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# Application of *Moringa* in the Removal of Salts from the Desalinator Reject

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## ABSTRACT

This study aims to analyze the reject produced by the desalinators implanted in the semi-arid Pernambuco in contact with the seeds of *Moringa oleifera* Lam. For this, *Moringa* seeds were collected and prepared with the following treatments: reject (control), reject with whole seed with and without husks, reject with crushed seed with and without husks, seed residue with and without husks, in five replicas. Each replica was constituted with doses equivalent to 2.0g of *Moringa* seeds for 200 mL of reject, with contact time corresponding to 30, 60, 120 and 180 minutes, in a completely randomized design, under laboratory conditions, a total of 140 experimental units. The physical-chemical and statistical ~~analyzes~~ analyses were performed through analysis of variance (ANOVA), and ~~using~~ the F test, ~~with~~ ~~a~~at confidence interval of 95%. It has been found through laboratory tests that seeds with crushed or ground Moringa husks are equally effective at adsorbing sodium from ~~1,868.0~~ 1.868,0?? mg/L to 24,6 mg/L (98,7 %), calcium from 1,005.0 mg/L to 894.6 mg/L (11%), magnesium from 741.0 mg/L to 728.3 mg/L (1.7%) and chloride from 6.997.5 mg/L to 6.782.4 mg/L (1.8%). Conclusion?


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**Keywords:** *Moringa*; desalinators; saline water; Pernambuco semi-arid.

## 1. INTRODUCTION

One of the major problems in the semi-arid North-eastern region is drought, a recurrent theme with no apparent solution.~~,~~ ~~for t~~The surface waters that form the main sources of drinking water on Earth are scarce, especially in the semi-arid region, causing water shortages in rural communities. Therefore, groundwater appears as a viable alternative to ensure that these communities have access to water. However, these water sources, in most cases, present restrictions of use for human, animal and agricultural consumption due to their high concentrations of mineral salts [1]. The treatment widely used to reduce the concentration of salts of these waters has been the desalination, by the process of reverse or contrary osmosis. However, it is necessary to consider the environmental risks inherent in this technique, because in the desalination process, besides drinking water, the wastewater (reject) is produced highly saline and with a high risk of environmental contamination. This reject has not received any treatment and thus is released into the soil, providing a high accumulation of salts in its superficial layers, which will give rise to serious environmental problems in the short and medium term for the populations that are favored by this technology [2].

Therefore, the need to use the ecologically correct and economically feasible way of the reject is imperative, since water flows and soil are almost always the main environments for their disposal. Salinity reduces the soil's water potential due to its specific toxic effects and correlated to this is the gradual loss of fertility and also the problems of soil permeability [3, 4].

The use of *Moringa oleifera* as a natural coagulant, due to its effectiveness in the adsorption of salts, is one of the sustainable alternatives that ~~has~~have been used in the northeastern region, especially in the semiarid region, where water scarcity represents the greatest difficulty for the population. The treatment with the crushed seed of this plant can be used *in situ*, and at low cost and without the use of electric energy [5].

Thus, several researches have proved that these seeds are biocoagulants, that is, they produce improvement in the physical-chemical properties of brackish or contaminated water, through the mechanism of adsorption and neutralization [6].

Therefore, the objective of this work was to evaluate the *Moringa oleifera* Lam. as adsorbent for the removal of salts present in the reject from desalinators from the semi-arid Pernambuco.

## 2. MATERIALS AND METHODS

The seeds of *Moringa oleifera* were collected and dried in an oven at 45ºC for 24 hours (is this temperature sufficient for drying?). After temperature stabilization, they were prepared according to the following treatments: whole seeds with and without husks.

Then one part of the seeds was crushed, and the other part was ground (14 mesh), thus: whole seeds with husks (CCI), crushed seeds with husks (CCT) and ground seeds with husks (CCM); whole seeds without husks (SCI), crushed seeds without husks (SCT) and ground seeds without husks (SCM).

