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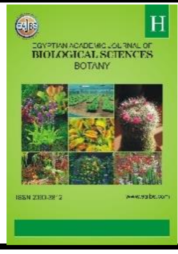

Morphological, Biochemical and Soluble Sugars Characters of Aloe vera Subjected to Saline Condition

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ABSTRACT

Aims:Salinity is one of the factors limiting the growth and survival of the plants, stops their growth by interactions such as osmotic potential and toxicity and makes the nutrition imbalance.

Methods: The research examined the salinity effect on pharmaceutical *Aloe Barbadensis* plant; the plant was irrigated with half percent Hoagland nutritional solution containing different rates of Sodium chloride (0, 6, 12 & 18 dS/m) and the plants were harvested in 15 and 45 day intervals.

Results:The following morphologic specifications were tested: the plant height, the leaf and root length, the leaf thickness and breadth, the weight of wet shoot and root, the weight of dry shoot and root and the weight of the gel and gel soluble sugars in Aloe vera leaves. In addition, the concentration of Na, K, Cl and Ca of the shoot and root and K/Na and Ca/ Na ratio were examined.

Conclusions:One of the most important Aloe Vera's tolerance mechani may be the creation of appropriate K/Na , Ca/Na ratio in the shoot in prin time of the tension namely in 15 days and also the salinity rates create m fluctuations on the soluble sugars rates especially glucose and xylose.

INTRODUCTION

Salt stress is one of the major abiotic stress factors that affect almost every aspect of physiology and yield. Thus, it is a serious threat to agriculture productivity especially in arid and semiarid regions. Soil salinity stress plants in two ways: high concentrations of salts in the soil make it harder in roots to extract water, and high concentrations of salts within the plant can be toxic (Munns and Tester, 2008). Salt stress causes hyperosmotic stress and ion disequilibrium thereby disabling the vital cellular function of a plant, reduce of availability of water, increase respiration rate, altered mineral distribution are some of the events that prevail during this stress episode. Plants try to withstand these stresses either by tolerating it or by adopting a dormant stage (Babu *et al*., 2012). Salt tolerance is a complex trait which involves numerous genes various physiological and biochemical mechanisms (Cuartero *et al*., 2006). Tolerance to biotic stresses is very complex at the whole plant and cellular levels (Grewal, 2010). This is in part due to the complexity of interactions between stress factors and various molecular, biochemical physiological phenomena affecting plant growth and development (Hamdia and Shaddad, 2010).

Aloe barbadensis Miller or Aloe Vera, which live several years, is of the Liliaceae or Aloeaceae family; it may be found in all tropical regions of the world so it is difficult to plant it in other ones. It is thought that it is local in the north of Africa or the Nile River in Sudan. The Aloe family includes more than 400 genera of them *Aloe barbadensis*, *Aloe aborescens* and *Aloe chinensis* are known more and it seems that *Aloe barbadensis* is biologically more active; it may divide the products of it into two groups as follows: Aloe latex and Aloe gel; the first one which is yellow and bitter secreted from the phloem circumference towards the leafs' surface. The most important and active is the Aloe latex structure is the hydroxyanthracene derivatives such as Anthraquinone glycosides aloin A and B. Aloe gel is colourless found in new leafs; it includes more than 98 percent water and polysaccharides such as pectins, cellulose, hemicelluloses, glucomannan, acemannan and mannose derivatives (Bozzi *et al*., 2007).

Aloe vera is known in many regions because of the unique organic photochemistry in its leafs useful to man's health. In recent years most studies done related to Aloe vera have assessed the role of controlling or supervising man's diseases such as stomach gastric traumas , antibacterial activities , defense against hippocampus and brain membrane , acne treatment and other remedial factors ; that is why Aloe vera has a potential in new pharmaceutical plants in arid regions so it is important to know the molecular physiology, biochemistry and mechanism in relation to nutritional elements absorption , transfer and synthesis and also accumulation in this genus under environment conditions to improve the plants' nutritional value and nutritional ingredients and concentration (Hernandez *et al* ., 2002) . CAM (crassulacean acid metabolism) plants such as Aloe vera (*Aloe barbadensis*. Miller) are known as succulent because they accumulate water in their leaves and stems. They are also characterized by nocturnal Co_2 assimilation and nocturnal stomata aperture; the stomata are kept closed during the day to avoid water loss. Due to physiological characteristics, these plants increase water use efficiency (Winter *et al*., 2005). *Aloe barbadensis* Miller, known as Aloe vera, require limited irrigation depending on the capacity of the soil to retain humidity since it is a CAM species and thus naturally adapted to the condition of dryness and high temperature (Delatorre- Herrara., 2010).

