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The biosorption of heavy metals by immobilised green microalgae Desmodesmus sp. biosmass

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ABSTRACT

Gold mining had a prominent place in the South African economy since its discovery in 1886. However, its fall in production and imminent resource exhaustion over the years has come with extensive environmental problems. This therefore calls for sustainable and cost-effective technologies that can reduce toxic levels of heavy metal concentrations in water streams to environmentally acceptable levels. A green microalgae such as *Desmodesmus sp.* has a potential to be a sustainable and cost-effective solution, due to its proficient capability of heavy metal sequestration in aqueous solutions. This study is therefore governed by two key complimentary components: (i) in-depth optimization study of Ca-alginate matrix composition for the purpose of immobilizing *Desmodesmus sp.* and (ii) the immobilized *Desmodesmus sp.* being used for biosorption of heavy metals from aqueous solutions. Following the preliminary optimization studies, bead diameter of 3 mm; calcium chloride concentration of 9 % w/v; sodium alginate concentration of 6 % w/v and biomass loading of 8 % w/v were used for subsequent biosorption experiments. High correlation coefficients was found for the Freundlich model indicating that it can be used to best describe the sorption of Fe (II) and other heavy metals on immobilized algal biomass. The correlation coefficient study showed the R^2 value of Fe (II) sorption kinetics for pseudo-second order kinetic equation was close to 1, making it a better fit to the experimental data compared to pseudo-first order where R^2 values were 0.18; 0.38; 0.76; 0.41; 0.48 and 0.76 for 5; 60; 120; 240; 480 and 1000 mg / L. The trend in binding of heavy metal ions is as follows: Ni (II) > Mn (II) >Cr (III) > Fe (II). The increase in loading capacity as a function to time when Fe (II), Ni (II), Mn (II) and Cr (III) are adsorbed by the immobilized microalgae *Desmodesms sp.* is an indication that microalgae cells are tolerant of toxic heavy metals in aqueous solutions. According to this study a flow rate of 4 mL/min with a packing height of 82 cm (C_o = 120 mg / L) seems to be the most effective combination, which has a potential to increase the metal removal rate significantly. Further work will be required to develop models that will best describe the biosorption of heavy metals in a continuous flow system, packed bed column. From this study the immobilized green microalgae *Desmodesmus sp.* has shown to have a high loading capacity for Fe (II), it has a potential to be re-used and regenerated for multiple cycles of heavy metal uptake.