International Journal of Research Studies in Science, Engineering and Technology
Volume 7, Issue 6, 2020, PP 01-07
ISSN 2349-476X

Use of *Moringa Oleifera* for Adsorption of Chemical Elements from the Mangrove Sediment

L.M.Vieira[1], A. C. Silva[1], J.C.B. Almeida Neto[1], S.C. Paiva[2], G.M.C. Takaki[2], A.S. Messias[2]*

[1]*Student of the Environmental Engineering Course at the Catholic University of Pernambuco - UNICAP, Recife, Pernambuco, Brazil.*

[2]*Teacher of Catholic University of Pernambuco, Recife, Pernambuco, Brazil.*

***Corresponding Author:** A. S. Messias, Teacher of Catholic University of Pernambuco, Recife, Pernambuco, Brazil.*

ABSTRACT

The application of Moringa oleifera, popularly known as white wattle, is gaining more and more space in research as a biosorbent. The objective of this research was to use Moringa oleifera seeds with husk and crushed to detect the best adsorption of chemical elements present in the mangrove sediment.Under laboratory conditions, an experiment with PVC tubes was set up, where 1.5 kg of mangrove sediment was added. Shortly thereafter, 300g of the crushed seed of Moringa oleifera was applied to the surface and also incorporated into the sediment, with irrigation with desalinator reject twice a week.The extract was collected every 15 days until 60 days, which determinedpH, CE, Na+, K+, Ca2+, Mg2+and Cl-. After statistical analysis of the results obtained, it was found that the seeds of the shelled and crushed moringa when incorporated into the mangrove sediment were effective in adsorbing the ions, as they presented the lowest values in the percolate: sodium (2,410.0mg/l), potassium (9786.7mg/l), calcium (114.8mg/l), magnesium (79.3mg/l) e chloride (470.0mg/l), at 60 days of contact.

Keywords: *Biosorbent,Desalinator reject, Mangrove, Sediment, Sorption.*

INTRODUCTION

The mangrove consists of a coastal ecosystem, in transition between terrestrial and marine environments, characteristic of tropical and subtropical regions, subject to the tidal regime.The geographical distribution of mangroves is related to the places that favor sediment deposition, normally associated with low-slope coastal plains or flooded river valleys. Its distribution covers 60 to 75% of the world coastline[1].

Due to their peculiar characteristics, mangrove sediments have a transition from aerobic to anaerobic zones. Other characteristics are high temperatures, high levels of salinity, high pH, high levels of organic matter and low aeration.This combination provides infinite conditions of extremely small niches with the presence of association between communities[2].

The mangrove that is the object of this study is located in the municipality of Rio Formoso, located in the physiographic region of the Southern Meridional of the state of Pernambuco, 92km from the capital Recife. Part of its territory is included in an Environmental Protection Area - APA (State Decree No. 19,635of March 13, 1997), called APA de Guadalupe, which is located in the southern portion of the southern coast of the state of Pernambuco, covering part of the municipalities of Sirinhaém, Rio Formoso, Tamandaré and Barreiros[3].

The Formoso River is 12km long and rises in the northwest portion of the municipality of the same name. Close to the mouth, located between the Guadalupe point and the Carneiros beach, it receives Ariquindá and its affluent União, two important components of its basin. Along its route it receives domestic waste and residues from the sugar agribusiness[4].

Salinity has become a serious problem of land degradation and is steadily increasing in many parts of the world, particularly in arid and semi-arid areas. Among the main natural factors that contribute to this salinization are the weathering of rocks, deposition of ocean salts, topographic factor, and groundwater fluctuation[5].

The process used for water desalination in Northeast Brazil is based on reverse osmosis. Such a process implies the generation of waste, a wastewater from the process, with high ionic concentration.This extremely salt-rich reject is deposited in decanting ponds or placed outdoors, without major concerns, constituting a real environmental challenge to be solved, since it directly contributes to the generation of other problems, such as the increase in the salinized area and consequent agricultural infertility[6].