Zan *et al* (2007) studying the physiological and ecological characters on Aloe vara under seawater irrigation (Ec = 24.3 dS/m) reported that salinity stress caused a decrease in tissue water, total soluble sugar and glucose. Moghbeli *et al* (2012) studying the effect of salinity stress on growth and yield od Aloe vara, results indicated that Aloe plants are not able to tolerant long time salinity stress while in short time they show positive responses like root length. Mustafa (1995) suggested that in Aloe vara 0.1% salinity results in increased growth parameters while 0.4% salinity reduces growth parameters. Additionally, demonstrate that the highest amounts of compound carbohydrates were obtained with 0.4% salinity while the highest amount of crude aloin and barbalion were obtained with 0.2% salinity. The results of study concentration of heavy metals in Aloe vara leaves collected from different geographical locations of India showed that Aloe vara plant is a good absorber of metals and concentration of minerals depends on the different geographical conditions as well as the composition of soils. Therefore, direct use of this plant for a human may cause heaths problems but can be used after proper removal of metals by appropriate techniques. This study also concluded that it could also be used for the removal of heavy metal from the soil and wastewater because it has the capacity to absorb the metal from soil (Rai *et al*., 2011). Rahimi- Dehgolan *et al* (2012) study were conducted to examine the morphological and physiological characters under salt stress; result indicated that salinity influenced the plant growth and morphological traits and the biomass. Glucose, xylose and mannose concentration in leaf gel increased with increasing salinity up to 9 dS/m and decreased with higher saline concentration.

The objectives of this study were to determine Aloe vera resistance with morphological and biochemical parameters under salt stress.

MATERIALS AND METHODS

The sample containing sand, perlite and farm soil in the ratio of 1:1:1 was used in the greenhouse to examine the salinity effect on Aloe Vera (Table 1) and Aloe Vera offshoots were cultured in plastic vases by convenient drainage for six months. Half Hoagland nutritional solution was used during the irrigation (Hoagland and Arnon , 1950) and the salinity rates were controlled gradually in 0 , 6, 12 and 18 salinity rates dS/m by chloride sodium during the tensions three times after one week ; the salinity was controlled by EC meter device and Hoagland nutritional solution was added to the created salinities . The plants were harvested in 15 and 45 day intervals and examined in the germination phase.

Table 1. Soil physical and chemical properties

Soil texture	Clay %	Silt %	Sand %	Ec (ms)	pH
Sandy loam	10.92	14.72	76.36	0.46	7.58

Having harvested the plants and separated root and aerial organs all the samples were washed with distilled water and then the plant height, leaf and root length, leaf thickness and breadth were measured. The wet leaf and root were weighed and having extracted gel it was weighed, too. The samples were dried in the oven in 65^{o} C for 48 hours in order to weigh the dry leaf and root. Having the dried plant turned into ashes they were extracted and the sodium and potassium (Knudson *et al*., 1982) and chlorine concentration (By Nitric acid 0.01 normal) were measured by flame measurement and titration methods with $AgNo_3$, respectively (Chapman and Pratt, 1961).

In this study the factorial test was conducted as the basic design randomly with sodium chloride (Four levels) concentration factors three times; the findings included the weight of wet and dry aerial organs, root and gel, plant height, leaf length, thickness and breadth, sodium and potassium in the plant were analyzed by Excel and SAS software by using Duncan test.

