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Seasonal Variations in Nutritive Value and Elemental Composition of Two Saltbush Plants Grown in Assiut, Egypt

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Abstract:

Saltbush shrubs are halophytic plants found in many regions of the world, they are promising as forage sources, but their chemical composition varies during the seasons of the year. This study was conducted in Assiut, Egypt to investigate the nutritive value and chemical composition of quail saltbush (*Atriplex lentiformis*) and old man saltbush (*Atriplex nummularia*) as affected by the seasonal variations. Composite samples of leaves and stems of each species were collected in the winter, spring, summer and autumn of 2013. The nutritive value and mineral contents of the tested plants varied considerably during the year. Leaves had relatively low concentrations of phosphorus (P) and high concentrations of sodium (Na), potassium (K), and chloride (Cl) during the summer season; however calcium (Ca) and magnesium (Mg) contents remained unaffected throughout the seasons. The crude protein in the leaves of *A. nummularia* and *A. lentiformis* was about 22 and 18%, while in the stems it was about 6.7 and 4.6% respectively. The tested saltbush plants are good as protein source during the winter. In that season of the year, the crude protein (CP) of the leaves of *A. lentiformis* and *A. nummularia* was increased by 32 and 26% respectively compared to the summer. The ash content of saltbush plants was increased by about 25% in the summer compared to the other seasons, while the moisture content remained unaffected during the winter, spring and autumn seasons and then declined by about 17% during the summer, this indicates that saltbush plants may be minimize their succulence moisture content during the summer to achieve osmotic adjustment.

Keywords: Halophytes, *Atriplex*, Nutritive value, Elemental composition.

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1. Introduction:

Most of the agricultural potential expansions in the world are found in deserts which reside in arid zones where shortage of water, unfavorable soil properties and nutrients deficiencies are the most troublesome issues facing any agricultural project proposed for such areas (Silvertooth, 2005; Badr *et al*., 2012). Halophytic plants grow naturally in saline environment in many arid and semi-arid regions around the world and are distributed from coastal areas to mountains and deserts. Halophyte species can be irrigated with saline water and can also tolerate drought, freezing and heat (Thomas *et al.,* 1998; Jordan *et al*., 2002; Lutts *et al*., 2004). Halophytic plants have many uses: They can be used as animal feeds, vegetables, and drugs, as well as for sand dune fixation, wind shelter, soil cover, cultivation of swampy saline land and paper production (El Shaer and Attia-Ismail, 2002). Feed shortage especially in arid and semi-arid regions has led to the exploration and exploitation of marginal resources such as halophytes. As an animal feed component, halophytes are promising because they have the potentiality of being good feed resource (Masters *et al.,* 2007).

Among the halophyte flora, species belonging to the genus *Atriplex* may be of special interest because of their high biomass production associated with a deep root system able to cope with the poor structure and xeric characteristics of several soils (Thomas *et al.,* 1998; Jordan *et al.,* 2002; Lutts *et al.,* 2004). *Atriplex* (saltbush) species are characterized by good forage production, adaptation to living in environments affected by desertification, especially in arid areas, their applicability for restoration of rangelands, preventing erosion and protecting wildlife, fuel usage, tolerance to salinity and harsh environmental conditions (Mousavi Aghdam, 1986; Le Houerou 1992, 1995; Walker *et al.,* 2014). Although the traditional forage crops (e.g., corn, alfalfa and Sudan grass), have high nutritive values and productivity compared to halophytic plants (Swingle *et al.,* 1996; Dann *et al.,* 2008), the water use efficiency by that forage crops is very low compared to halophytes (Soliz *et al.,* 2011; Hashim *et al.,* 2012). Moreover, saltwater irrigation is becoming an increasingly important practice because the quality of irrigation waters is decreasing as water supplies for agriculture become restricted due to urban needs and climate change (Wahla and Kirkham, 2008).

There is little information available about the nutritive value and elemental composition of saltbush plants grown under the conditions of Assiut, Egypt. The objective of this study was to investigate the ionic contents and nutritive value of quail saltbush (*A. lentiformis*) and old man saltbush (*A. nummularia*) during the different seasons of the year. This information will be useful in determining the potential of saltbush plants as animal feed.