Moringa oleifera has high nutritional and food value (leaves, green fruits, roasted flowers and seeds), forage (leaves, fruits and seeds), medicinal (the whole plant), spice (the roots), meliferous (flowers) and fuel (wood and oil); as well as it can be used in cooking, in the cosmetic industry (seed oil) and in the treatment of water for human consumption (cotyledons and seeds). In addition, it is used for making fences, windbreaks, having a fundamental environmental role[7].

With all these qualities and uses, the species was also introduced in other countries, besides Brazil[8, 9].Several researches have been carried out showing that the seeds are effective as coagulants, due to a protein that when placed in contact with the impurities of the water, cause their macromolecules to ionize forming hydrolyzed entities, causing the destabilization of the particles of the material dispersed in it and the electro kinetic imbalance of the solution, improving the physical-chemical properties of the contaminated water.Moringa oleifera seed functions as a biocoagulant, through the adsorption and neutralization mechanism[10, 11].

This work's objective was to evaluate the efficiency of adsorption of chemical elements of the mangrove sediment, using the*Moringa oleifera*.

Materials And Methods

The experiment was conducted at the Analytical Chemistry Laboratory, on the 8^{th} floor of Block D, at the Science and Technology Center at Universidade Católica de Pernambuco, Recife, Pernambuco, Brazil, with average temperature of 20ºC.

Five subsamples of mangrove sediment were collected in the municipality of Rio Formoso, Pernambuco, at coordinates 8º41'17"S and 35º06'30.1"O, under the SIRGAS 2000 reference system, located in the mesolitoral region, with little water.

These subsamples were mixed to form a composite sample, with the following characteristics: Apparent density = 1.05g/cm^3; Real density = 2.49g/cm^3; Degree of flocculation = 32%; Texture class = clay loam; Natural clay = 25%; Residual humidity = 2.75%; Humidity 0,33atm = 56.80%; Humidity 15atm = 28.14%; Available water = 28.66%; pH (H_2O) = 5.70; Ca^{2+}= 4.00$cmol_c$ / dm^3; Mg^{2+} = 1.10$cmol_c$ / dm^3; Na^+ = 0.34$cmol_c$ / dm^3; K^+ = 0.20$cmol_c$/dm^3; Sum of Exchangeable Bases (S) = 5.60$cmol_c$ / dm^3; Cation Exchange Capacity (CEC) = 10.3$cmol_c$/dm^3; Base Saturation (V) = 55%, according to the methodology of the Brazilian Agricultural Research Corporation.

The desalinator reject for irrigation was obtained from the desalinator located in the municipality of Riacho das Almas, Pernambuco, Brazil. The physicochemical analysis was performed at the Agronomic Institute of Pernambuco (IPA) Plant, Ration and Water Analysis Laboratory - LAPRA with the following characteristics: electrical conductivity = 11.541µS/cm at 25ºC, Ca^{2+} = 403mg/l, Mg^{2+} = 393.09mg/l, Na^+ = 200mg/l; K^+ = 40mg/l, RAS = 23.67, pH = 7.9, classification for irrigation = C4S4 (very high salinity water and high sodium concentration).

Agronomic Institute of Pernambuco (IPA) provided *Moringa oleifera* seeds. The physicochemical analysis was performed at the IPA Plant, Ration and Water Analysis Laboratory - LAPRA with the following characteristics: pH = 6.21; Ca^{2+} = 284.0mg/mg; Na^+ = 33.0mg/mg ;Humidity = 5.7%; ashes = 9.12%; fiber = 14.56%; lipids = 12.89%; ether extract = 5.0%; protein = 18.93%; carbohydrate = 38.85%.

For the installation of the experiment, PVC tubes with 25cm height and 9.8cm internal diameter were used, presenting at the base an opening connected to a 0.7cm diameter flexible hose that allowed the percolating liquid to pass through the sediment into the container collector, with three replications, totaling 12 tubes.