Soluble Sugar Assay:

Soluble sugar including glucose, xylose and mannose were estimated as described earlier. Leaf gel and leaf skin samples were homogenized in a mortar and pestle with 3ml distilled water and homogenate were filtered by filter paper; then 0.5 mol phenol (5%) and 2.5 mol sulphuric acid (98%) were added to homogenate. After the reaction, the test tubes were allowed to cool room temperature. The amount of glucose, xylose and mannose were determined at absorbance 490, 485 and 480 nm, receptivity. The sugar concentration was calculated from glucose, xylose and mannose standard curves (Dubios *et al*., 1956).

RESULTS AND DISCUSSION

The Effect of Sodium Chloride on Morphologic Properties:

Sodium chloride has influenced significantly the plant height, the leaf length, thickness and breadth, the weight of wet shoot and root and the weight of dry shoot and gel (Table 2). The plant height, leaf breadth and the weight of wet shoot and root have increased 6 dS/m in 15 days and then decreased when the salinity increased and the salinity influenced the mentioned factors in 45 days. The leaf length and thickness and the weight of dry shoot increased 6 and 12 ds/m in 15 days and then decreased when the salinity increased and then had a decreasing effect on measuring factors in 45 days due to increased salinity. The root length grew (Figure1) essentially 6 and 18 dS/m in 15 days and the growth decreased in other salinity rates and increased 6 and 12 dS/m in 45 days and then decreased when salinity increased. The gel weight increased 6 and 12 dS/m in 45 days and decreased when salinity increased but decreased in 45 days by salinity process (Table 3).

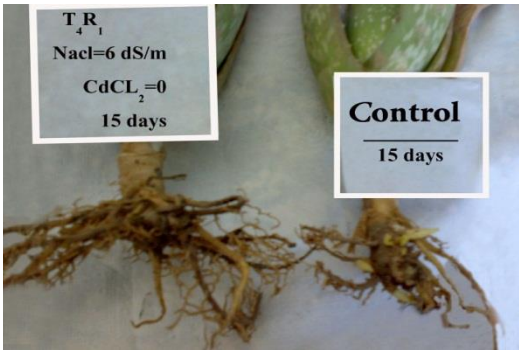

Fig 1. Effect of salt stress on root length

Table 2. The effect of Sodium Chloride on the morphologic specifications of Aloe Vera Average of 3 replications Means followed by a common letter(s) are not significantly different at the 5% level by DMRT.

Nacl	Time	Gel. W (g)	Dry root. W(g)	Dry shoot. W(g)	Leaf breadth (cm)	Leaf thickness (cm)	Root length(cm)	Leaf length (cm)	Plant height (cm)
Control	15days	96.40 ^{ab}	4.59 ^{bc}	6.41 ^{ab}	56.67^{bcd}	0.87^{ab}	6.5^{f}	33.06 ^{ab}	38.83^{ab}
6 dS/m	15days	141.95^{a}	7.0^{abc}	8.80 ^{ab}	75.50^{a}	1.07^{a}	8.38 ^{bcde}	35.78 ^{ab}	45.07^{a}
12dS/m	15days	127.82 ^{ab}	5.68^{abc}	9.07^{a}	68.19^{abc}	0.95^{ab}	7.17^{ef}	36.17^{ab}	40.7^{ab}
18dS/m	15days	90.18 ^{ab}	7.23 ^{abc}	5.80 ^{ab}	69.27^{abc}	0.84^{ab}	9.33 ^{bcd}	34.83 ^{ab}	43.5^{ab}
Control	45days	216.86^{a}	7.10^{a}	11.84 ^{ab}	79.53^{ab}	1.27^{a}	8.17 ^{c}	36.33 ^{a}	44.77^{a}
6 dS/m	45days	60.42^{b}	11.86 ^{a}	11.38 ^{abc}	63.32^{bc}	0.78^{b}	9.00^{abc}	29.44 ^{bc}	37.83^{b}
12dS/m	45days	46.25 ^{b}	8.48^{a}	7.48^{bc}	58.55^{cd}	0.70^{b}	8.83 ^{abc}	27.05 ^{bc}	33.17^{bcd}
18dS/m	45days	45.35.^{b}	7.54 ^{a}	9.23^{abc}	60.16^{cd}	0.80^{b}	8.50 ^{c}	27.78 ^{bc}	34.63^{bcd}