Subsequently, 200.0 mL of the desalinator's reject and 2.0 grams of freshly prepared seeds (treatments) were added to plastic containers with five replicas of each treatment. The tests had a duration of 30, 60, 120 and 180 minutes of contact between the reject and the seeds of *Moringa*.*(characterization of the reject not reported)*

After the contact times, the resulting extracts were submitted to physical-chemical analysis, determining pH, electrical conductivity (EC), sodium, potassium, calcium, magnesium and chloride. pH was determined by pHmetry, electrical conductivity by conductometry, sodium (Na) and potassium (K) by flame emission spectrophotometry, chloride ($Cl^-$) by precipitation titrimetry and calcium (Ca) and magnesium (Mg) by complexation titrimetry.

For the statistical analysis of the data, Sigma Plot 11.0 software (Systat Software, 2008, USA) was used, with a significance level of 5% for all determinations. Before the ANOVA was performed, the normality of the data was tested through the Kolmogorov-Smirnov test and the homogeneity of variances by the Barlett test. ANOVA one-way (ANOVA unifatorial) was used for data that presented a normal distribution or homogeneity of variance. When the tests showed significant differences ($p < 0.05$), the means of the treatments were compared and, in relation to the control, by the Dunnett test. The Kruskal-Wallis test was used when the requirements for ANOVA were not achieved.

## 3. RESULTS AND DISCUSSION

In the experiment it was possible to verify that the seeds of *Moringa oleifera* did not significantly alter the pH and alkalinity. It was observed that the contact time did not significantly modify the pH in the samples tested, but, specifically in the treatments with crushed or ground seeds, the pH reduction was verified, according to Figure 1.

~~No results for the characteristics of the reject~~

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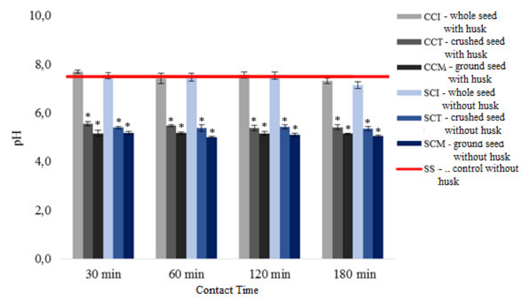


**Figure 1. pH of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (* = significant difference).**

Statistical analysis of pH was performed among all treatments of Moringa with and without husks (whole, crushed and ground), according to Table 1. In the variance between the groups and the residual (Table 2), the P-value was less than 5% and revealed that the difference between the groups (treatments) was significant. The Fisher Coefficient (F = 518.093) also showed that there is a significant difference between the groups (Table 2). In the comparison between the factors (Dunnett test) it was verified that the difference between the test and the crushed Moringa with husks (CCT) sample is relevant, the P-value is less than 5% (Table 3). What is responsible for the observed differences?

**Table 1. pH kinetics of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera (Moringa* with and without husk)*.**

| Group Name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST** | 5 | 0 | 7,488 | 0,219 | 0,0981 |
| **CCI** | 5 | 0 | 7,688 | 0,0653 | 0,0292 |
| **CCT** | 5 | 0 | 5,554 | 0,0953 | 0,0426 |
| **CCM** | 5 | 0 | 5,156 | 0,132 | 0,0591 |
| **SCI** | 5 | 0 | 7,532 | 0,119 | 0,0531 |
| **SCT** | 5 | 0 | 5,388 | 0,0563 | 0,0252 |
| **SCM** | 5 | 0 | 5,17 | 0,0561 | 0,0251 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 2. Analysis of pH variance (groups vs. residual).**

| Source of Variation | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| **Between groups** | 6 | 44,137 | 7,356 | 518,093 | <0,001 |
| **Residual** | 28 | 0,398 | 0,0142 | | |
| **Total** | 34 | 44,535 | | | |

**Table 3. Kinetics of pH – Comparison control vs. samples (*Moringa* with and without husk)*.**

| Comparison | Difference of means | q' | P | P<0,050 |
|---|---|---|---|---|
| **TEST vs. CCM** | 2,332 | 30,944 | -- | Yes |
| **TEST vs. SCM** | 2,318 | 30,758 | -- | Yes |
| **TEST vs. SCT** | 2,1 | 27,866 | -- | Yes |
| **TEST vs. CCT** | 1,934 | 25,663 | -- | Yes |
| **TEST vs. CCI** | 0,2 | 2,654 | -- | No |
| **TEST vs. SCI** | 0,044 | 0,584 | -- | No |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).



