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A PRELIMINARY STUDY ON *COCCINIA INDICA* FRUIT MUCILAGE EXTRACT AS COAGULANT-FLOCCULENT FOR TURBID WATER TREATMENT

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ABSTRACT

Lab scale experiments were conducted to investigate the efficiency of mucilage isolated from the fruits of *Coccinia indica* as flocculent for the treatment of turbid water samples containing synthetic turbidity of kaolin. Jar test experiments at optimum pH and time were carried out for 10, 25, 50, 75 and 100 (NTU) levels of turbidity in the flocculent dose range, of 0.1 mg, 0.2 mg, 0.4 mg, 0.8 mg, 1.2 mg, 1.6 mg and 2.0 mg/l. The flocculation efficiency of *C. indica* fruit mucilage (also known as Kundoor mucilage) at different turbidity levels and the effects of flocculent dose on percent removal of turbidity are reported. At all the experimental turbidity levels, the increased flocculent dose increased the percentage of turbidity removal upto a certain level, beyond which further increase in dosage showed a decreasing trend in the removal. The optimum dose of the flocculent in the present study was found to be 0.4 mg/l. *C. indica* mucilage has higher efficiency in removing high turbidity in comparison with low turbidity. Highest turbidity removal (94%) was obtained with very high i.e. 100 NTU initial turbidity. The mucilage of *C. indica* fruit is an ecofriendly and low cost anionic polysaccharide capable of reducing suspended particles helps in lowering turbidity of water/wastewater through flocculation process.

Key words: *coagulant, Coccinia indica, flocculation, kaolin, turbidity.*

INTRODUCTION

Growing population, increased economic activity and industrialization has not only created an increased demand for fresh water but also resulted in severe misuse of these natural resources. Water resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. The cost of water treatment is increasing and the quality of river water is not stable due to a suspended and colloidal particle load caused by land development and high storm runoff during rainy season, such is experienced in a country like India. About 1.2 billion people still lack safe drinking water and more than 6 million children die from diarrhea in developing countries every year. In many parts of the world, river water that can be highly turbid is used for drinking purposes. World Health Organization (WHO) has set the guideline value for the residual turbidity in drinking water at 5 Nephelometric Turbidity units (NTU) [1].

As identified by the United States Environmental Protection Agency (USEPA), turbidity is a measure of the cloudiness of water; it is used to indicate water quality and filtration effectiveness. High turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites and some bacteria in the water. These organisms can cause symptoms such as nausea, cramps, diarrhoea and headaches [2]. Water-borne infectious diseases caused by viruses, bacteria, protozoa and other microorganisms are associated with outbreaks and background rates of diseases in developed and developing countries worldwide[3].

Developing countries pay a high cost to import chemicals including polyaluminium chloride and alum [4, 5] for water purification. This is the reason why these countries need low cost methods requiring low maintenance and skill. Nowadays, polyaluminium chloride is widely used in water treatment plants all over the world. Polyaluminium chloride and alum add impurities such as epichlodine are carcinogenic [6, 7]. Aluminium is regarded as an important poisoning factor in dialysis encephalopathy. Aluminium is one of the factors which might contribute to Alzimer disease [8, 9]. Aluminium reaction with water alkalinity reduces water pH and its efficiency in cold water [10, 11]. However some synthetic organic polymers such as acrylamide have neurotoxicity and strong carcinogenic effect [6, 8]. Coagulation has been subject of much research, most of which has been related to coagulation in the context of water treatment. Inorganic coagulants such as alum in combination with lime have been conventionally used for removal of turbidity from surface waters. The sludge formed from such treatment poses disposal problems because of its aluminium content and tend to accumulate in the environment and also because of large volume [12]. Therefore, it is desirable that other cost effective and more environmentally acceptable alternative coagulants be developed to supplement if not replace alum, ferric salts and synthetic polymers. In this context, natural coagulants present viable alternatives for developing countries [13, 14].

Natural macromolecular coagulants are promising and have attracted the attention of many researchers because of their abundant source, low price, multi-purposeness and biodegradation [10, 13, 15]. Okra, Rice, *Moringa olifera* and chitosan are natural compounds which have been used in turbidity removal [16, 17, 18]. The present study used a coagulation-filtration test using *Coccinia indica* mucilage extract as coagulant for water treatment and as flocculent aid for wastewater treatment.

MATERIALS AND METHODS

In coagulation experiments, samples of turbid water were prepared by adding kaolin into distilled water. 10 gm of measured kaolin powder (Fluka Company) was dried in an oven with the temperature 105ºC for 5 hours. After that it was removed from the oven and was embedded in desiccators for half an hour. Then 100 ml of distilled water was added to the kaolin powder. Suspension was kept at room temperature for 24 hours and was completely mixed for 20 minutes by an electrical blender. The suspension was kept in stable conditions for 4 hours in order to settle coarser particles. One litre of supernatant was transferred to erlenmayer flask and was kept as stock solution [19, 20.] From this stock solution, desired

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experimental turbidities of 10 NTU, 25 NTU, 50 NTU, 75 NTU and 100 NTU were generated.

