

# Use of the *Salicornia ramosissima* for the Phytoextraction of Minerals from the Desalinizer Reject

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## ABSTRACT

The objective of this work was to evaluate the absorption of Nitrogen (N), Sodium (Na), Potassium (K), Calcium (Ca) and Magnesium (Mg) by *Salicornia ramosissima* cultivated in pots with saline soil and submitted to treatments: TA(water), T1 (desalinizer reject), T2 (desalinizer reject + 7g / NaCl), T3 (desalinizer reject + 14g / NaCl) and T4 (desalinizer reject + 21g / NaCl) monitored for four months. The experiment was conducted under greenhouse conditions at the headquarters of the Agronomic Institute of Pernambuco - IPA, a completely randomized design with autoclaved and non - autoclaved soil. A dose corresponding to 1.0 mL/ kg of soil of complete nutrient solution of Hoagland & Arnon was added every ten weeks. The desalinizer rejects were daily and the results obtained for absorption of the elements by *Salicornia* showed that with the intermediate dose there was a better absorption mainly of Magnesium (Mg).

**Keywords:** Halophyte; *Salicornia*; Salinity; Absorption

## Introduction

Salinization is one of the main problems in the semi-arid Pernambuco region. Therefore, producers are obliged to use water with high concentrations of salts for irrigation and food production [1]. In view of the above, desalinators have been implanted with increasing frequency in order to obtain potable water. However, despite having advantages, it has as main disadvantage the generation of high salt level waste that can cause environmental problems [2]. Therefore, salt-tolerant halophytes, even beyond the concentrations of seawater, can bring significant benefits to rural communities. However, there is no competition for the use of land or water between profitable conventional attitudes and plants tolerant to high salt content [3,4]. In the work of [5], it was found that halophytes also have the potential to be used for pharmaceuticals, functional foods, and adequate management practices to exploit saline soils and desalinator rejects. As seen, this type of plant has a very diversified use, ranging from the recovery of degraded areas, pollution of biomass, feeding of cattle or human feeding.

Among these species is *Salicornia* (family Salicornioideae), which presents extensive development in saline areas associated with coastal lines, tidal floodplains and salt lakes. They are distributed worldwide and found on all continents, except Antarctica [6,7]. In order to contribute to the minimization of the negative effects of the inadequate use of the desalinator waste, an experiment was proposed to analyze the absorption of the chemical-bromatological composition of in the development of *Salicornia ramosissima* submitted to different levels of salinity.

## Materials and Methods

The experiment was conducted from November 2017 to March 2018, under greenhouse conditions, at the Institute Agronomic of Pernambuco - IPA, Recife, Pernambuco, Brazil. The experimental design was completely randomized, in a 2 x 2 x 2 x 5 factorial arrangement, corresponding to autoclaved and non-autoclaved soil, inoculated and noninoculated plants, presence and absence

of [8] nutrient solution (biweekly) and 5 levels of (total control), water (absolute control), desalinator reject (control) and three salinity combinations, whose concentrations were obtained from addition of sodium chloride (NaCl) to the waste, calculated according to Richards (1954): 7g - CE = 12,612  $\mu\text{S}/\text{cm}^2$ ; 14g = CE = 13,744  $\mu\text{S}/\text{cm}^2$  and 21g = CE = 14,746  $\mu\text{S}/\text{cm}^2$ , with three replicates. The soil used in the experiment was collected at the IPA Experimental Station, in the city of State, Brazil, with the following characteristics: sandy texture, soil density - 1.34 g /  $\text{cm}^3$ , pH - 7.60, P-209 mg /  $\text{dm}^3$  and Ca, Mg, Na and K-33.60, 6.00, 12.00 and 0.70  $\text{cmolc} / \text{dm}^3$  respectively. The average temperature inside the greenhouse during the experiment was 34°C. According to Köppen classification, the region presents an As' (Tropical Moist) climate. The mean relative air humidity inside the greenhouse was 56.6%.

