RESULTS AND DISCUSSION

**Introduction and Objectives**

Biosorption is a wastewater purification process that uses biological materials for the removal of contaminants through different mechanisms such as physisorption, chemisorption, ion exchange and microprecipitation [1]. The principal mechanism of metal ions sequestration by brown marine macro-algae involves the formation of complexes between the metal ion and functional groups present on the cell wall of the biological material by an ion exchange process [2].

**Material and Methods**

**Characterization of Biomass**

<table>
<thead>
<tr>
<th>Table 1. Mass characteristics of different brown marine macro-algae.</th>
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<tr>
<td>Algae</td>
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<tr>
<td>L. hyperborea</td>
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<tr>
<td>F. spiralis</td>
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<tr>
<td>P. canaliculata</td>
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<td>A. nodosum</td>
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</table>

**Conclusions**

The heavy metal removal from aqueous solution and wastewaters can be successfully achieved using brown macro-algae harvested from the north coast of Portugal, as natural cation exchangers. The properties of the brown macro-algae are associated with the presence of weakly acidic (carboxyl groups) and strongly acidic (sulfonic groups) functional groups on the surface of the biomass particles. The maximum cation exchange capacity was between 2.2 and 2.4 mEq/g. The better operating conditions obtained at lab scale were: 0.44 mg Zn/L and 31 mL for saturation step, 4.3 mg/L of 3.0 % HCI for elution and, as regeneration solution, 0.1 M CaCl₂·2H₂O. These conditions, which were scaled-up according to the lab scale, lead to almost 90% zinc displacement.

**References**


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**Figure 1.** FTIR spectrum of different marine macro-algae.  
**Figure 2.** SEM images of different marine macro-algae (a) L. hyperborea; (b) F. spiralis; (c) A. nodosum.

**Figure 3.** Equilibrium within experimental data points and model-predicted points for different pH-values using raw A. nodosum.

**Figure 4.** Kinetic model data and model fitting for Cu²⁺ uptake (Cᵢ = 200 mg/L and pH = 4.0) on raw A. nodosum.

**Figure 5.** Breakthrough curves for Zn removal from diverse waters at different flow rates using L. hyperborea (pH = 4.0; 10.5 cm/min; volume: 1500 cm³).  
**Figure 6.** Breakthrough curves for Zn removal from diverse waters at different flow rates using L. hyperborea (pH = 4.0; 10.5 cm/min; volume: 1500 cm³).

**Figure 7.** Breakthrough curves for Zn removal from diverse waters until breakthrough (a) and elution (b) during 3 cycles of precipitation/desorption/regeneration at shaking rate of 200 rpm and pH = 4.0.

**Figure 8.** Breakthrough curves for Zn removal from diverse waters until breakthrough (a) and elution (b) during 3 cycles of precipitation/desorption/regeneration at shaking rate of 200 rpm and pH = 4.0.

**Figure 9.** Breakthrough curves for Zn removal from diverse waters until breakthrough (a) and elution (b) during 3 cycles of precipitation/desorption/regeneration at shaking rate of 200 rpm and pH = 4.0.