To obtain *Coccinia indica* mucilage extract (also known as Kundoor mucilage), the fruits were thoroughly washed with water, cut into pieces and then soaked in distilled water overnight. The mucilaginous extract was filtered through muslin cloth. It was precipitated from the extract by addition of alcohol. The precipitate was washed with acetone 2-3 times and finally dried by keeping in oven at 40º C for 24 hours. It is easily soluble in water. The filtered extracted was then used in the experiment [13, 14] after optimizing the pH and time of contact between the flocculent and suspended particles in the solution (unpublished data). Jar test method as described in [21] on Flocculator was carried out on experimental turbid water samples with 0.1 mg, 0.2 mg, 0.4 mg, 0.8 mg, 1.2 mg, 1.6 mg and 2.0 mg/l mucilage extracts of *Coccinia indica*. The speed of fast and slow mix was respectively 180 rpm for 10 minutes and 40 rpm for 20 minutes and the settling time was considered to be 1 hour. The final turbidity of each test sample was measured by digital Nephelo turbiditymeter.

RESULTS

The result of effect of different dosage of *C. indica* mucilage at 10 NTU is represented in Fig 1. Initially as the dose increased from 0.1 to 0.4 mg/l, the % removal of turbidity from the test solution also increased. But thereafter with the increase in the dosage, there is a decline in the removal. Maximum turbidity removal was reported at 0.4mg/l dose of *C. indica* mucilage. Similar results were obtained with the test solutions of 25, 50, 75 and 100 NTU turbidities (Fig 2, 3, 4 and 5). Moreover, in high turbid test solution i.e. 100 NTU the percentage of removal was the highest as compared to low turbid solutions. Therefore *C. indica* mucilage extract was found to be effective in the treatment of high turbid waters. From the graphs it is clear that all the experimental dosage of *C. indica* mucilage can more or less remove turbidity from the test solutions.

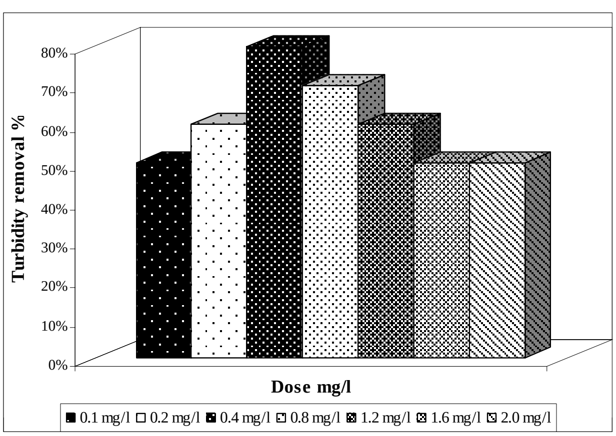

Fig. 1 *C. indica* fruit mucilage extract at different dose in 10 NTU solutions.