The reject used in the experiment was collected in a desalinator located in the city of Riacho das Almas, Pernambuco, Brazil, with the following characteristics: Electrical Conductivity - 10,905  $\mu\text{S}/\text{cm}^2$  at 25°C, pH - 7.0, and Ca, Mg, Na and K-139.83, 304.94, 2,760.00 and 22.00  $\text{cmolc}/\text{dm}^3$  respectively. *Salicornia ramosissima* 5 cm cuttings were used in the experiment, which were planted on commercial substrates in 128-cell germination trays for a period

of 30 days. After 30 days of rooting, the plants were transferred to the polyethylene pots with 8kg of air-dried soil, dewormed, homogenized and sieved in 2 mm mesh, where 50% of the soil was sterilized by autoclaving. The inoculation with Arbuscular Mycorrhizal Fungus - FMA was carried out when the rooted plants were transported to the vessels, adding 50g of spores the *Claroideoglomus etunicatum* from the FMA Inoculum Bank of the Laboratory of Soil Microbiology - IPA, where they were kept under refrigeration at  $\pm 4^\circ\text{C}$ .

After four months, the shoot and root were collected, separating them at the height of the plant neck, in paper bags, dried in an air circulation oven at 60°C for 72 hours, to determine the dry matter of shoot (MSPA) and root (MSR), the material was ground in a Wiley-type mill, provided with a 42 mm aperture sieve, by means of nitroperchloric digestion [9], determine the contents of the absorbed elements (K, Ca, Mg, Na) and total nitrogen by the microkjedahl method. A soil sample, too, was collected for complete chemical analysis [10]. The data were submitted to individual and joint statistical analysis, pertinent to the studied variables. The variance was tested by ANOVA (Analysis of Variance) using Minitab statistical software.

## Results and Discussion

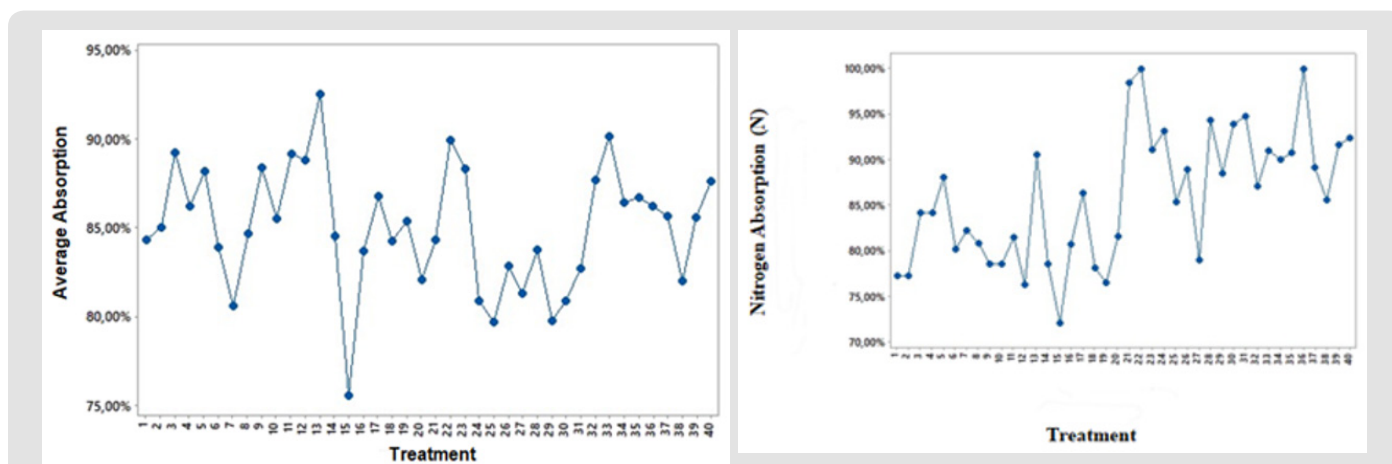


Figure 1: Mean absorption of the chemical elements (K, Ca, Mg and Na) in relation to the treatments used.

**Caption:** ONLY AUTOCLAVA: 1. Water - 2. Water + FMA - 3. Water + FMA + Solution - 4. Water + Solution - 5. Reject - 6. Reject + FMA - 7. Reject + FMA + Solution - 8. Reject + Solution - 9. Rejected +

1NaCl - 10. Reject+ 1NaCl+ FMA - 11. Reject+ 1NaCl+ FMA+ Solution - 12. Reject+ 1NaCl+ Solution - 13. Rejected + 2NaCl - 14. Rejected + 2NaCl + FMA - 15. Rejected + 2NaCl + FMA+ Solution - 16. Reject + 2NaCl + Solution - 17. Reject + 3NaCl - 18. Reject + 3NaCl + FMA - 19. Reject + 3NaCl + FMA + Solution - 20. Reject + 3NaCl + Solution.