The tubes were filled with 1.5 kg of mangrove sediment, enough to obtain a 20 cm high column. Shortly thereafter, 300g of the *Moringa oleifera*seed with husk and crushed was applied to the surface (MS) and incorporated (MI) into the sediment, in addition to the control (TEST), with irrigation with the desalinator reject twice a week.

The percolate in each tube was collected in a 250ml conical flask, at intervals of 15 days, up to 60 days, with the hydrogen potential being determined - pH (potentiometry), electrical conductivity - EC (conductivity measurement), Na^+ and K^+ (flame emission spectrophotometry), Ca^{2+} and Mg^{2+} (complexation titrimetry) and Cl^- (precipitation titrimetry - Mohr method), for later statistical analysis, using the Minitab 19 software.

Results And Discussion

The results obtained for pH, CE, Na^+, K^+, Ca^{2+}, Mg^{2+} e $Cl^-$are shown in Figures 1 to 7. In Fig.1 it can be seen that the pH values remain alkaline for the treatments used (TEST - control, MS - moringa on the surface, MI - incorporated moringa) at all contact times (15, 30, 45 and 60 days) , with the exception of percolate collected at 15 days after the seed of *Moringa oleifera*was incorporated (MI) to the sediment (6.95).

The experiments by[12, 13]also presented pH with basic values. It is important to note that the studies already carried out by[14, 15]indicated that *Moringa oleifera* seed proved to be efficient in removing water turbidity and removing metals, without causing a change in pH; it proves to be a viable and significant alternative in the treatment of water in places where salt concentrations are present.A possible assumption for these different results may be the fact that, in the present study, the substance tested was mangrove sediment, which presents salts, in addition to those from irrigation with a desalinator reject.

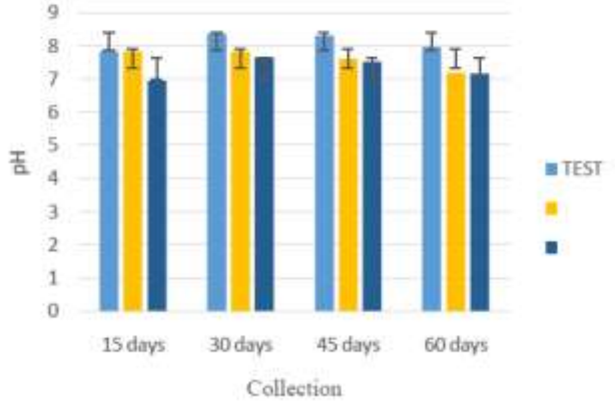

Fig.1. *Average percolate pH values collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

Regarding the electrical conductivity (EC), Fig.2 shows that the values are decreasing as the collection time approaches 60 days. It is noticed that the moringa incorporated in the mangrove sediment registered in the percolate, at 15 days, EC equal to 37.4 mS/cm and, at 30 days, 28.6 mS/cm. The moringa on the surface of the sediment presented 18.3mS/cm and 13.1mS/cm in the EC percolate, respectively at 45 and 60 days of contact.

According to[16],natural waters have conductivity values in the range of 10 to 100µS/cm. A body of water rich in humic compounds and with low pH can present high values of electrical conductivity, when polluted by domestic or industrial sewage and the levels can reach up to 1,000µS/cm. The EC estimates the amount of salts or ions dissolved in the water.

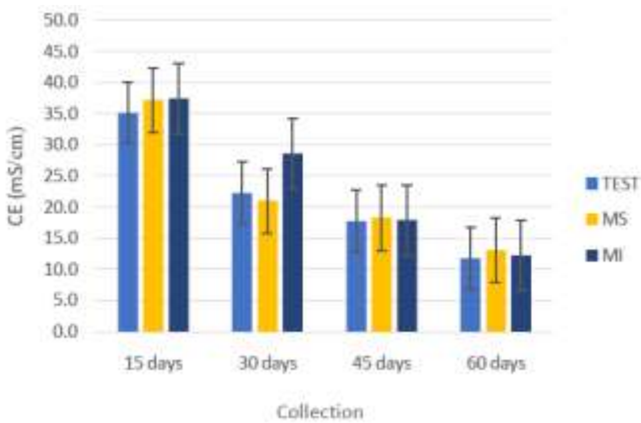

Fig2. *Average values of electrical conductivity (EC) of percolate collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