2. Materials and Methods:

2.1. Site description and plant samples collection:

The plants of quail saltbush (*A. lentiformis*) and old man saltbush (*A. nummularia*) were transplanted in the Experimental Station of Department of Soils and Water, Faculty of Agricultural, Assiut University, Assiut, Egypt (27º12'N, 31º09'E) in 1990. The plants were cultivated in a non saline soil (EC = 1.1 dS m^{-1}) and were irrigated by River Nile water (EC = 1.2 dS m^{-1}). Composite plant samples from each species were collected randomly during 2013; sampling started in the 15th of February and was made every three months. Three replicates of each sample were collected. The study area is characterized by a hot climate in summer and cold in winter without rain fall, Table 1 summarized the meteorological data of the study area during 2013.

Table (1): Average monthly maximum (T_{max}) and minimum (T_{min}) temperature, maximum (R_{max}) and minimum (R_{min}) relative humidity, wind speed (WS), soil temperature (ST), evapotranspiration (ET_o) and rain fall during 2013

Month	T_{max} (°C)	T_{min} (°C)	R_{max} (%)	R_{min} (%)	WS (km h^{-1})	ST (°C)	ET_o (mm)	Rain fall (mm)
January	18.1	4.0	78.1	40.5	2.4	12.5	2.3	0.0
February	22.2	6.8	67.7	31.6	2.6	16.0	3.5	0.0
March	24.8	8.4	68.8	30.1	3.5	18.4	4.8	0.0
April	29.4	12.0	62.9	27.0	3.0	22.7	6.0	0.0
May	33.8	18.7	65.4	29.2	3.4	27.5	7.4	0.0
June	36.2	20.7	65.4	31.1	4.2	29.7	8.4	0.0
July	37.7	22.0	66.1	31.7	3.9	31.6	8.5	0.0
August	36.3	20.8	68.2	33.3	3.2	30.4	7.7	0.0
September	33.6	17.9	70.6	34.2	2.9	27.6	6.7	0.0
October	16.6	8.8	36.2	17.1	1.2	13.6	2.7	0.0
November	13.0	6.7	37.9	19.7	1.1	10.6	1.7	0.0
December	20.2	6.6	76.4	39.1	2.4	14.4	2.7	0.0

Table (2): Physical and chemical characteristics of the experimental site (0-30cm)

Soil properties	Value
Clay (g kg^{-1})	200
Silt (g kg^{-1})	350
Sand (g kg^{-1})	450
Texture	Loam
$CaCO_3$ (g kg^{-1})	52
pH (1:2)	7.92
EC (1:2) (dS m^{-1})	1.10
Organic carbon (g kg^{-1})	7.2
Total nitrogen (mg kg^{-1})	260
Available-P (mg kg^{-1})	12.5
Available-K (mg kg^{-1})	300
Available-Fe (m kg^{-1})	5.5
Available-Zn (mg kg^{-1})	1.8
Available-Mn (mg kg^{-1})	4.2
Available-Cu (mg kg^{-1})	1.1

Each value represents a mean of three replicates

2.2. Soil characterization:

Composite soil sample (0-30 cm) was collected from the experimental site to assess the physical and chemical characteristics. The soil was air-dried and ground to pass through a 2-mm sieve. Particle-size distribution of the soil sample was performed using the pipette method that was described by Jackson (1973). Soil pH was measured using a digital pH meter in a 1:2 suspension of soil-to-water ratio. Organic matter content of the soil was determined using the dichromate oxidation method as described by Wakley and Black (Jackson, 1973). Total carbonates in the soil was estimated using calcimeter method and calculated as $CaCO_3$ (Nelson, 1982). The electrical conductivity (EC) was estimated in 1:2 soil to water extract using the salt bridge method (Rhoades, 1982). Total soil nitrogen was determined using micro-Kjeldhal method. Available soil phosphorus was extracted by 0.5 M sodium bicarbonate solution at pH 8.5 according to Olsen *et al.* (1954) and phosphorus was determined by spectrophotometer. Available soil potassium was extracted by 1 M ammonium acetate at pH 7 and then measured by flame photometer. Available soil iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) were extracted from the soil sample using a 0.005 M DTPA (diethylene triamine penta acetic acid) solution buffered at pH 7.3 as described by Lindsay and Norvell (1978), then measured by the Inductivity Coupled Plasma Optical Emission Spectrometry (ICP-OES, thermo iCAP 6000 series). The physical and chemical characteristics as well as the concentrations of available nutrients of the experimental site are presented in Table 2.