The stem and shoot decrease is visible in primary reactions of salinity tension in glycophytes. Of course, the root growth increases in the saline region and the harmful effects are significant in long terms (Weeks and months); especially we believe that the leaf is more sensible in high salinities and influence the root growth in medium salinities (Hadi and Karimi, 2012). The saline solutions impose both osmotic and ionic tensions on the plant; such tensions may be distinguished in different rates. The stem and root growth decreases permanently during the salinity tension, if the plant is sensitive to salinity. In fact, the effects depend on the sodium concentration in the growing tissues and the special sodium damage depends on its concentration in the leaf tissues so the leaf becomes necrosis. Both growth and function decrease so the plant life shortens (Tester and Davenport, 2003).

The sodium toxicity metabolism is because of potential competition with potassium to occupy the special bands of the cells. More than 50 enzymes while sodium may not be replaced in this regard. So it seems high ratio of potassium to sodium in the plants under the saline condition is an important choice for the criterion to sustain the salinity (Ashraf, 2004).

Table 3. Comparing the means of the morphologic specifications of Aloe Vera

Change source	DF	Mean Squares									
		Gel.W(g)	Dry root weight (g)	Dry shoot (g)	Wet root weight	Wet shoot weight	Leaf breadth	Leaf thickness	Root length	Leaf length	Plant height
Sodium chloride	3	30547.00**	4.57 ns	7.57*	192.01**	109579.79**	535.35**	0.37**	3.36*	72.52**	67.19**
Time	1	3425.02**	68.54**	107.01**	178.60**	1819.12 ns	104.44**	0.017ns	1.65ns	581.23**	601.46**
Salinity & Time	3	46619.87**	7.13 ns	32.09**	358.20**	127401.60**	1918.43**	0.37**	5.33**	91.19**	1253.53**
Error	48	111.77	3.21	2.11	17.96	1713.15	10.85	0.010	0.88	7.04	8.66

** and ** are the significances in the probability rates of 5 and 1 percent , respectively and 'ns' indicates No significance .*

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The Effect of Sodium Chloride on Soluble Sugar:

In this study, three monosaccharides (Glucose, xylose and mannose) which are soluble sugars were assessed and related findings are as follows:

As you see in Table 4 the effect of Sodium Chloride on glucose is significant in some rate. The highest rate of glucose with a significant difference is 18 and 12 dS/m in 15 days and then we see decrease in control and 6 dS/m. The highest rate of glucose was in 12 dS/m and control with a significant difference in 45 days and decreased in 6 and 18 dS/m (Figure 2.a).

Sodium Chloride had no significant effect on xylose (Table 4). The highest rate was in control, 12 and 18 dS/m in 15 days without any significant difference and decreased in 6 dS/m. The highest rates of xylose have been in 12 dS/m, control over time without any significant difference, and then decreased in 6 and 18 dS/m (Figure2.b). Sodium chloride had no significant effect on mannose (Table 5). Having increased Sodium Chloride rate in 15 days mannose decreased with a significant difference with the control. The highest rate without any significant difference relates to 12 dS/m in 45 days and then decreased orderly in 6 and 18 dS/m and control (Figure 2.c).

tolerance are more.

Karimi. (2006) concluded in their examination concerning resistance mechanisms against salinity in the pasture species: *Atriplex verrucifera* that it increased significantly proline , glycine betaine and soluble sugars in the plant ; their salinity was not significant to 200 millimolar Sodium Chloride , but it was significant when the salinity was more than it . In fact, the plant synthesizes the compatible compounds such as glycine betaine, prolin and soluble sugars as the resistance mechanisms against salinity for osmotic regulation. Bajji *et al*. (1998) stated that one of most usual the plants' reaction to environment tensions specially osmotic changes because of dryness and salinity are known as 'Osmotic Regulation or adjustment' which is considered as an adjustment reaction in vascular and nonvascular plants responding to the environment tensions and are of osmotic protectors such as glycine, betaine, proline and soluble sugars in cytoplasm.