In relation to the electrical conductivity (Figure 2), it was observed that all treatments reduced their values, but there were some oscillations, when the seeds were treated with and without peels, during the time of exposure.

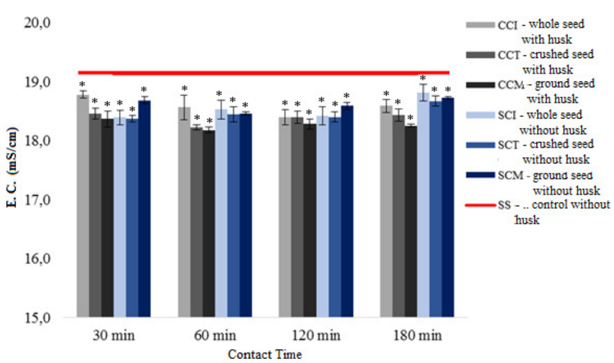

**Figure 2. Electrical Conductivity (E.C.) of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (* = significant difference).**

Research carried out by [7] showed that the seeds of *Moringa oleifera* contain proteins with low molecular weight and that, when crushed, their powder dissolved in water acquires positive charges that attract negatively charged particles, which corroborates with the results found in the present study with both crushed and ground Moringa seeds (Figure 2). Ambiguous! What are the chemical species that dissolve to acquire a net positive charge and at what pH values??

According to [8], in a comparison of ground seeds of loofah, pumpkin, almond, *moringa*, Algaroba, Umbu, Umburana and Mulungu, it was seen that *Moringa* seeds increase the percentage of adsorption from 60 minutes contact with saline water.

The results obtained in this work were compared with the analys~~z~~es performed by [9], which used some parameters, which served as reference for this study, such as pH, e~~E~~lectrical ~~C~~conductivity, ~~C~~calcium and ~~M~~magnesium. As shown in this analysis, these three parameters had good results? (Table??), showing the efficiency of the Moringa extract in their removal/decrease. The expression good is relative and ambiguous; use values observed for comparison.

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The statistical analysis of the electrical conductivity was also performed (Table 4), where, in the variance between the groups and the residual (Table 5), the P-value was less than 5% and revealed that the difference between the groups (treatments) was significant. The Fisher Coefficient (F = 26.889) showed that there is a significant difference between the groups (Table 5). In the comparison between the factors (by the Dunnett test), the difference between the test and the crushed moringa with husks (CCT) sample is relevant, the P-value is lower than 5% (Table 6).



**Table 4. Kinetics of the E.C. of the extracts in contact with the seeds of *Moringa oleifera (Moringa* with and without husk)*.**

| Group Name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST** | 5 | 0 | 19,132 | 0,0589 | 0,0263 |
| **CCI** | 5 | 0 | 18,784 | 0,0773 | 0,0346 |

| | | | | | |
|---|---|---|---|---|---|
| **CCT** | 5 | 0 | 18,458 | 0,139 | 0,062 |
| **CCM** | 5 | 0 | 18,37 | 0,156 | 0,0699 |
| **SCI** | 5 | 0 | 18,394 | 0,162 | 0,0723 |
| **SCT** | 5 | 0 | 18,37 | 0,149 | 0,0667 |
| **SCM** | 5 | 0 | 18,686 | 0,0733 | 0,0328 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 5. Analysis of the variance of E.C. (groups vs. residual).**

| Source of Variation | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| **Between groups** | 6 | 2,463 | 0,411 | 26,889 | <0,001 |
| **Residual** | 28 | 0,428 | 0,0153 | | |
| **Total** | 34 | 2,891 | | | |