2.3. Plant analysis:

The plant samples were weighed, cleaned, washed with tap and distilled water, air dried, then dried in oven at 70 $^{\circ}$C until constant weight, ground and stored for chemical analysis. The fresh and dry weights of samples were recorded to assess the moisture content. Plant samples were digested in H_2SO_4 and H_2O_2 as described by Parkinson and Allen (1975), then analyzed for the different elements according to the standard methods (see Burt, 2004; Cottenie *et al.*, 1982). Phosphorus was measured by spectrophotometer. Crude protein was determined by Kjeldhal distillation method and calculated as % nitrogen multiplied by the factor 6.25. Ash content was defined by dry-ashing in a muffle furnace at 450°C for 6 h. Sodium and potassium were measured by flame photometer. Chloride in the digested plant samples was measured by titration with silver nitrate after neutralizing the pH of the plant digest. Calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) in the digested plant samples were measured by the Inductivity Coupled Plasma Optical Emission Spectrometry (ICP-OES, thermo iCAP 6000 series).

2.4. Statistical analysis:

The Analysis of Variance (ANOVA) was used to test the significant of differences between the species and seasons. The collected data were statistically analyzed using MSTAT computer program as described by Michigan State University (1983). Means were compared using

Duncan multiple range tests at 5% level of probability. All data in tables and figures are means of three replicates.

3. Results and Discussion:

3.1. Concentrations of calcium, phosphorus and magnesium in saltbush plants:

The data in Table 3 show the concentrations of phosphorus (P), calcium (Ca) and magnesium (Mg) in the leaves and stems of *A. lentiformis* and *A. nummularia* during the winter, spring, summer and autumn seasons of 2013. The concentrations of P in the leaves and stems of *A. lentiformis* and *A. nummularia* varied significantly ($P < 0.05$) during the seasons of the year. Phosphorus concentrations in the leaves of saltbush plants ranged between 1.75-2.35 g kg^{-1} and in the stems ranged between 0.65-1.10 g kg^{-1}. The leaves of *A. nummularia* which collected in the winter contained the higher P concentration (2.35 g kg^{-1}), while that collected in the summer contained the lowest value of P (1.75 g kg^{-1}). Leaves had relatively higher concentrations of P during the autumn, winter and spring seasons than that recorded in the summer season. El Shatnawi and Mohawesh (2000) reported that during the hot conditions in the summer the concentrations of P in the leaves and stems of saltbush plants *A. halimus* may be reduced.

Table (3): Concentrations of phosphorus (P), calcium (Ca), and magnesium (Mg) in the leaves and stems of the tested saltbush plants (g kg^{-1})

Season	*A. lentiformis*			*A. nummularia*		
	P	Ca	Mg	P	Ca	Mg
	leaves					
Winter	2.33 a	4.78 a	1.23 a	2.35 a	4.98 a	1.55 a
Spring	2.12 ab	4.72 a	1.20 a	2.10 a	4.95 a	1.45 a
Summer	1.82 b	4.82 a	1.18 a	1.75 b	4.92 a	1.56 a
Autumn	2.22 a	4.89 a	1.23 a	2.00 ab	5.00 a	1.46 a
	stems					
Winter	1.10 a	1.85 a	0.50 a	1.00 a	1.57 a	0.45 a
Spring	0.95 ab	1.83 a	0.45 a	0.92 a	1.57 a	0.48 a
Summer	0.75 b	1.80 a	0.48 a	0.65 b	1.52 a	0.55 a
Autumn	1.10 a	1.90 a	0.48 a	0.92 a	1.50 a	0.52 a

Means denoted by the same letter indicate no significant difference according to Duncan's test at $P<0.05$.

The data in Table 3 show the concentrations of calcium (Ca) and magnesium (Mg) in the leaves and stems of *A. lentiformis* and *A. nummularia* during the different seasons. The concentrations of Ca and Mg varied significantly ($P < 0.05$) between the two studied species. Niekerk *et al*. (2004) studied the mineral concentrations of *Atriplex canescens*, *A. halimus* and *A. nummularia* and they found significant differences between the species. Calcium concentrations in the tested plants ranged between 4.72-5.00 g kg^{-1} in the leaves and between 1.50-1.90 g kg^{-1} in the stems. Magnesium concentrations in the tested plants ranged between 1.18- 1.90 g kg^{-1}in the leaves and between 0.45-0.55 g kg^{-1} in the stems.