The sodium values in the percolate, shown in Fig.3, indicate that there is a tendency of adsorption of this chemical element in the mangrove sediment with the husked and crushed seed of Moringa oleifera, after 30 days of contact, namely: Na^+ in the leachate at 30 days (MS = 3,620.0mg/l; MI = 3,246.7mg/l), Na^+ in the leachate at 45 days (MS = 2,746.7mg/l; MI = 2,880.0mg/l), and Na^+ in the leachate at 60 days (MS = 2.533.3mg/l; MI = 2.410.0mg/l).

According to[8] it has been found through laboratory tests that seeds with crushed or ground Moringa husks are equally effective at adsorbing sodium from 1,868.0mg/l to 24.6mg/l (98.7%).

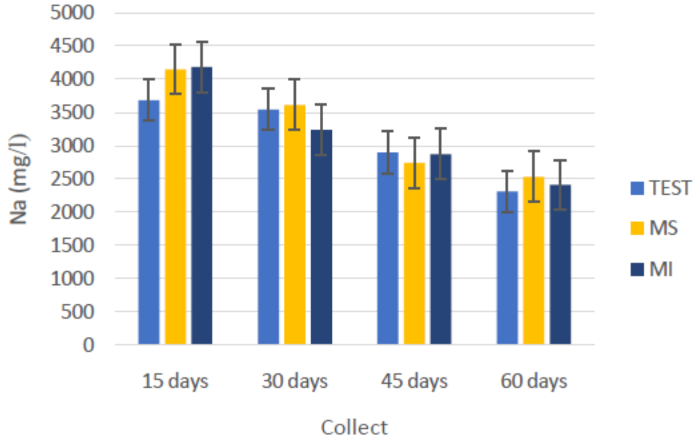

Fig3. *Average sodium values (Na^+) of percolate collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

In Fig.4 it can be seen that the moringa incorporated in the mangrove sediment presented the highest K^+ values in the percolate, for all contact times: 15 days (1,166.7 mg/l), 30 days (970.0mg/l), 45 days (1,036.7mg/l) and 60 days (786.7mg/l).Therefore, the moringa on the surface favors more potassium adsorption. On the other hand, the values that showed less potential for adsorption, in all contact times, were moringa witness (TEST): 15 days (683.3mg/l), 30 days (576.7mg/l), 45 days (523.3 mg/l) and 60 days (300mg/l).

When[17]used samples of 50 seeds of *Moringa oleifera* immersed in a volume of 70.0 ml of water showed the lowest potassium leaching rates in batches 1, 2 and 4 in the 1 hour soak period, and in batch 1 in the 5 and 6 periods hours of soaking.

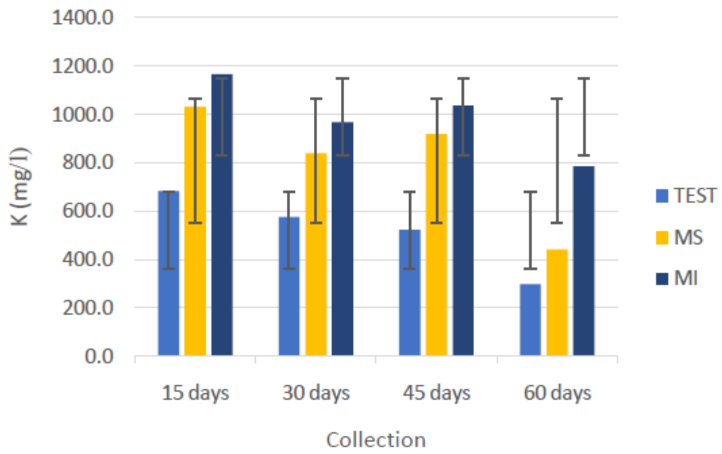

Fig4. *Average values of potassium (K^+) of percolate collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