**Table 6. Kinetics of E.C. - Comparison control vs. samples (*Moringa* with and without husk)*.**

| Comparison | Difference of means | q' | P | P<0,050 |
|---|---|---|---|---|
| **TEST vs. CCM** | 0,762 | 9,75 | -- | Yes |
| **TEST vs. SCT** | 0,762 | 9,75 | -- | Yes |
| **TEST vs. SCI** | 0,738 | 9,443 | -- | Yes |
| **TEST vs. CCT** | 0,674 | 8,624 | -- | Yes |
| **TEST vs. SCM** | 0,446 | 5,707 | -- | Yes |
| **TEST vs. CCI** | 0,348 | 4,453 | -- | Yes |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

In the present study it was observed that 30 minutes contact of the reject with the crushed or ground seeds of moringa with husks was sufficient to reduce the concentration of sodium in the collected extract. It should be noted that this effective reduction of sodium (Na) occurred in all treatments that used seeds with husks during the periods of exposure, unlike the treatments with seeds without husks, as shown in Figure 3.

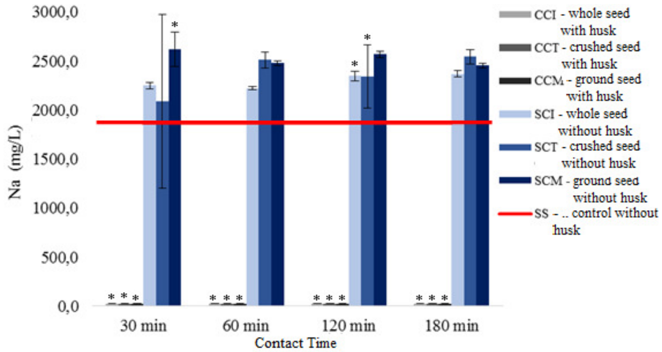


**Figure 3. Sodium (Na) of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (* = significant difference).**

In relation to the sodium present in the reject, the adsorption of the ground seed of *M. oleifera* caused a significant reduction in the concentration of this element in the whole process when compared to the control (Figure 3). This fact was also proven by [8], who researched ten different types of biological materials, among them the *M. oleifera* seed and observed the existence of proteins that act as natural organic polymers that, in contact with the brackish water, increase the sodium adsorption, mainly in 60 minutes of contact.

In relation to potassium, it was verified that in all the treatments, when compared with the control (only reject), there was no effectiveness of the moringa adsorption, as shown in Figure 4.

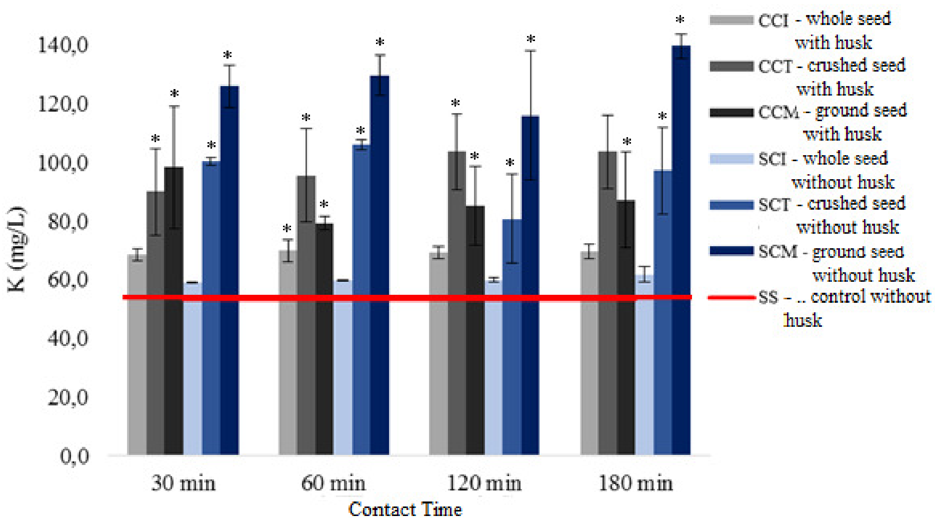


**Figure 4. Potassium (K) of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (* = significant difference).**



In relation to potassium (K), there was no reduction in its content in the reject, but an increase in its concentration. It can be verified that all the treatments presented values above the control (Figure 4). Therefore, it is concluded that the *M. oleifera* seed was unable to adsorb this chemical in the 180-minute period, corroborating the results obtained by [10], who also did not find evidence of potassium's harmful effect to the coagulation provided by the moringa seed extract. What favors adsorption of sodium over potassium??