The concentrations of Ca and Mg in the leaves and stems of the two studied saltbush plants remained constant during the year and was not affected by the weather changes during the different seasons. Nedjimi (2011) studied the effect of seasonal variations on the ion contents of *Atriplex halimus* and found that the concentrations of Ca during the four seasons (autumn, winter, spring and summer) were stable and no significant changes were recorded during the year. In general, the concentrations of P, Ca and Mg in the leaves of *A. lentiformis* and *A. nummularia* were higher than that recorded in the stems; similar results were recorded by El Shatnawi and Mohawesh (2000), Soliz *et al.* (2011) and Eissa (2015).

3.2. Concentrations of some micronutrients in saltbush plants

The concentrations of iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) in the leaves and stems of *A. lentiformis* and *A. nummularia* are presented in Table 4.

Table (4): Concentrations of iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) in the leaves and stems of the tested saltbush plants (mg kg^{-1})

Season	*A. lentiformis*				*A. nummularia*			
	Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
	leaves							
Winter	350 b	90 a	82 a	22 a	400 a	115 a	85 b	26 ab
Spring	345 b	85 b	81 a	20 ab	400 a	95 b	88 a	27 ab
Summer	360 a	85 b	78 a	18 b	402 a	110 a	80 c	28 a
Autumn	360 a	89 a	83 a	20 ab	395 a	94 b	78 d	25 b
	stems							
Winter	60 b	23 ab	18 a	5.5 a	70 b	26 a	17 a	8.0 a
Spring	62 ab	23 ab	14 b	6.5 a	75 a	22 b	18 a	6.5 a
Summer	65 a	22 b	17 ab	5.0 a	65 c	27 a	15 ab	7.0 a
Autumn	60 b	24 a	18 a	5.0 a	66 c	24 ab	13 b	7.5 a

Means denoted by the same letter indicate no significant difference according to Duncan's test at $P<0.05$.

The concentrations of micronutrients in the leaves and stems of the tested saltbush plants generally followed the order: Fe > Mn > Zn > Cu. The concentrations of the mentioned nutrients in the stems were less than that found in the leaves. The leaves of *A. nummularia* significantly ($P < 0.05$) contained more Fe, Mn and Cu than the leaves of *A. lentiformis* did, the concentrations of Fe, Mn and Cu in the leaves of *A. nummularia* were higher by about 12, 19 and 32% respectively in comparison to the concentrations of that nutrients in the leaves of *A. lentiformis*. Similar results were reported by Khalil *et al.,* (1986) and Eissa (2015). The concentrations of Zn were almost equal in the leaves of both saltbush species and the differences between the two species were not significant. Overall the two species, the effect of seasonal variations on the concentrations of Fe, Mn, Zn and Cu was no clear and had not apparent trends, but the concentrations varied during the four seasons. The variations in mineral contents of halophytes depend on several factors. Type of soil, level of salinity (in either soil or irrigation water), mineral content of the soil, plant species, season, stage of growth and part of the plant are among the factors affecting mineral contents of halophytes (Attia-Ismail, 2008).

3.3. Concentrations of sodium, potassium and chloride in saltbush plants:

Table 5 shows the concentrations of sodium (Na), potassium (K) and chloride (Cl) in the leaves and stems of *A. lentiformis* and *A. nummularia*. The concentrations of Na, K and Cl varied significantly ($P < 0.05$) between the two species, the leaves and stems of *A. nummularia* contained the highest values of the mentioned elements compared to the leaves and stems of *A. lentiformis*. The concentrations of Na, K and Cl varied between the *Atriplex* species (Khalil *et al.,* 1986; Irshad *et al.,* 2000; Niekerk *et al.,* 2004, Eissa, 2015). Based on the data in Table 5, it is clear that *Atriplex* plants accumulated high levels of Na, K and Cl into leaves tissues. This was unsurprising since *Atriplex* spp. are halophytes (Malik *et al.,* 1991; Blank *et al.,* 1998; Gul *et al.,* 2000; Khan *et al.,* 2000; Mendez *et al.,* 2007). The leaves and stems of the studied *Atriplex* species exhibited high affinity for Na than K. Mozzafar *et al.,* (1970) reported that *A. halimus* exhibited a higher affinity for Na than K. It had been observed that the Na contents in roots and shoots of the species of *Chenopodiaceae* (*Atriplex spongiosa* and *Suaeda monoica*) were higher than the K contents (Story and Jones 1979). Irshad *et al.*, (2000) and Eissa (2015) found the same phenomena for *A. lentiformis, A. undulata* and *A. amnicola*.