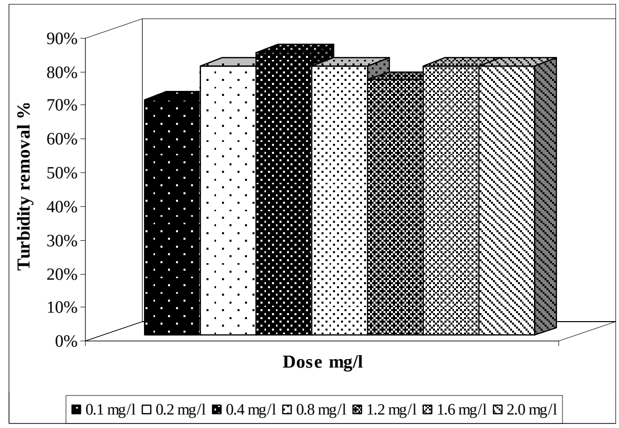

Fig. 2 *C. indica* fruit mucilage extract at different dose in 25 NTU solutions

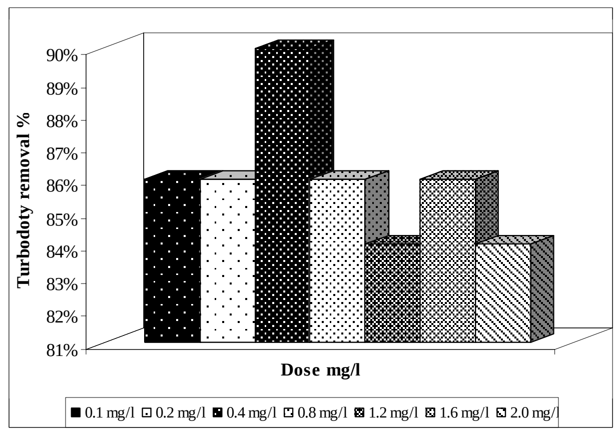

Fig. 3 *C.indica* fruit mucilage extract at different dose in 50 NTU solutions

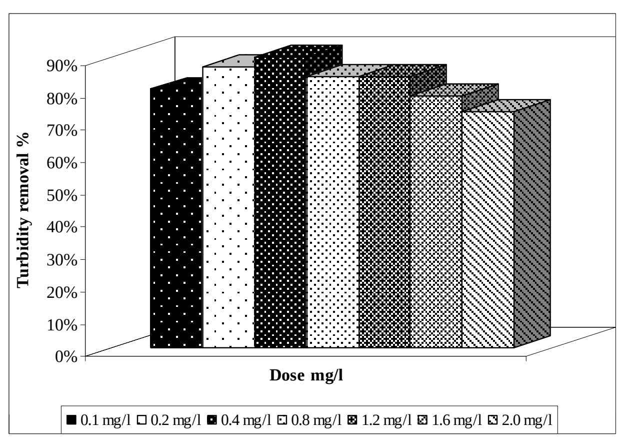

Fig. 4 *C. indica* fruit mucilage extract at different dose in 75 NTU solutions

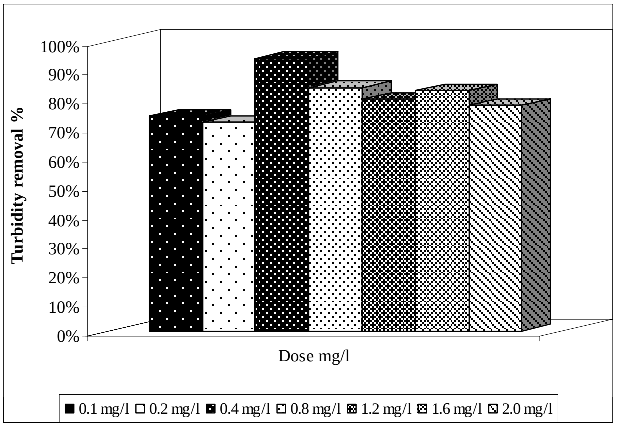

Fig. 5 *C. indica* fruit mucilage extract at different dose in 100 NTU solutions

Dosage was one of the most important parameters that have been considered to determine the optimum condition for the performance of *C. indica* fruit mucilage in coagulation and flocculation. There are several researches which reported that initially, with an increase in the dose of plant material (flocculent) the percentage removal of turbidity increases, but after a certain dose, a decreasing trend in removal is seen with an increase in the dose of the flocculent [22, 23, 24]. The behaviour could be explained by the fact that the optimal dose of flocculent in suspension causes larger amount of solid to aggregate and settle. However an overoptimal amount of flocculent would cause the aggregated particles to re-disperse in the suspension and would also disturb particle settling. Our results are in agreement with the previous reports. The optimum dose of the *C. indica* fruit mucilage in the present study was found to be 0.4 mg/l.

The present study also showed that the fruit extract of *C. indica* mucilage has higher efficiency in removing high turbidity in comparison with low turbidity. Highest turbidity removal (94%) was obtained with very high i.e. 100 NTU initial turbidity whereas the lowest turbidity removal of 82% was observed with water containing initial turbidity of 10 NTU. The coagulation efficiency of *C. indica* mucilage in the current study was found to be dependent on initial turbidity of water samples. This type of results had been obtained by several researchers [25, 26, 27]. Hence it is concluded that the turbidity removal is influenced by the initial turbidity of the test solutions.

The use of plant materials as natural coagulants-flocculants to clarify turbidity of wastewaters is of common practice since ancient times. Natural anionic polysaccharide present in *C. indica* mucilage is found to be a very effective flocculent capable of removing almost 94 % of suspended solid from turbid water samples. A very low flocculent concentration of 0.4 mg/l was capable of removing appreciable amount of suspended particles. There are several reports which suggest that natural water-soluble polysaccharides have capability of flocculating small particles and of causing turbulent drag reduction. These properties have been ushered in their novel applications in agriculture, in effluent treatment and mineral beneficiation. Natural polymers such as starch, sodium alginate, amylopectin, guar gum, xanthan gum, kendu gum, chitosan, okra mucilage and psyllium mucilage [28] find extensive application as flocculants. These anionic polymers present in the mucilage make larger flocs with the suspended particles in the wastewater by bridging mechanism, finally settled them down and can be easily removed from turbid waters. The possibility of industrial application of this biodegradable flocculent to clarify turbid wastewater may be explored to evaluate their full potential.

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