Regarding calcium, it was observed that the time had a positive influence on its adsorption. In the case of the contact of the reject with the whole Moringa seed with husk (CCI) there was greater adsorption within 60 minutes of contact. However, whole without husk (SCI), the highest adsorption occurred with 120 minutes of contact, as shown in Figure 5.

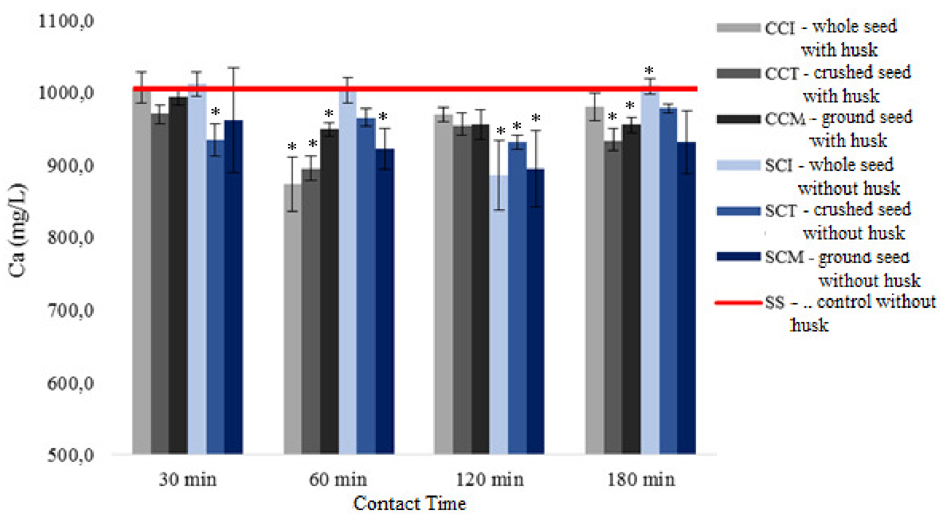


**Figure 5. Calcium (Ca) of the extracts obtained with the residue in contact with the seeds of *Moringa oleifera* (* = significant difference).**

In the case of Calcium and Magnesium, the experiments carried out showed that there was a reduction in their contents when confronted with the control (Figures 4 and 5). These results confirm the study by [11], which proved that the moringa seeds interact with the organic material of the water, destroying the colloidal stability and facilitating its removal by sedimentation, as well as reducing the water hardness. ~~The researcher verified that the m~~Moringa powder in contact with well water reduced the hardness in 24h.

~~Also~~Furthermore, it was observed that the time determined a significant adsorption of magnesium in the crushed seeds with husks and the whole ones without husks with 30 minutes of contact, as well as in the whole seeds with husks with 120 minutes of contact, in relation to the control, as shown in Figure 6.

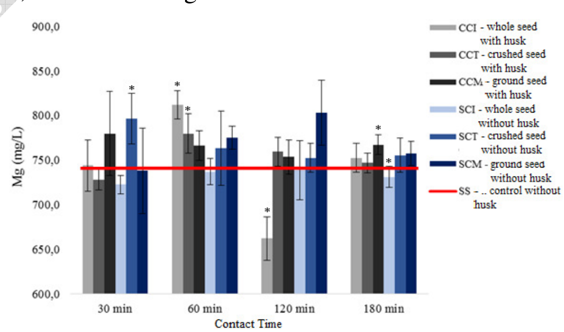

**Figure 6**. **Magnesium (Mg) of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (* = significant difference).**

The results obtained in this experiment between the *M. oleifera* seed and the chloride ion (Cl) ~~were also~~reveal the reduction in the concentration of this element in the reject, when compared to the control (Figure 6). This same phenomenon was observed in a survey carried out by [12] with open water wells in Kolhapur (India), which showed the reduction of chloride ions from 12 to 5 mg/L for water in contact with the Moringa seed-. This occurred due to the chemical attraction of the cationic substance present in the seed with anionic ions of the chlorides present in the water.