Table (5): Concentrations of sodium (Na), potassium (K) and chloride (Cl) in the leaves and stems of the tested saltbush plants (g kg^{-1})

season	*A. lentiformis*			*A. nummularia*		
	Na	K	Cl	Na	K	Cl
	leaves					
Winter	41.3 b	21.0 c	30.0 c	51.4 b	24.1 b	31.2 c
Spring	40.0 b	21.8 b	31.2 b	47.2 c	23.8 b	33.8 b
Summer	54.2 a	25.0 a	35.4 a	64.5 a	30.0 a	39.2 a
Autumn	40.0 b	22.4 b	31.5 b	51.8 b	22.5 c	34.0 b
	stems					
Winter	13.8 a	9.50 a	10.0 b	15.2 a	10.00 ab	12.2 a
Spring	13.5 a	8.90 a	12.2 a	16.2 a	9.90 ab	12.5 a
Summer	14.0 a	10.0 a	10.0 b	15.5 a	11.00 a	11.5 a
Autumn	14.2 a	9.20 a	9.50 b	15.8 a	9.40 b	10.0 a

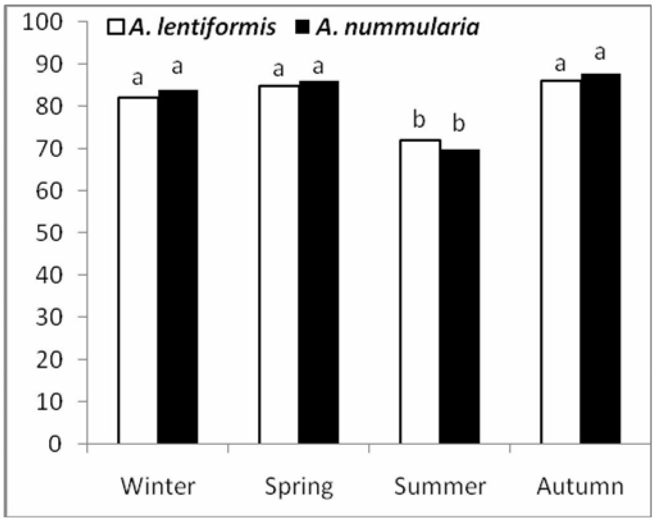
Means denoted by the same letter indicate no significant difference according to Duncan's test at $P<0.05$.

The concentrations of Na, K and Cl in the leaves of *A. lentiformis* and *A. nummularia* were affected significantly ($P < 0.05$) by the seasonal variations, while the concentrations of the mentioned elements in the stems remained stable through the different seasons. The leaves of *A. lentiformis* which collected in the summer contained Na higher by about 35% compared to that collected in the other seasons. The concentrations of Na^+ in the leaves of *A. nummularia* which collected in the summer were higher by about 37% compared to that collected in the spring and by about 20% compared to that collected in the winter or autumn. The leaves of *A. lentiformis* which collected in the summer contained K higher by about 19% compared to that collected in the winter. The concentrations of K in the leaves of *A. nummularia* which collected in the summer were higher by about 33% compared to that collected in the autumn. The leaves of *A. lentiformis* and *A. nummularia* which was collected in the summer contained higher Cl by about 18 and 26% respectively compared to that collected in the winter. In general, the concentrations of Na, K and Cl in the leaf tissues of the studied *Atriplex* plants were higher in the summer compared to the other seasons of the year. Nedjim (2011) studied the seasonal variations in the chemical composition of *Atriplex halimus* and found that the contents of Na and K in plant were higher during the summer, also Aziz *et al.,* (2011) and Agha and Khan (2009) found that the concentrations of Na, K and Cl in *Atriplex stocksii* varied significantly ($P < 0.05$) through the year. Chenopods are known as salt accumulators and have high Na and Cl contents (Gul *et al.*, 2000; Khan *et al.*, 2000), Na and Cl uptake, necessary for osmotic adjustment in halophytes (Flowers 2004; Koyro and Eisa, 2008). Nedjim (2011) suggested that *A. halimus* employs an osmo-conformer strategy during the summer period and appears to use osmotic adjustment during the dry periods.