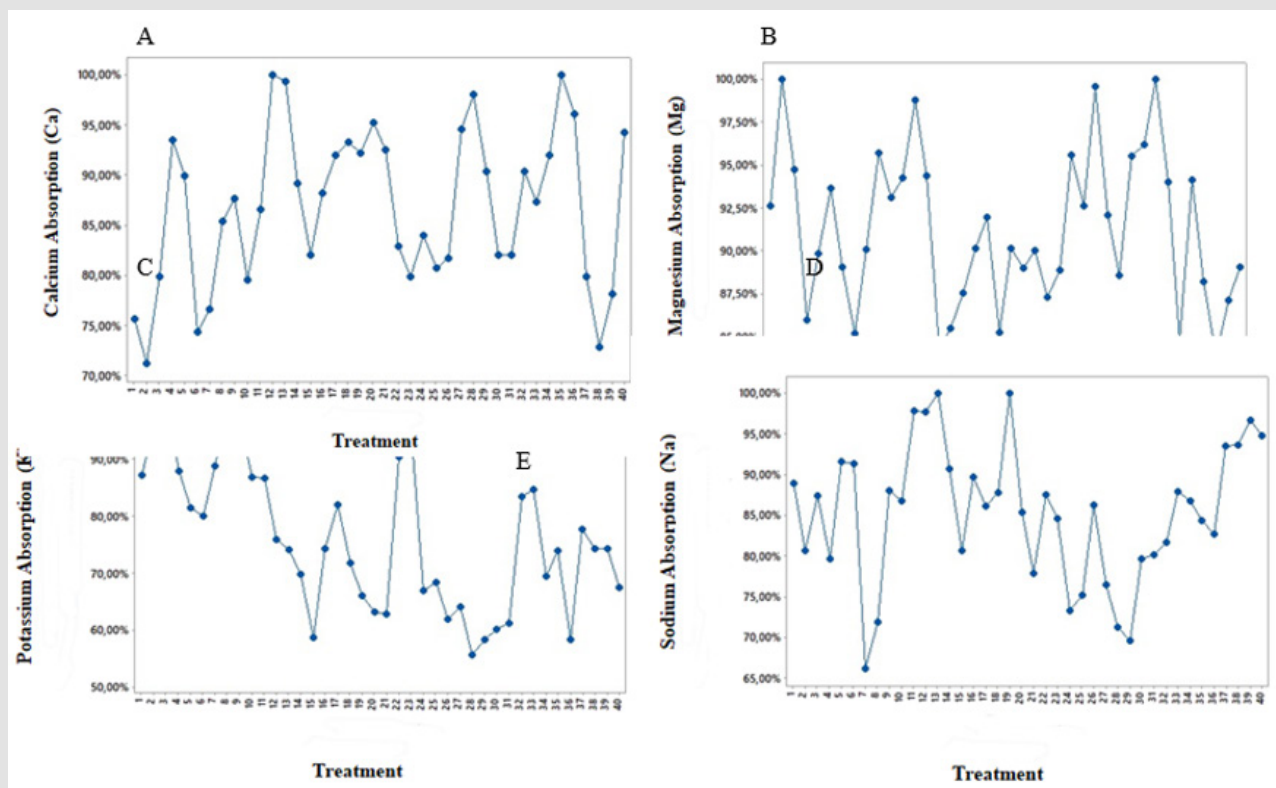
ONLY NO AUTOCLAVA: 21. Water - 22. Water + FMA - 23. Water + FMA + Solution - 24. Water + Solution - 25. Rejection - 26. Rejection + FMA - 27. Rejection + FMA + Solution - 28. Reject+ Solution 29. Reject + 1NaCl + Solution - 30. Reject\_1NaCl+ FMA - 31. Reject + 1NaCl + FMA + Solution - 32. Reject+ 1NaCl+ Solution - 33. Reject + 2NaCl - 34. Reject + 2NaCl + FMA - 35. Rejection + 2NaCl + FMA+ Solution - 36. Rejected + 2NaCl + Solution - 37. Rejected + 3NaCl - 38. Rejected + 3NaCl + FMA - 39. Rejected + 3NaCl + FMA + Solution - 40. Rejected + 3NaCl + Solution.