Concerning the adsorption of chloride, it was verified that the ground or crushed seeds altered the level of adsorption, in relation to the time of exposure. The highest adsorption occurred in the treatment of the crushed seed without husk in 60 minutes of contact, shown in Figure 7. What is the possible explanation for this variance? This could be the contribution of this work

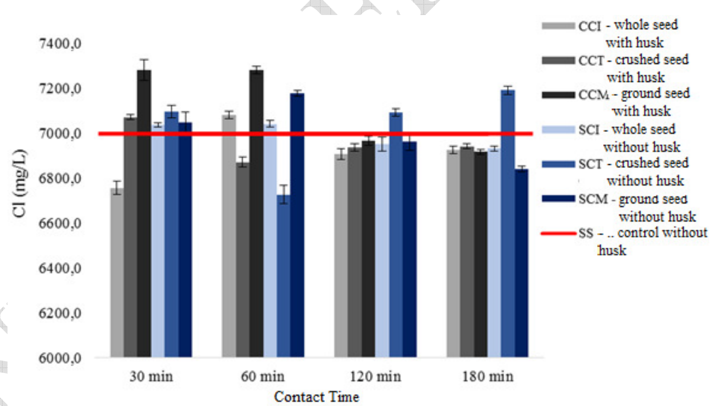


**Figure 7. Chloride (Cl) of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (* = significant difference)**

Statistical analysis was also carried out regarding the salts present in the reject in contact with the Moringa. In general, it was observed that there is significant difference between the groups, in the same way as in the Fisher's Coefficient (Tables 7 to 20).

**Table 7. Kinetics of Sodium of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (*Moringa* with and without husk)*.**

| Group Name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST** | 5 | 0 | 1868 | 59,749 | 26,721 |
| **CCI** | 5 | 0 | 25,26 | 0,195 | 0,0872 |
| **CCT** | 5 | 0 | 26,54 | 0,305 | 0,136 |
| **CCM** | 5 | 0 | 26,4 | 0,316 | 0,141 |
| **SCI** | 5 | 0 | 2250 | 30,822 | 13,784 |
| **SCT** | 5 | 0 | 2090,8 | 888,523 | 397,36 |
| **SCM** | 5 | 0 | 2622 | 175,699 | 78,55 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 8. Analysis of Sodium variances (groups vs. residual).**

| Source of Variation | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| **Between groups** | 6 | 42308402 | 7051400 | 59,84 | <0,001 |
| **Residual** | 28 | 3299454 | 117837,6 | | |
| **Total** | 34 | 45607856 | | | |

**Table 9. Kinectics of Na – Comparison control vs. samples (*Moringa* with and without husk)*.**

| Comparison | Difference of means | q' | P | P<0,050 |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **TEST vs. CCI** | 1842,74 | 8,488 | -- | Yes |
| **TEST vs. CCM** | 1841,6 | 8,482 | -- | Yes |
| **TEST vs. CCT** | 1841,46 | 8,482 | -- | Yes |
| **TEST vs. SCM** | 754 | 3,473 | -- | Yes |
| **TEST vs. SCI** | 382 | 1,76 | -- | No |
| **TEST vs. SCT** | 222,8 | 1,026 | -- | No |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 10. Kinetics of Potassium of the extracts obtained with the reject in contact with the seeds of *Moringa oleifera (Moringa* with and without husk)*.**