The percolated calcium (Fig.5) showed lower values at 15 days (214.7mg/l), 45 days (128.2mg/l) and 60 days (114.8mg/l) when the moringa seed incorporated in the sediment of mangrove.At 30 days, Ca^{2+} showed a value equal to 171.5mg/l when the moringa was placed on the surface of the mangrove sediment, indicating increasing calcium adsorption.

Through laboratorytests [14] realized that the seeds with crushed or ground *Moringa oleifera* bark are equally effective in adsorption of calcium from 1.005.0mg/l to 894.6mg/l (11%), with 60 minutes of contact with desalination reject.

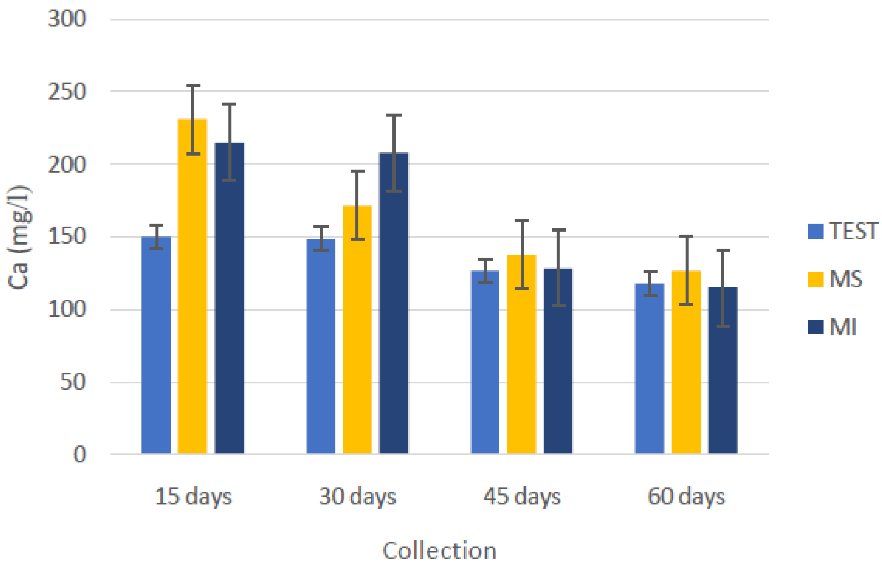

Fig5. *Average values of calcium (Ca^{2+}) of percolate collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

In Fig.6 it is observed that the magnesium values in the percolate, when the moringa was incorporated (IM) in the mangrove sediment, presented decay over the days of collection. At 15 days, Mg^{2+} equal to 124.7mg/l; at 30 days, 106.8mg/l; at 45 days, 99.8mg/l; and at 60 days, 79.3mg/l, indicating increasing magnesium adsorption in this treatment.Only after 60 days of contact, when the moringa was added to the mangrove sediment, did it show a lower value (78.3mg/l) than the incorporated one. A study carried out by [18], reached the same result: the researcher proved that the powder of *Moringa oleifera*seeds in contact with the organic material of the well water reduces the hardness value in the period of 24 hours.

According to[19], after statistical analysis of the extracts collected and analyzed at seven and 15 days, it was noticed that the results presented demonstrated that the adsorption of calcium, magnesium, sodium and potassium was more effective at eight days of contact of the sediment with the rice husk, water hyacinth and barley.