Weinberg *et al*. (1984) stated that the glucose and fructose increase in sorghum leaves from witness to salinity care from 25 micromoles in leave weight gram to 70 micromoles. Girma and Krieg (1992) showed the sugar increase in sorghum leave in salinity conditions, too.

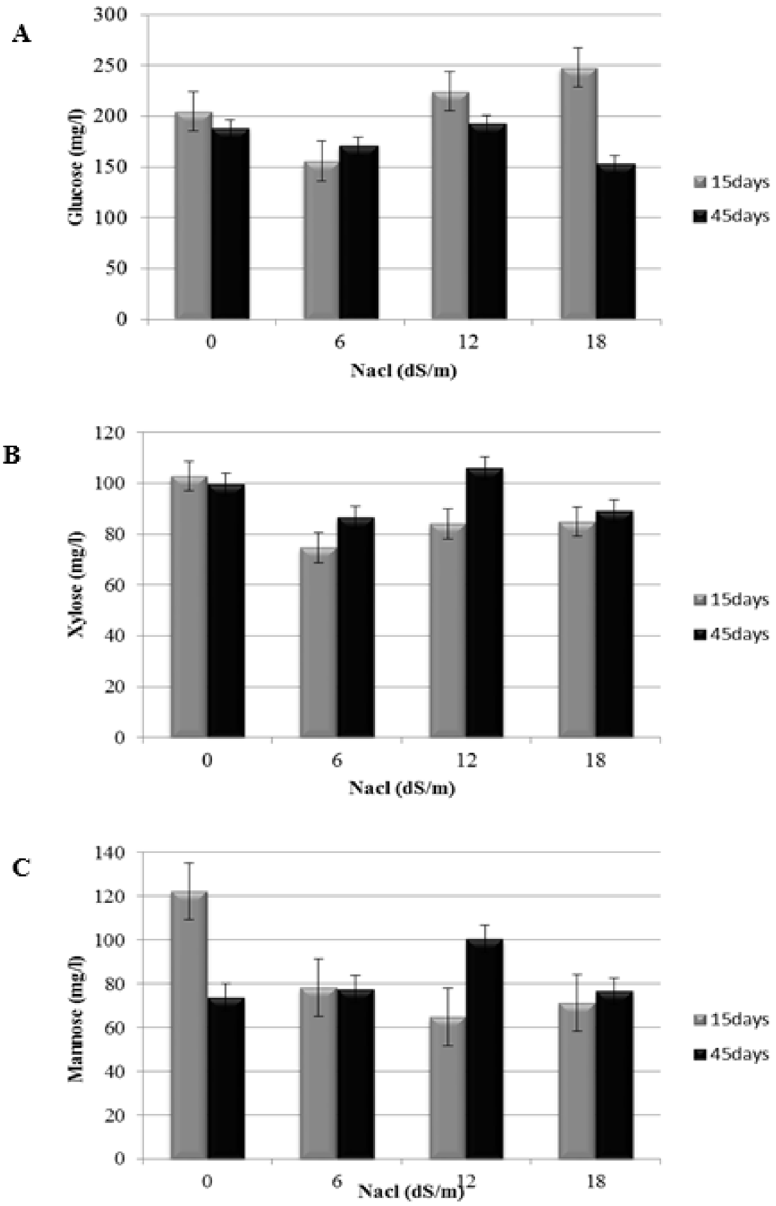

Fig 2. Effect of salt stress on gel glucose, xylose, mannose concentration in Aloe vera leaves.

By virtue of the findings, the salinity increased the sugars in Aloe Vera gel solutions and many studies reported the accumulation of soluble carbohydrates in the plants reacted to salinity and dryness. The soluble sugars were examined in five types of sunflowers tolerated salinity. In salinity conditions, the mean of the soluble sugars increase significantly and the plants tolerated salinity have usually more soluble sugars than the sensible ones (Ashraf & Harris, 2004).