The treatment with a reject plus 14 g of NaCl (S2) was the one that best favored the absorption of Na, K, Ca, Mg and N when the autoclaved soil was used, in the absence of nutrient solution and the fungus *Claroideoglomus etunicatum* (Figure 1) [11]. working with

seedlings of *Spondias tuberosa* in nutrient solution, with different levels of NaCl, under greenhouse conditions, perceived that the low concentrations of NaCl favored the presence of Na in the roots. In the absence of a nutrient solution and the fungus *Claroideoglomus*

etunicatum (Figure 1), the treatment with reject plus 14 g of NaCl (S2) with autoclaved soil favored Na, K, Ca, Mg and N absorption [11]. working with umbuzeiro seedlings in nutrient solution, with different levels of NaCl. Under greenhouse conditions, the low

concentrations of NaCl favored the presence of Na in the roots, translocating a small amount to the aerial part and that N and Ca were few significant in the absorption by the umbuzeiro with the increase of NaCl concentration.



**Figure 2:** Nutritional Analysis of *Salicornia ramosissima*.

**Caption:** ONLY AUTOCLAVA: 1. Water - 2. Water + FMA - 3. Water + FMA + Solution - 4. Water + Solution - 5. Reject - 6. Reject + FMA - 7. Reject + FMA + Solution - 8. Reject + Solution - 9. Rejected + 1NaCl - 10. Reject+ 1NaCl+ FMA - 11. Reject+ 1NaCl+ FMA+ Solution - 12. Reject+ 1NaCl+ Solution - 13. Rejected + 2NaCl - 14. Rejected + 2NaCl + FMA - 15. Rejected + 2NaCl + FMA+ Solution - 16. Reject + 2NaCl + Solution - 17. Reject + 3NaCl - 18. Reject + 3NaCl + FMA - 19. Reject + 3NaCl + FMA + Solution - 20. Reject + 3NaCl + Solution.

ONLY NO AUTOCLAVA: 21. Water - 22. Water + FMA - 23. Water + FMA + Solution - 24. Water + Solution - 25. Rejection - 26. Rejection + FMA - 27. Rejection + FMA + Solution - 28. Reject+ Solution 29. Reject + 1NaCl + Solution - 30. Reject\_ 1NaCl+ FMA - 31. Reject + 1NaCl + FMA + Solution - 32. Reject+ 1NaCl+ Solution - 33. Reject + 2NaCl - 34. Reject + 2NaCl + FMA - 35. Rejection + 2NaCl + FMA+ Solution - 36. Rejected + 2NaCl + Solution - 37. Rejected + 3NaCl - 38. Rejected + 3NaCl + FMA - 39. Rejected + 3NaCl + FMA + Solution - 40. Rejected + 3NaCl + Solution.

Figure 2A, 2B, 2C, 2D and 2E present individualized information on the absorption of the nutritional composition of the plant with all the treatments used, indicating that Magnesium was the element most absorbed by *Salicornia ramosissima* [12]. observed that Na absorbed by *Atriplex* was higher than those of Ca, Mg and K when grown in greenhouse on saline-sodium soil [13]. in experiment with cassava, observed that, in the case of magnesium, the highest levels were also observed in the treatments that received saline water, which provided greater moisture in the soil, which facilitates the absorption of this ion.

## Conclusion

In view of the obtained results, it is concluded that the bromatological composition of *Salicornia ramosissima* was not affected by the increase of salinity of irrigation water. The

intermediate dose (S2 – desalinizer reject plus 14g NaCl) showed a better absorption mainly of magnesium. High salinity (S3 - desalinizer reject plus 21g NaCl) reduces the growth of *Salicornia ramosissima*. The addition of nutrient solution and FMA is not significant for the absorption of the determined elements (N, Na, K, Ca and Mg). The *Salicornia* was very promising as a phytoextrator.

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## Conflicts of Interest

The authors declare that they have no conflicts of interests.

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