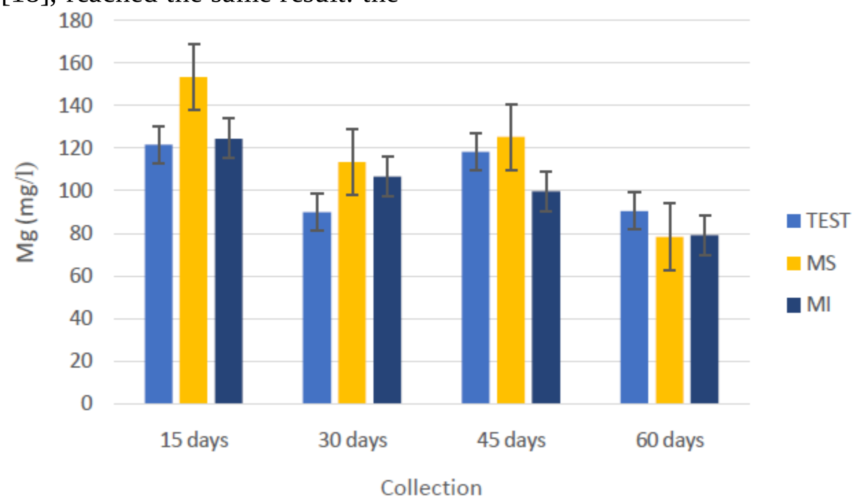

Fig6. *Average values for magnesium (Mg^{2+}) in percolate collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

As can be seen from Fig.7, the chloride ion showed lower percolate values when the moringa was incorporated into the mangrove sediment at 15 days (797.0mg/l), 30 days (540.8mg/l), 45 days (485.2mg/l) and 60 days (470.0mg / l) of contact.

This behavior was more effective in adsorbing Cl^- in relation to the moringa on the surface. According to[8],it has been found through laboratory tests that seeds with crushed or ground Moringa husks are equally effective at adsorbing chloride from 6.997.5 mg/l to 6.782.4 mg/l (1.8%).

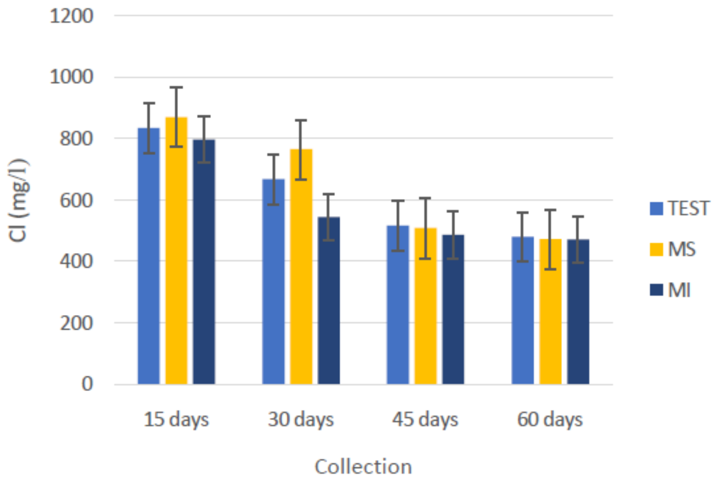

Fig7. *Average values of chloride (Cl^-) of percolate collected at 15, 30, 45 and 60 days for the control (TEST), Moringa oleifera seed on the surface (MS) and incorporated (MI) in the mangrove sediment.*

Conclusion

In view of the results obtained, it can be inferred that there is a tendency to recommend the seed with the husk and crushed *Moringa oleifera* when incorporated into the mangrove sediment, by favoring the adsorption of ions, as they presented the lowest values in the percolate: sodium (2,410.0mg/l), potassium 9786.7mg/l), calcium (114.8mg/l), magnesium (79.3mg/l) and chloride (470.0mg/l), at 60 days of contact.

References

[1] Miranda MLP. Bioprospecting of microorganisms producing lipases and biosurfactants isolated from the mangrove of Babitonga Bay, Joinville - SC. Dissertation (Master in Health and Environment). University of Joinville Region, 2018: 95.

[2] Ghizelini MA, Mendonça-Hagler CSL, Macrae A. Microbial diversity in brazilian mangrove sediments:a mini review. Brazilian Journal of Microbiology, 2014; 43(4): 1242-1254.

