of the selected forage weeds may be considered as a good fodder species. The total carbohydrate (41.94 %) which provides the plant itself and animal by energy were represented by higher value than that the study of El-Shamy (1995) and relatively comparable to that study of El-Kady (1987), Otal et al., (2010) and El-Amier and Ejgholi (2014) on same species.

The nutritive value of any forage depends upon its content of energy producing nutrients as well as its content of nutrients essential to the body (Dewhurst et al., 2009). The digestibility of the organic matter is of great importance for the evaluation of forage used for animal nutrition (Schubiger et al., 2001); TDN can be recorded as a measure of energy requirement of animals and the energy value of feeds. Crampton et al. (1957) reported that the caloric value of TDN is very close to 4500 kcal/ kg TDN. In the present study, the nutritive value attained 241.77 Cal/100g and TDN is about 54.37% DM (Table 2). For consumable forage, Abdel-Razik et al., (1988) reported annual average TDN value as 75% DM.

In comparison, Soliman and EL-Shazly (1978) calculated values of TDN for Egyptian clover, barley and corn as about 56, 64 and 68% DM, respectively. Also, red clover (*Trifolium pratense*) digestibility was ranging from 73.1 % to 66.4 % (Tremetsberger, 2010).

Herbs contained on average relatively high values of Net energy lactation is 6.45 ± 0.34 MJ /kg DM with only little variation between the species (Daccord et al., 2002). Metabolic energy and Net energy lactation from the feeding of *A. halimus* in the current study (Table 2) that was comparable according to DLG (1997). Tremetsberger (2010) reported that perennial ryegrass (*Lolium perenne*) and red clover had average neto energy content of 6.03 and 4.95 MJ /kg DM, respectively.

Macro- and micro-elements

Minerals have essential structural and physiological roles in animals (Daccord et al., 2002). The mineral content in forage is mainly determined by the site conditions (geology and soils), the plant community and the time of harvest (Buchgraber and Resch, 1997). Plants and animals need proper amounts of minerals to achieve maximum health and production.

The concentrations (mg/g dry weight) of the measured minerals in *A. halimus* are as shown in Figures 1 and 2.

Table 2; Calculated **parameters for the potential use of *Atriplex halimus* as fodder.**

Plant species	Calculated parameters				
	Total carbohydrate	Total digestible nutrients	Nutritive value	Metabolic energy	Net energy lactation
Atriplex halimus	%		Cal/100g	MJ/Kg	
	41.94	54.37	241.77	18.22	8.84

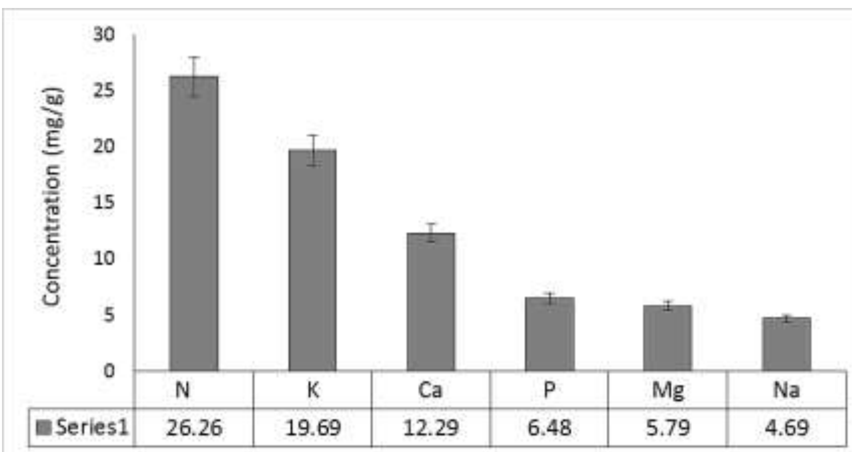

Figure 1; Different concentrations of macro-elements (mg/g dry weight) of *Atriplex halimus*.

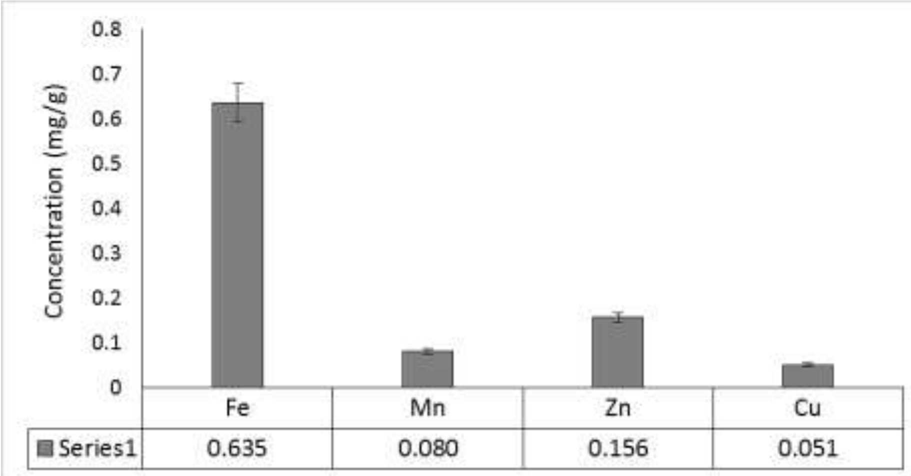

Figure 2 ; Different concentrations of micro-elements (mg/g dry weight) of *Atriplex halimus*.

The sequence of macro-minerals in *A. halimus* is: N (26.26) > K (19.69) > Ca (12.29) > P (6.48) > Mg (5.79) > Na (4.69), while the sequence of micro- minerals is: Fe (0.635) > Zn (0.156) > Mn (0.080) > Cu (0.050). Minerals play a role in four types of functions in animals: structural, physiological, catalytic, and regulatory (Suttle, 2010). The ARC (1980) system and NRC (2001) system, reported that the requirement for mineral nutrients for gestating beef cows or lactating beef cows is 38 mg/kg for K, 15.4 mg/kg for Ca, 12 mg/kg for P, 3 mg/kg for Mg, 6.8 mg/kg for Na, 45 µg/kg for Zn, 2 µg/kg for Mn and 7.1 µg/kg for Cu. Deficiency or excess of dietary mineral elements may cause animal production and health concerns; therefore, mineral elements balance is very important to keep animal health (Silva et al., 2015).

CONCLUSION

In arid areas, rangelands are subject to different stresses, including drought and erosion. Therefore, the results suggest that saltbush (*A. halimus*) could be used as feed for livestock due to their carbohydrates, proteins and minerals contents as well as low in soluble salts and water (especially in summer). Therefore, it is considered to be a partial solution to the problem of feed shortage in the Kingdom of Saudi Arabia.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

The author designed and implemented experiments, data analysis and also wrote the manuscript. In addition, the author has read and approved the final version.

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