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Atriplex halimus: halophyte plant as potential forage for ruminants in the arid area of South-East Algeria

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Abstract. The area of El Haouche in South-East of Algeria is considered as an extremely arid zone. Chenopodiaceous shrubs (*Salsola vermiculata*, *Sueada mollis*, *Atriplex halimus*) and the tree *Tamarix africana* are endemic species grazed specially by small ruminants and dromedary in this region. The physiognomic map of the study area vegetation reveals the predominance of *Atriplex halimus*. This is a perennial shrub tolerates well harsh conditions. Trace elements concentrations (Cu, Fe, Mn, Zn, Cd and Pb) were measured in *A. halimus*. Potential intake of Cu and Zn satisfy the requirement of small ruminants. Levels of Fe were high. Mn concentrations were lower. Cd and Pb contents correspond to the background level.

Keywords. *Atriplex halimus* – Chemical composition – Trace metal – Arid zone.

Le potentiel fourrager de la plante halophyte* Atriplex halimus *dans la région aride au sud-est de l'Algérie

***Résumé**. La région d'El Haouche au sud-est de l'Algérie est considérée comme une zone extrêmement aride. Les arbustes* Salsola vermiculata*,* Sueada mollis*,* Atriplex halimus *et l'arbre* Tamarix africana *sont des espèces endémiques dans cette région, pâturées spécialement par les petits ruminants et le dromadaire. La carte physionomique de la zone d'étude révèle la prédominance de* l'Atriplex halimus*. C'est un arbuste vivace qui tolère bien les conditions difficiles. Des recherches récentes ont démontré sa capacité à tolérer une forte concentration de métaux lourds. Les éléments traces (Cu, Fe, Mn, Zn, Cd et Pb comme élément toxique) ont été mesurés dans cet arbuste. Les teneurs en Cu et en Zn peuvent satisfaire les besoins des petits ruminants. Les concentrations du Fe sont élevées, par contre celles du Mn sont plus faibles. Les teneurs en Cd et en Pb sont naturelles.*

***Mots-clés**.* Atriplex halimus *– Composition chimique – Élément trace – Zone aride.*

I – Introduction

Arid regions in South-East of Biskra in East of Algeria contain soils and water resources that are too saline for most common crops. Vegetation at the edges of the Chott Melghir in this region comprises mainly taxa of the Chenopodiaceae family (such as *Atriplex* ssp., *Salsola* ssp., *Suaeda* ssp.) and the Tamaricaceae family, *Tamarix africana* grazed specially by goats, dromedary and sheep in this region. *Atriplex halimus* is a perennial spontaneous shrub of South-East of Biskra with an excellent tolerance to drought and salinity (Nedjimi, 2012). Moreover, recent researches demonstrated their ability to tolerate high concentration of heavy metal (Lotmani and Mesnoua, 2011).Trace elements (Cu, Mn, Fe, Zn…) function as activators of enzyme systems or as constituents of organic compounds. The ruminant may be exposed to toxic concentration of heavy metal (Cd, Pb) and other trace elements (Cu) by consuming contaminated forage in pasture. The aim of this study was to evaluate and compare seasonally through year the trace mineral levels (Cu, Mn, Fe, Zn) ; Cd and Pb as toxic element in *Atriplex* *halimus* (endemic Chott halophyte) in order to assess contributions, deficit and excess in animals requirements.

II – Materials and methods

The study was conducted in El Haouche (5 ° N 28 'E 30 ° 15') on the edge of Chott Melghir 30-35 km South-East of Biskra in South of Algeria. This area is characterized by a high salinity of the soil. Average annual precipitation is 140 mm (Haddi *et al*., 2009). The main soil has high pH value (7.5-8.2), the type soil is gypsum-lime, characterized by high salinity, and its conductivity ranges from 20 to 36 µS/cm (Haddi *et al*., 2009). Samples of *Atriplex halimus* were collected in different phonological stages. Due to overgrazing, edible green aerial parts of plants were not quantitatively available at each sampling period. Only edible green aerial parts, from 15 to 25 cm of length, were hand clipped. Edible parts were dried in air forced oven at 55℃ for 72 h. The dried samples were ground in K-Janke mill (1 mm screen) and stored in polypropylene bottles at room temperature for subsequent analysis. The wet digestion with nitric and perchloric acid (Elmer, 1994) was made to obtain extracts for the determination of trace minerals (Cu, Mn, Fe and Zn) using the flame Atomic Absorption Spectrophotometry (Shimadzu model AA 6800). Cd and Pb were analyzed with a graphite furnace after dry ashed at 550℃ for 16 h (Afri-Mehennaoui *et al*., 2009). Data were analyzed statistically, using the SAS software, by one -way ANOVA, to determine differences between means.

III – Results and discussion

The Cu concentration of *A. halimus* has no significant difference (P>0.05) in all seasons except for autumn (Table 1). The higher level was observed in winter (14.7 mg/kg) and the lower (11.5 mg/kg) in autumn. Cu levels were sufficient to meet maintenance requirements for goats (NRC, 1981; Kessler, 1991 and Ramirez-Orduna *et al*., 2005), sheep and cattle (Meschy, 2010).