3.4. Nutritive value of saltbush plants:

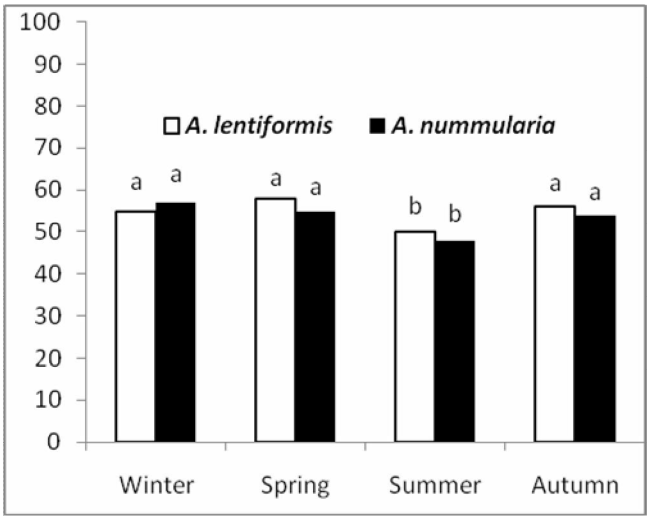
The water content in the leaves and stems of *A. lentiformis* and *A. nummularia* remained unaffected during the winter, spring and autumn seasons, but it declined significantly ($P < 0.05$) during the summer (Fig. 1 and 2). In the summer season, the saltbush plants minimized the water content of leaves and stems. On the other hand the ash content of these plants was elevated. The highest significant ($P < 0.05$) values of ash were recorded in the summer season, while the lowest values were recorded in the winter (Fig. 3 and 4). The ash content of the leaves of *A. lentiformis* and *A. nummularia* which collected in the summer was higher by about 21 and 23% compared to that collected in the winter. The seasonal variations affected significantly ($P <$ 0.05) the ash content of the stems of the studied plants.

Figure (1): Moisture content (%) of the leaves of saltbush plants



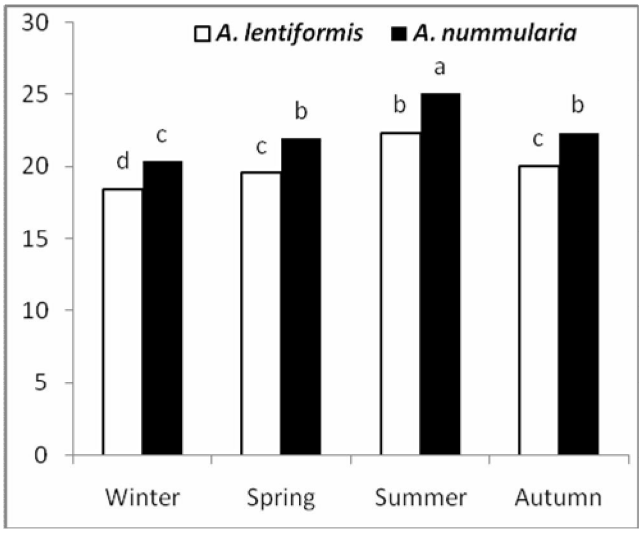
Means denoted by the same letter indicate no significant difference according to Duncan's test at *P*<0.05.

Figure (2): Moisture content (%) of the stems of saltbush plants



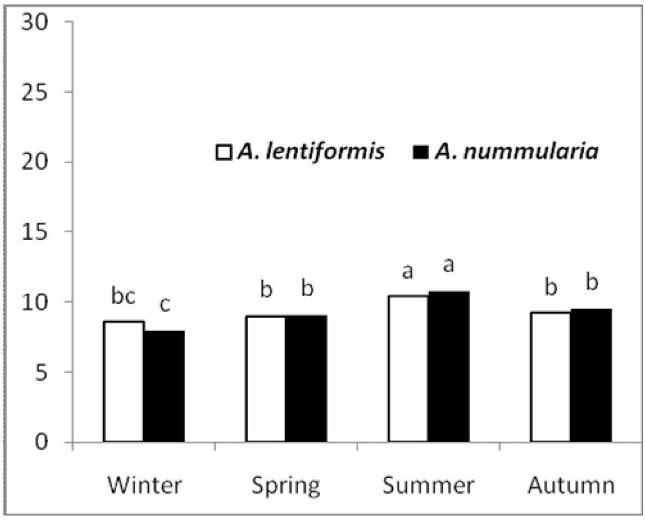
Means denoted by the same letter indicate no significant difference according to Duncan's test at *P*<0.05.