| Group Name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST** | 5 | 0 | 53,4 | 1,317 | 0,589 |
| **CCI** | 5 | 0 | 68,42 | 2,027 | 0,906 |
| **CCT** | 5 | 0 | 90 | 14,765 | 6,603 |
| **CCM** | 5 | 0 | 98,4 | 20,804 | 9,304 |
| **SCI** | 5 | 0 | 59,04 | 0,329 | 0,147 |
| **SCT** | 5 | 0 | 100,3 | 1,245 | 0,557 |
| **SCM** | 5 | 0 | 126 | 7,071 | 3,162 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 11. Analysis of variance of Potassium (groups vs. residual).**

| Source of Variation | DF | SS | MS | F | P |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **Between groups** | 6 | 20334,92 | 3389,153 | 33,494 | <0,001 |
| **Residual** | 28 | 2833,2 | 101,186 | | |
| **Total** | 34 | 23168,12 | | | |

**Table 12. Kinetics of K – Comparison control vs. samples (*Moringa* with and without husk)*.**

| Comparison | Difference of means | q' | P | P<0,050 |
|---|---|---|---|---|
| **Test. vs. SCM** | 72,6 | 11,412 | -- | Yes |
| **Test. vs. SCT** | 46,9 | 7,372 | -- | Yes |
| **Test. vs. CCM** | 45 | 7,073 | -- | Yes |
| **Test. vs. CCT** | 36,6 | 5,753 | -- | Yes |
| **Test. vs. CCI** | 15,02 | 2,361 | -- | Yes |
| **Test. vs. SCI** | 5,64 | 0,887 | -- | No |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).



**Table 13. Kinetics of Calcium from the extracts obtained with the reject in contact with the seeds of *Moringa oleifera* (*Moringa* with and without bark)*.**

| Group name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST** | 5 | 0 | 1005,206 | 13,412 | 5,998 |
| **CCI** | 5 | 0 | 1006,81 | 21,658 | 9,686 |
| **CCT** | 5 | 0 | 971,54 | 10,452 | 4,674 |
| **CCM** | 5 | 0 | 993,984 | 11,337 | 5,07 |
| **SCI** | 5 | 0 | 1011,606 | 17,359 | 7,763 |
| **SCT** | 5 | 0 | 934,666 | 21,658 | 9,686 |
| **SCM** | 5 | 0 | 961,92 | 72,146 | 32,265 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 14. Analysis of Calcium variance (groups vs. residual).**

| Source of | DF | SS | MS | F | P |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| **variation** | | | | | |
| **Between groups** | 6 | 24538,24 | 4089,707 | 4,172 | 0,004 |
| **Residual** | 28 | 27448,65 | 980,309 | | |
| **Total** | 34 | 51986,9 | | | |

**Table 15. Kinetics of Ca - Comparison control vs. samples (*Moringa* with and without barks)*.**

| Comparison | Difference of mean | q' | P | P<0,050 |
|---|---|---|---|---|
| **TEST vs. SCT** | 70,54 | 3,562 | -- | Yes |
| **TEST vs. SCM** | 43,286 | 2,186 | -- | No |
| **TEST vs. CCT** | 33,666 | 1,7 | -- | No |
| **TEST vs. CCM** | 11,222 | 0,567 | -- | No |
| **TEST vs. SCI** | 6,4 | 0,323 | -- | No |
| **TEST vs. CCI** | 1,604 | 0,081 | -- | No |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 16. Kinetics of Magnesium from the extracts obtained with the reject in contact with the seeds of *Moringa oleifera (Moringa* with and without husk).**

| Group name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST** | 5 | 0 | 740,97 | 17,729 | 7,929 |
| **CCI** | 5 | 0 | 743,886 | 28,761 | 12,862 |
| **CCT** | 5 | 0 | 728,33 | 12,106 | 5,414 |
| **CCM** | 5 | 0 | 779,864 | 47,338 | 21,17 |
| **SCI** | 5 | 0 | 722,492 | 10,083 | 4,509 |
| **SCT** | 5 | 0 | 796,392 | 28,224 | 12,622 |
| **SCM** | 5 | 0 | 738,05 | 47,81 | 21,382 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 17. Analysis of Magnesium variance (groups vs. residual).**

| Source of Variation | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| **Between groups** | 6 | 22660,4 | 3776,733 | 3,938 | 0,006 |
| **Residual** | 28 | 26852,36 | 959,013 | | |
| **Total** | 34 | 49512,76 | | | |