Table1. Trace minerals levels (mg/kg DM) in *Atriplex halimus*

Season	Cu (mg/kg)		Mn (mg/kg)		Fe (mg/kg)		Zn (mg/kg)	
	Mean	SD†	Mean	SD†	Mean	SD†	Mean	SD†
Autumn	11.50[b]	2.12	19.30[a]	1.41	541[b]	63	49[b]	10,04
winter	14.70[a]	5.96	18.50[a]	2.21	679[a]	264	59[b]	13,40
Spring	14.50[a]	6.50	19.17[a]	6	578[a]	140	67[a]	6,40
Summer	13.15[a]	4.60	11.50[b]	1.84	608[a]	101	69[a]	6,00
Ruminants requirements (mg/kg M)[1]	10		50-60		30		50-60	
Goat requirements (mg/kg M)[2]	9		30		35		30	

Means with different letters are significantly different (P<0.05), †SD: standard deviation.

[1]Recommended requirement (Meschy, 2010), [2] Recommended requirement (NRC, 1981; Kessler, 1991 and Ramirez-Orduna *et al*., 2005).

The Mn concentrations of *A. halimus* has no significant difference in all seasons (P>0.05) except for summer. The high level was observed in autumn (19.3 mg/kg DM) (Table 1). However, Mn did not meet the requirement of goats, sheep and cattle as it was below the reported value (30 and 50-60 mg/kg DM) (Table 1). Manganese availability is inversely related to soil pH. The highest Mn concentrations are found in forages growing on acid soil (MacPherson, 2000). It is known that gypsum-lime soil has high level of Ca to lead a low level of Mn in plant. In our study area, the lower Mn concentrations in *Atriplex* are possible due to high concentration of Ca in soil.

Fe concentrations in *A. halimus* has no significant difference in all seasons, except autumn (Table 1). The higher concentration was in winter (679 mg/kg DM) and the lower one in autumn (541 mg/kg DM). The high levels of soil Fe about 29 g/kg (unpublished data) suggest a Fe translocation in high quantity to *A. halimus* growth in this soil. Mean Fe levels were higher than the requirements for ruminants in all seasons (Table 1). Concentration of Fe >300 mg/kg DM has a deleterious effect on Cu availability (MacPherson, 2000; Givens *et al.*, 2000). As reported by Ramirez-Orduna *et al.* (2005) Fe in levels from 250 to 1200 mg/kg may negatively affect Cu status of cattle and sheep.

The concentration of Zn varied from 49 mg/kg in autumn to 69 mg/kg in summer (Table 1). *A. halimus* in all season except for autumn had such Zn concentration to satisfy range cattle and sheep requirements (Table 1).These concentrations are above the Zn requirements for goat (NRC, 1981; Kessler, 199 and Ramirez-Orduna *et al.*, 2005).

The Zn levels of *Atriplex* in South Algeria is higher than that measured in South Africa at Lovedale (11mg/kg DM) (Van Niekerk *et al.*, 2004), site with an average annual rainfall of approximately 130 mm, similar to our arid area.

In this study Cd levels ranged from 0.06 mg/kg in summer to 0.35 mg/kg in winter, which was the significant highest concentration (Table 2). The forage Cd levels are dependent on the background level in soil. According to European directives Cd is limited in ruminant feed to 1 mg/kg DM (Meschy, 2010). Underwood and Suttle (1999) considered that Cd level varied from 0.5 to 5 mg/kg DM in the diet is high.

Table 2. Cadmium and lead (mg/kg DM) levels in *Atriplex halimus*

Season	Cd (mg/kg)		Pb (mg/kg)	
	Mean	SD	Mean	SD†
Autumn	0.20[b]	73	3[b]	0.62
Winter	0.35[a]	80	3[b]	0.81
Spring	0.08[c]	27	5[a]	3.73
Summer	0.06[c]	14	3[b]	2.13
Diet (mg/kg DM) Cattle and Sheep†	0.1-0,2		1-6	N. Normal
	0.5- 5		20- 1000	H. High
	> 50		> 2000	T. Toxic

Means with different letters are significantly different (P<0.05); SD: standard deviation.
†Underwood and Suttle (1999).

According to the results, *A. halimus* has a natural Cd content. Due to their electronic configuration close, Cd, Cu, Fe and especially Zn are competing against protein intestinal absorption. Excess cadmium can decrease their absorption and induce deficiencies in these elements. Cadmium toxicity is due to its accumulation in the liver and especially in the kidneys, and symptoms of Cd poisoning are similar to those in partnership with Zn deficiency (Meschy, 2010).

Lead (Pb) is among the most common heavy metals that cause toxicity to animal and humans. Pb level in whole plant (Table 2) was high (P<0.05) in spring (5 mg/kg DM), while it had no significant differences in the other seasons (P>0.05). Those levels were lower than that observed in contaminated area. According to Zafar et al. (2012) maximum tolerable levels of Pb by animals is 30 mg /kg DM. High tolerance may have been due to the insoluble source used, toxicity is likely to be reduced when diets rich in calcium are fed (Underwood and Suttle, 1999).

IV – Conclusions

According to the results themean levels of trace metals in *Atriplex halimus* are high for Fe, close to the recommended value by INRA for Cu and Zn, deficient for Mn and close to the background level for the Cd and Pb. Levels of Fe in the plants are very high suggesting a high level in soil. The range small-ruminants grazing the *Atriplex halimus* in these areas must be supplemented with Mn throughout the year in order to sustain goat and sheep productivity. The knowledge of bioavaibility of these trace minerals in ruminant's asks for a detailed study in the future.

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