Figure (3): Ash content (%) of the leaves of saltbush plants



Means denoted by the same letter indicate no significant difference according to Duncan's test at $P<0.05$.

Figure (4): Ash content (%) of the stems of saltbush plants

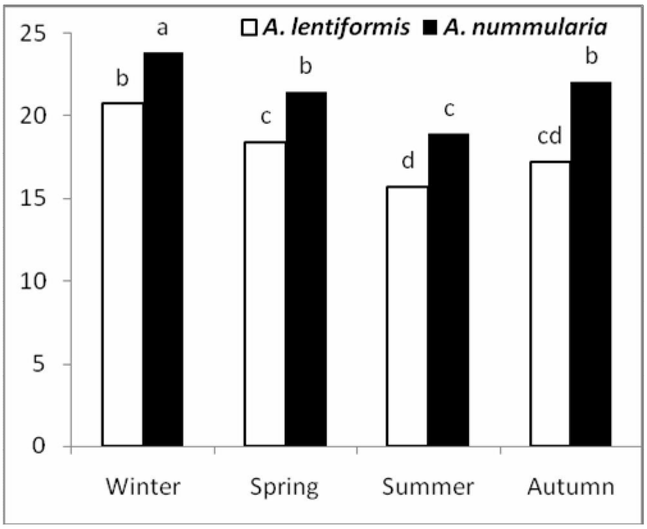


Means denoted by the same letter indicate no significant difference according to Duncan's test at $P<0.05$.

The ash content of the stems of *A. lentiformis* and *A. nummularia* which collected in the summer was higher by about 21 and 36% compared to that collected in the winter. The concentrations of Na, K and Cl in the leaves of the tested plants elevated in the summer compared to the other seasons and this may be explained the raising of ash content in the plant tissues. Ash is the inorganic residue remaining after either ignition or complete oxidation of organic matter in a plant material. It represents a measure of the total amount of minerals (e.g., Na, K, Ca) present within plant tissues. The saltbush plants minimized the water content of leaves and stems in the summer season; on the other hand the ash content of these plants was increased. This indicates that plants of saltbush minimize their water uptake during summer to achieve osmotic adjustment, which helps them to adapt with the high temperature in the summer. Similar results were found by Nedjim (2011). The ash content of the leaves varied significantly between the two saltbush plants, whereas the leaves of old man saltbush contained higher ash by about 11% compared to the leaves of quail saltbush. Khalil *et al.,* (1986), Attia-Ismail (2008) and Eissa (2015) found similar results. There were no significant differences between the stems ash of the two tested plants.