Rader (1984) stated that salinity increased leaf saccharose in the types sensible to salinity compared to the tolerated ones. He proposed the leaf saccharose concentrations and starch might be used as a choice index to screen the genotypes tolerated salinity. Shanon (1994) related ion absorption and sugars increase soluble in lines of wheat grass to osmotic regulation and said that the lines with high tolerance to salinity would have Na^+ in root and Na^+ , Ca^+ and Cl^- in the stem in critical rate and their soluble sugars from the lines with less

Table 4. The effect of NaCl on soluble sugars

Change source	Df	Mannose (mg/l)	Xylose (mg/l)	Glucose (mg/l)
Nacl	3	765.49^{ns}	88.30^{ns}	7558.12**
Time	1	279.15^{ns}	3.92^{ns}	15169.92**
Nacl & Time	3	1193.60*	318.64^{ns}	3040.41^{ns}
Error	48	309.93	326.09	1405.72

** and ** are the significances in the probability rates of 5 and 1 percent , respectively and 'ns' indicates No significance*
.

Table 5. Comparing the means of the soluble sugars

Nacl	Time	Mannose (mg/l)	Xylose (mg/l)	Glucose (mg/l)
Control	15 days	122.15^{a}	102.91^{ab}	204.80^{abcd}
6 dS/m	15 days	78.21^{bcd}	74.73^{e}	156.13^{d}
12dS/m	15 days	64.88^{cd}	84.12^{b}	224.80^{abcd}
18 dS/m	15 days	71.33^{bcd}	84.88^{b}	248.13^{abc}
Control	45 days	73.82^{c}	99.58^{a}	187.80^{ab}
6 dS/m	45 days	77.61^{c}	86.49^{a}	170.53^{ab}
12dS/m	45 days	100.46^{abc}	106.06^{a}	192.13^{ab}
18 dS/m	45 days	76.49^{c}	89.12^{a}	152.87^{b}

Average of 3 replications Means followed by a common letter(s) are not significantly different at the 5% level by DMRT.

The Effect of Sodium Chloride on Concentration of Na, K, Cl AND Ca

Sodium chloride has had a significant effect on the sodium concentration of the shoot and root, shoot and root potassium and foliage and root chlorine (Table 6). The shoot sodium concentration was the highest in the ds/m 18, 6 and 12 rates in 15 days and then increases while the salinity increases in 45 days. The root sodium concentration increases in the 18 and 6 ds/m and then decreases in control and ds/m 12 rates in 15 days and the root sodium decreases by treating different rates of salinity in 45 days. The shoot potassium concentration increases in the 6 and 12 ds/m rates in 45 days and then decreases while the shoot potassium increases in the 12 and 6 ds/m rates and then decreases in 15 days and when the salinity rate increases in 45 days the shoot potassium concentration decreases . The highest root potassium concentration was 12 ds/m in 15th and 45th days and decreases in other rates. The shoot chlorine concentration increased 6 and 18 ds/m on 15th and then decreased 12 ds/m and when salinity increases after 45 days the chlorine rate decreases. The highest rate of the root chlorine was 12 ds/m on 15th day and was increasing during 45 days and the highest chlorine rate was 18 ds/m (Table 7).

The high rate of sodium in the leaf may lead to some problems such as vast metabolism and osmotic disorders for the plants. The leaf is more vulnerable than the roots because the sodium and chlorine concentrations are more in the stems than the roots. The roots tend to keep the sodium chloride rate stable and may regulate it by secreting through the soil or stems. Sodium transfers rapidly through the xylem to the stems and when the leaf grow old its concentration increases (Tester and Davenport, 2003). High concentration of poisonous salts such as sodium and chlorine in the leaf apoplast and cytoplast cells lead to dry the leaf and finally the cells are plasmolyzed and the cells die because of osmotic pressure; related signs are chlorosis and necrosis in merismatic places and old leafs margins and finally in the young ones, too. When salt is concentrated in the leaf the immature leafs fall in reaction to the salinity tension as a defense mechanism by the plants against damaging other organs (Rahimi - Dehgelan *et al*., 2012).

Sodium chloride had a significant effect on the Calcium concentration of shoot in the one percent rate (Table 4). The most concentration rate is in 6 and 12 dS/m in 15 days with a significant difference and was the in the lowest rate in 18 dS/m and control. The highest rate is in 12 dS/m in 45 days with a significant difference and decreases in 6 and 18 dS/m.