**Table 18. Kinetics of Mg - Comparison control vs. sample (*Moringa* with and without barks)*.**

| Comparison | Difference of mean | q' | P | P<0,050 |
|---|---|---|---|---|
| **TEST vs. SCT** | 55,422 | 2,83 | -- | Yes |
| **TEST vs. CCM** | 38,894 | 1,986 | -- | No |
| **TEST vs. SCI** | 18,478 | 0,943 | -- | No |
| **TEST vs. CCT** | 12,64 | 0,645 | -- | No |
| **TEST vs. SCM** | 2,92 | 0,149 | -- | No |
| **TEST vs. CCI** | 2,916 | 0,149 | -- | No |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).



**Table 19. Kinetics of Chloride of extracts obtained with the reject in contact with the seeds of *Moringa oleifera (Moringa* with and without husk)*.**

| Group name | N | Absence | Mean | Standard Deviation | SEM |
|---|---|---|---|---|---|
| **TEST.** | 5 | 0 | 6997,548 | 57,614 | 25,766 |
| **CCI** | 5 | 0 | 6757,29 | 155,289 | 69,447 |
| **CCT** | 5 | 0 | 7072,628 | 97,893 | 43,779 |
| **CCM** | 5 | 0 | 7282,856 | 405,486 | 181,339 |
| **SCI** | 5 | 0 | 7037,594 | 100,733 | 45,049 |
| **SCT** | 5 | 0 | 7097,658 | 285,68 | 127,76 |
| **SCM** | 5 | 0 | 7047,604 | 253,748 | 113,48 |

*Whole with husk (CCI) / crushed with husk (CCT) / ground with husk (CCM) / crushed without husk (SCT) / ground without husk (SCM) / whole witout husk (SCI).

**Table 20. Analysis of Chloride variance (Groups vs. residual).**

| Source of Variation | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| **Between groups** | 6 | 725669,9 | 120945 | 2,368 | 0,056 |
| **Residual** | 28 | 1430337 | 51083,46 | | |
| **Total** | 34 | 2156007 | | | |



## 3. CONCLUSION

From the experiments carried out, it was possible to ~~prove~~ demonstrate that the *Moringa oleifera* Lam. seed has significant potential in the treatment of the reject of desalinators.

The pH and electrical conductivity (EC) presented indices that demonstrate the efficiency of *Moringa* in the reduction of these values, highlighting the treatments without husk of 7.5 (control) to 5.2 dS/cm (30.6%) and ground with husk 19.1 to 18.2 dS/cm (4.7%) in 60 minutes of contact. Sodium $Na^+$ (mg/L) obtained relevant indices in all the treatments with the seed with husk, from 1868.0 (control) to 24.7 mg/L, with reduction of (98.7%). In the treatments without husk, the opposite occurred, the indices were above the control. Calcium $Ca^{\cancel{++}2+}$ (mg/L) also showed satisfactory results in treatments with whole seeds with husk, which showed a reduction of 1005.2 (control) to 894.6 mg/L (11%), in 60 minutes of contact. Magnesium $Mg^{++}$ (mg/L) was not reduced in most treatments. Specifically, the 120-

minute period was important for adsorption of magnesium in the experiment with seeds with husks, which was reduced from 741.0 to 662.2 mg/L (10.6%), in comparison to the control. Chloride $Cl^-$ (mg/L) had its indices reduced in some of the treatments. Among these, the crushed seeds with and without husks stood out in 60 minutes of contact, as they obtained adsorption levels in this period of 1.8% and 4.1%, respectively. The potassium $K^+$ (mg/L) was the only element that did not present satisfactory results in relation to the control, indicating that the use of *Moringa oleifera* Lam. in this parameter is not efficient.

In view of the above, the highlight is the experiments that used crushed or ground seeds with husks, mainly due to their relevance in the adsorption of elements such as sodium, calcium, magnesium and chloride.

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