[3] Companhia Pernambucana do Meio Ambiente (CPRH). Management plan, coastal Economic Ecological Zoning- ZEEC de Guadalupe Litoral Sul de Pernambuco, 1998.

[4] Companhia Pernambucana do Meio Ambiente (CPRH). Socio-environmental diagnosis and ZEEC - Ecological Economic Zoning Coastal South coast of Pernambuco, 1999.

[5] Saxena B, Kamlesh S, Bhoopander G. Arbuscular mycorrhizal fungi and tolerance of salt stress in plants. Arbuscular Mycorrhizas and Stress Tolerance of Plants.Springer Singapore, 2017: 67-97.

[6] Associação Brasileira de Águas Subterrâneas (ABAS). How to increase the supply of water in Brazil. Campinas, São Paulo, 2016.

[7] Santos CAB, Nogueira SEM, Moura GJB, Andrade MJG. Conservation of natural resources. Paulo Afonso: SABEH, 2016:138.

[8] Gomes Filho AJ, Paiva SC, Takaki GMC, Messias AS. Application of moringa in the removal of salts from the desalinator reject. Current Journal of Applied Science and Technology, 2019; 36(1): 1-13.

[9] Pereira ER, Alves MM, Bicudo BR. Application of *Moringa oleifera* as a natural coagulant in the treatment of pool water. Maringa, Paraná, 2014.

[10] Oliveira NT, Nascimento KP, Gonçalves BO, Lima FC, Costa ALN. Water treatment with oil moringa as coagulant / natural flocculant. Scientific Journal of the Faculty of Education and Environment, 2018;9(1): 373-382.

[11] Soriani M. Efficiency of *Moringa oleifera* as a natural coagulant in saline solution for water supply. Londrina. Technological University of Parana. Other Open Collections Repository, 2015; 2(9).

[12] Santana PMA, Messias AS. Cadmium sorption by *Moringa oleifera* Lam. Asian Journal of Environmental & Ecology, v. 11, p. 1-7, 2019.

[13] Amagloh FK., Benang A. Effectiveness of *Moringa oleifera* seed as coagulant for water purification. African Journal of Agricultura Research, 2009; 4(1): 119-23.

[14] Gomes Filho AJ, Paiva SC, Takaki GMC, Messias AS. Application of moringa in the removal of salts from the desalinator reject. Current Journal of Applied Science and Technology, 2019; 36(1): 1-13.

[15] Gomes Filho AJ, LimaFilho HJB, Paiva SC, Messias AS.Use of the *Moringa oleifera* seeds fixed-bed model and Pernambuco semi-arid desalinator reject. Current Journal of Applied Science and Technology, 2019; 37(1): 1-7.

[16] Silva CB. Potential use of *Moringa oleifera* Lam., a matrix for biodiesel production and water treatment in the northeastern semiarid, 2012:117.

[17] Medeiros MLS, Demartelaere, ASF, Pereira MD, Pádua GVG. Adequacy of potassium leaching test

in *Moringa oleifera* seeds. Ciência Florestal, 2019; 29(2): 10.

[18] Mangale SM, Chonde SG, Raut PD. Use of *Moringa oleifera* (drumstick) seed as natural absorbent and an antimicrobial agent for ground water treatment. Research Journal of Recent Sciences, 2012; 1(3): 31-40.

[19] Lemos DGL, Silva Filho AAP, Barreto GCM, Batista CM, Paiva SC, Messias AS. Use of alternative residues for adsorption of chemical elements from river sediment. International Journal of Research Studies in Science, Engineering and Technology, 2020; 7(5): 1-12.

Citation: *A. S. Messias, et al. "Use of Moringa Oleifera for Adsorption of Chemical Elements from the Mangrove Sediment" International Journal of Research Studies in Science, Engineering and Technology, 7(6), 2020, pp. 01-07.*