As you see in Table 6 it is clear that the Sodium Chloride effect on root calcium concentration is significant in one percent rate. When the salinity cares' rates increased in 15 days the root Calcium concentration increased with a significant difference and the highest rate is in 18 dS/m; it decreased over time and the control with a significant difference includes the highest calcium concentration. Sodium Chloride in saline soils may influence directly nutritional materials absorption such as calcium decrease and less nitrate absorption by Sodium ions, Chloride, osmotic tension and nutritional imbalance, respectively (Patel *et al*., 2010). Calcium plays a known and definitive role in protecting vegetal organs structure and function and in strengthening the cell wall, ion transfer adjustment, selection and activity of cell wall enzymes. Considering Calcium rate is less than Sodium the former creates significant effects to prevent plants' growth and morphologic and anatomic changes (Ashraf, 2004).

Table 6. The effect of Sodium chloride on the Na, K and Cl concentration in the Aloe Vera shoot and root

Change source	DF	Mean Squares							
		Root Cl%	Shoot Cl%	Root K(mg/kg)	Shoot K(mg/kg)	Root Na (mg/kg)	Shoot Na(mg/kg)	Shoot Ca (mg/kg)	Root Ca (mg/kg)
Sodium	3	0.242**	0.203**	8151054.69**	188340117**	980069.34**	107929.084**	192775334**	85714980**
Time	1	0.239**	0.45**	20573554.69**	670507500**	369646.87**	179323.63**	1188179255**	11727564**
Na & Time	3	0.230**	0.026*	10446367.19**	339249688**	510516.22**	9466.26**	181352954**	590377963**
Error	32	0.001	0.006	78515.6	17011387	5714.98	580.78	773122	149913

** and ** are the significances in the probability rates of 5 and 1 percent , respectively and 'ns' indicates No significance*
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Table 7. Comparing the means of the Na, K, Cl and Ca concentration (mg/kg) in Aloe Vera shoot and root

Nacl	Time	Root Ca	Shoot Ca	Root Cl	Shoot Cl	Root K	Shoot K	Root Na	Shoot Na
control	15days	11801.3^{c}	29070^{e}	0.28^{d}	0.74^{e}	8125^{c}	24375^{ab}	781.25^{d}	706.25^{f}
6 dS/m	15days	9717.5^{d}	44425^{b}	0.31^{d}	1.14^{abc}	5425^{e}	26500^{ab}	1080.58^{b}	996.25^{c}
12 dS/m	15days	12362.5^{c}	42700^{c}	0.58^{a}	0.94^{d}	10050^{a}	27550^{ab}	562.50^{f}	875^{d}
18 dS/m	15days	21663.8^{b}	28892.5^{e}	0.49^{bc}	1.09^{abcd}	5875^{e}	22500^{b}	1218.75^{a}	1193.75^{a}
control	45 day	14085.^{c}	25893.8^{c}	0.28^{f}	0.66^{b}	8000^{d}	29313^{a}	968.75^{a}	771.88^{d}
6 dS/m	45 day	6185.0^{g}	19825^{e}	0.50^{d}	0.86^{a}	7500^{e}	16750^{bc}	893.75^{a}	825^{cd}
12 dS/m	45 day	6590^{f}	30175^{a}	0.47^{de}	0.88^{a}	12125^{a}	16250^{bc}	368.75^{b}	987.50^{a}
18 dS/m	45 day	7412.5^{e}	21348.8^{de}	0.78^{c}	0.98^{a}	8375^{cd}	6125^{d}	450.00^{b}	912.50^{b}

Average of 3 replications Means followed by a common letter(s) are not significantly different at the 5% level by DMRT.

Sodium Chloride had a significant effect on K/Na of the aerial organ in one percent rate. When the salinity care rates increased we saw the Potassium decreased compared to Sodium with a significant difference in 15 and 45 days.

