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SCHOOL OF ENVIRONMENTAL SCIENCES

DEPARTMENT OF HYDROLOGY AND WATER RESOURCES

**Investigation of Coagulant Properties and Efficiency of *Diceriocaryum Eriocarpum* Plant
for Turbidity Removal and Biosorbent for Heavy Metals Uptake in Aqueous Solution**

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Abstract

Environmental pollution over the past decades has reached crisis level due to the nature of pollutants that leach into the water bodies. Inadequate water services coupled with lack of potable drinking water infrastructure is one of the major challenges facing most of the rural communities in South Africa. This research was aimed at investigating the potential of a new and cost effective plant material as biosorbent in the removal of heavy metal ions from aqueous solution and also as coagulant for removal of turbidity from raw water. The material is intended for use in rural households where most of the domestic water supplies are untreated.

Therefore, this study proposed the use of mucilage from *Diceriocaryum eriocarpum* (DE) as biosorbent in the removal of heavy metals from aqueous solution and as coagulant in the removal of turbidity from raw water. To this end, modification of the DE mucilage was carried out by addition of chlorides during the extraction process. Extraction of the mucilage was carried out using KCl, NaCl solution and deionized water solely. Characterisation of the active agent in the mucilage was carried out using Fourier transform infrared spectroscopy (FTIR). Improvement of the coagulation efficiency was carried out by optimizing various parameters. Assessing the biosorption capability of DE mucilage was also achieved by optimizing parameters. Optimization was achieved by varying one parameter while keeping the others constant.

Application and improvement of coagulation and biosorption potential of DE was greatly attributed to the functional group (active agent) present in the mucilage. FTIR results showed that the functional groups acting as the active agent in DE both in modified and unmodified mucilage were carboxyl, hydroxyl and carbonyl groups. The chloride used in the modification of the mucilage did not introduce new functional groups but rather expanded and increased the already existing functional groups in the mucilage.

The modified mucilage: potassium crude extract (PCE) and sodium crude extract (SCE) display high coagulation and biosorption efficiency more than unmodified mucilage; deionized water crude extract (DCE). It was observed that an increase in coagulant dosage, settling time and initial turbidity influence the coagulation efficiency of DE mucilage. Assessing the EC-levels, pH and high reduction in turbidity levels of the treated water samples showed that the treated water was of high quality. Coagulation mechanism for unmodified mucilage was suggested to be

strong repulsion force while modified mucilage mechanisms occur via double layer interaction and charge neutralization.

Results from biosorption experiment showed that, DCE, SCE and PCE display good binding affinity with heavy metal ions (Zn, Cd, Ni, Cr and Fe) in the aqueous solution. It was also observed that an increase in the aqueous solution pH, mucilage concentration and initial concentration of metal ions also increased the sorption efficiency of DCE mucilage. The DCE biosorbent was able to attain equilibrium rapidly within 8-10 minutes of contact time. Biosorption mechanism for both modified and unmodified mucilage seems to occur via electrostatic interaction and binding chelation.

Generally, it was observed that the modified mucilage was highly efficient in turbidity removal and also in the removal of metal ions more than the unmodified mucilage. This can be attributed to the presence of the salts enhancing the mechanism in the active agent (functional groups) of DE coagulant.

Hence, the best method for improving the coagulation and biosorption efficiency of DE plant is by using salt solution in extracting the mucilage. Coagulation efficiency was improved to 99% using modified mucilage coagulant. In light of this, the adoption of DE mucilage in treatment of raw water showed good results and can be adopted for household use in communities where there is need for potable drinking water.