Biosorption Kinetics and Equilibrium uptake of Reactive Red 120
dye onto Nelumbo nucifera

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The ability of Nelumbo nucifera plant’s stem as a biosorbent for the removal of Reactive
Red 120 (RR120) from aqueous solution was studied. Experiments were conducted with the effect of
biosorbent dosage (0.2 to 1.0 g/L), pH (1 to 6) and initial dye concentration (30 to 110 mg/L) at batch
mode. The optimum biosorbent dosage was found to be 0.2 g/L for dye removal. The maximum uptake
of dye was observed at pH 2. Equilibrium dye uptake capacity was found to be increased with
increase in initial dye concentration. Batch kinetics and isotherm studies were carried out. The
kinetic data was analyzed using the Pseudo-first order and Pseudo-second order kinetic models. The
data showed that the Pseudo-second order rate equation was more appropriate. The suitability of the
Langmuir and Freundlich adsorption models to the equilibrium data were investigated and it was
found that the biosorption data conformed well to Freundlich isotherm model. The Fourier transform
infrared analysis was employed to confirm the existence of amine group in N. nucifera plant’s stem.
The surface morphology of the N. nucifera plant’s stem was exemplified by the scanning electron
microscopy.

Key words: Biosorption, Reactive dye, Nelumbo nucifera, Langmuir, Freundlich

Introduction

Many industries such as textile, tannery, food, paper
and pulp, printing and carpet industries employ dyes and
pigments to color their products. A high volume of wastewater
is produced in the textile industries. The disposal of these
wastes into receiving waters causes damage to the
environment. Because of reduced light penetration, dyes
may significantly affect photosynthetic activity in aquatic life
and may also be toxic to some aquatic life due to the presence
of aromatics, metals, chlorides, etc.

Several biological, physical and chemical methods have
been used for the treatment of industrial textile wastewater
including membrane filtration, coagulation/floculation,
sorption, ion exchange, advanced oxidation (chlorination,
ozonation), flotation, and chemical reduction. However, many
of these technologies are cost prohibitive, especially when
applied for treating large waste streams. Adsorption hold
promise in the treatment of wastewater, as it is low processing
cost, low cost adsorbent and easy to handle.

In recent years, several sorbents have been identified as
possessing good dye-binding capabilities. Among them
activated carbon has been widely used in industry as a sorbent
for the removal of colour and the treatment of textile effluents.

However, activated carbon is the most widely used as an
adsorbent; it is not used in a large scale because of its high
cost. For this reason, interest has been recently focused on
low-cost and locally available adsorbents such as wheat straw
and neem sawdust, orange peels, banana peel, water hyacinth roots, an invasive macro alga Sargassum muticum,
and peanut hull, bagasse pith and maize cob.

Biosorption is a process that utilizes dead biomass and/or
biomaterial for the removal of contaminants from
industrial effluents. In particular, aquatic plants are very
promising materials to be used as biosorbents in wastewater
treatments because they represent a low cost biosorbent and
readily available in large quantities. Dried biomass offers more
advantages because it does not require a continuous supply
of nutrients and is not sensitive to the toxicity of dyes or toxic
wastes. It can also be regenerated and reused in many cycles.
Using of dead biomass for the dye removal from aqueous
solution is both safe and eco-friendly.

Reactive dye is a class of highly colored organic
substances, primarily utilized for tinting textiles. They are
mostly azo compounds with one or several azo (N=N) bridges
having link to substituted aromatic structures. These dyes are
designed to be chemically and photolytically stable.

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