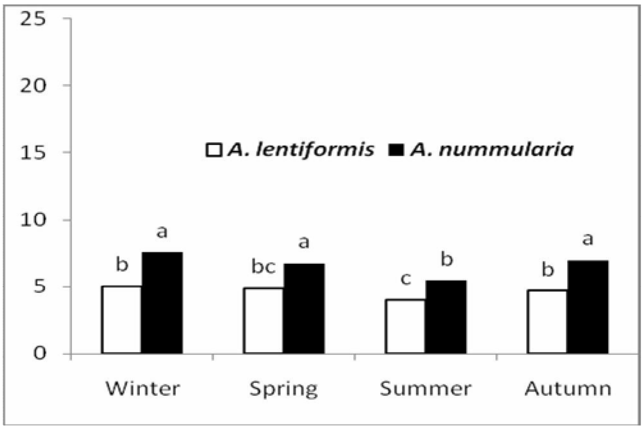
The seasonal variations significantly ($P < 0.05$) affected the crude protein (CP) of saltbush plants, whereas the highest values of CP were recorded in the winter season and the lowest values were recorded in the summer (Fig. 5 and 6). In the winter, the CP of the leaves of *A. lentiformis* and *A. nummularia* was increased by 32 and 26% respectively compared to the summer, while the CP of the stems of the two species was increased by 25 and 39% respectively. Remarkable variation in the crude protein content of *A. canescens* and *A. polycarpa* leaves had recorded during the different seasons of the year (Chatterton *et al.,* 1971; Thomson *et al.,* 1997). Nedjimi (2011) and El Shatnawi and Mohawesh (2000) found that the high CP in *Atriplex halimus* plants was recorded in the winter and spring seasons rather than the summer. The CP of the leaves and stems varied significantly ($P < 0.05$) between the two species. The leaves and stems of the old man saltbush contained higher CP by about 19 and 45% compared to the leaves stems of the quail saltbush plants. Similar results were reported by Khalil *et al.,* (1986), Irshad *et al.*, (2000), Attia-Ismail (2008) and Eissa (2015). The ash content and crude protein are indicators of the nutritive value of forage crops; the higher their concentration the higher is the nutritive value of the forage crop. The ash content is a measure of the nutrient content of the material and the protein content is a critical parameter in animal nutrition. Leaves contained more ash and crude protein than stems. Similar results were reported by El Shatnawi and Mohawesh (2000), Soliz *et al.,* (2011) and Eissa (2015).

Figure (5): Crude protein (%) of the leaves of saltbush plants



Means denoted by the same letter indicate no significant difference according to Duncan's test at *P*<0.05.

Figure (6): Crude protein (%) of the stems of saltbush plants



Means denoted by the same letter indicate no significant difference according to Duncan's test at *P*<0.05.

4. Conclusions:

Atriplex genus contains important halophyte plants. It is a genus contains more than 100 species, known by the common name of saltbush or orach. In the current study, the nutritive value and elemental composition of quail saltbush (*A. lentiformis*) and old man saltbush (*A. nummularia*) were investigated during the seasons of 2013. The tested saltbush plants are good protein source during the winter season and contain more ash in the summer. The nutritive value and elemental composition vary during the year. The tested plants tend to minimize their water content during the summer and increase the sodium, potassium and chloride to active osmotic adjustment strategy.

5. References:

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التغيرات الموسمية في القيمة الغذائية و التركيب العنصري لنوعين من نباتات القطف ناميين في أسيوط ، مصر

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الملخص:

نباتات القطف هي نباتات محبة للملحية تنتشر حول العالم في كثير من المناطق الجافة و هي نبات علف واعدة و لكن التركيب الكيميائي لها يتغير خلال فصول العام. هذه الدراسة أجريت في أسيوط، مصر لبحث التغيرات الموسمية في القيمة الغذائية و التركيب العنصري ل *Atriplex lentiformis* و *Atriplex nummularia*. تم جمع عينات مركبة من سيقان و أوراق كل نوع خلال الشتاء و الربيع و الصيف و الخريف فى عام ٢٠١٣. تباينت القيمة الغذائية و التركيب المعدني للنباتين المدروسين خلال العام. احتوت الأوراق على تركيزات منخفضة من الفوسفور و تركيزات مرتفعة من الصوديوم و البوتاسيوم و الكلوريد خلال فصل الصيف بينما لم تتأثر تركيزات الكالسيوم و الماغنسيوم خلال الفصول المختلفة. كانت قيم البروتين الخام في أوراق *A.lentiformis* و *A.nummularia* هي ٢٢ و ١٨% بينما في السيقان كانت ٦,٧ و ٤,٦% على الترتيب. نباتي القطف تحت الدراسة يعتبرا مصدرا جيدا للبروتين في فصل الشتاء، في هذا الفصل ازداد محتوى البروتين الخام في أوراق *A. lentiformis* و *A. nummularia* بمقدار ٣٢ و ٢٦% مقارنة بفصل الصيف. محتوى الرماد لنباتي القطف المدروسين ازداد تقريبا بمقدار ٢٥% في فصل الصيف مقارنة بفصول العام الأخرى، بينما لم يتغير محتوى الرطوبة في فصول الشتاء و الربيع و الخريف ثم انخفض في فصل الصيف، و هذا قد يدل على أن نباتات القطف تقلل محتوى العصارة من الماء لتحفيز ضبط الضغط الأسموزى.