Sodium Chloride had a significant effect on K/Na of the root in one percent rate. The highest rate of potassium to sodium was in 12 dS/m in 15 days with a significant difference and decreased orderly in 18 and 6 dS/m and control. The rate was in 12 and 18 dS/m over time with a significant difference and decreased orderly in 6 dS/m and control.

The toxicity metabolism of Sodium is due to its competition with Potassium to occupy the special bands of the cells. More than 50 enzymes are activated by Potassium while sodium may not replace in in this regard. So high rate of Sodium compared to Potassium disorders enzymes process in the cytoplasm (Tester and Davenport, 2003). It seems that high potassium rate compared to sodium in the plants under salinity conditions is an important choice for the salinity tolerance criterion (Ashraf, 2004).

The effect of Sodium Chloride in one percent rate is significant on Ca/Na of the aerial organ; it was the highest in 12 and 6 dS/d in 15 days with a significant difference and the lowest in witness and 18 dS/m. When salinity care rates increase over time the rate decreases with a significant difference.

Sodium Chloride in one percent rate had significant effect on Ca/Na of the root. The highest rate was in 12 and 18 dS/m in 15 days and over time without any significant difference and decreases in witness and 6 dS/m. The calculations findings concerning the potassium ratio to sodium and calcium to aerial organ's sodium are shown in Table 8.

Jin *et al*. (2007) stated that the calcium absorbed by Aloe Vera root is prevented in salinity tension and is not transferred to the leaves and branches so the calcium decreases in all parts of the plant because of the salinity tension. Also, they reported that the calcium had decreased in the leaves and stem in salinity tension. High concentration of sodium in root prevented calcium absorption and transfer so the ratio of calcium to sodium decreases in the plants under salinity conditions (Hadi *et al*., 2008). Also, Jane et al. stated that in Aloe Vera plants the genotypes tolerated salinity keep a significantly low rate of sodium compared to calcium and decrease the destruction of vegetal organs. The low rate of sodium to calcium in the genotypes tolerated Aloe Vera salinity showed that high capacity in such genotypes keeps many obstacles and permit less calcium goes out of the cell (Hadi and Karimi, 2012).

Table 7. Comparing the means of the K/Na and Ca/ Na in Aloe vera shoot and root

Nacl	Time	Root Ca/Na	Shoot Ca/Na	Root K/Na	Shoot K/Na
Control	15 days	15.11^{c}	41.16^{c}	10.40^{cd}	34.51^{bc}
6 dS/m	15 days	8.99^{c}	44.72^{b}	5.02^{d}	26.63^{cde}
12dS/m	15 days	22.45^{c}	48.80^{a}	18.38^{bc}	31.46^{bcd}
18 dS/m	15 days	17.77^{c}	24.20^{h}	4.82^{d}	18.85^{efg}
Control	45 days	14.54^{c}	$33/55^{ef}$	8.26^{d}	38.00^{b}
6 dS/m	45 days	6.92^{c}	24.10^{h}	8.41^{d}	20.28^{efg}
12dS/m	45 days	18.72^{c}	30.57^{g}	34.33^{a}	16.39^{fg}
18 dS/m	45 days	19.79^{c}	23.53^{hi}	22.06^{b}	6.60^{h}

Average of 3 replications Means followed by a common letter(s) are not significantly different at the 5% level by DMRT.

CONCLUSION

Considering One of the vegetal resistance mechanisms is to decrease toxic and harmful elements transfer to aerial organs the shoot sodium concentration ratio to root is to the salinity 6 dS/m so the sodium absorption has been more in root in such salinity and it was proved by creating ion balance by the plant, for example, not decreasing potassium and calcium concentration in the aerial organs in 15 days and also the shoot chlorine percent decreased after 45 compared to 15 days. One of the most important Aloe Vera's tolerance mechanisms may be the creation of appropriate K/Na , Ca/Na ratio in the shoot in primary time of the tension namely in 15 days and also the salinity rates create many fluctuations on the soluble sugars rates especially glucose and xylose . The glucose increased in 15 days when salinity increased, but mannose rate, which is of monosaccharides effective in creating important polysaccharides of pharmaceutical Aloe Vera decreased in 15 days but increased with salinity effects over time without any significant difference.

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