Removal of Turbidity from Waste Water by Adsorption Technology using natural adsorbent - Lotus Flower powder *(Nelumbo nucifera)*

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Abstract

Water is a universally available, most commonly used and vital compound found on earth. Its unique property of acting as a universal solvent makes it the most widely used chemical in all spheres of life. Due to multi-utility, the level of purity is deteriorating day by day and has reached to such an alarming extent that immediate measures are required for its purification.

Numerous methods are available in this regard but most of them are expensive and require artificially synthesized chemicals which add more pollutants back into the atmosphere. The best method utilizes naturally available substances for the removal of impurities from turbid waste water.

Batch adsorption experiments were carried out to determine the effect of optimum dosage level, effective concentration, stirring time, temperature and PH on the turbidity removal. Data obtained were used to calculate percentage removal and adsorption parameters by Lotus flower powder.

Keywords: *Water, Turbidity, Nelumbo, Nephelometer, Optimum Dosage, Effective concentration, Optimum Contact time, temperature, pH, percentage removal.*

Introduction

Safe drinking water is essential to humans and other life forms .Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack of access to adequate sanitation. However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability. A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%. Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture.

There are many physical (Osmosis, diffusion etc) and chemical (TiO2 treatment, nano-particles) means employed for the purification and treatment of waste water, but all the above means are either costly or they produces slurry which is contributed back to the environment as a pollutant.

Hence there is a need to adopt relatively cheap, cost effective, and natural means for the treatment of waste water by which water pollution as well as environment pollution will reduce simultaneously.

The history of use of natural coagulants is long. Natural organic polymers have been used for more than 2000 years in India, Africa, and China as effective coagulants which aids at high water turbidities. These may be manufactured from plant seeds, leaves, and roots. These natural organic polymers are interesting because, comparative to the use of synthetic organic polymers containing acrylamide monomers, there is no human health danger and the cost of these natural coagulants would be less expensive than the conventional chemicals alike since it is locally available in most rural communities of Bangladesh. A number of effective coagulants from plant origin have been identified: *Nirmali*, *Okra*, red bean, sugar and red maize, *Moringa oleifera*, *Cactus latifera*, and seed powder of *Prosopis juliflora*. Natural coagulants have bright future and are concerned by many researchers because of their abundant source, low price, environment friendly, multifunction, and biodegradable nature in water purification.

There have been various natural sources used in this regard like cumin, banana peel etc. The best method utilizes naturally available substances for the removal of impurities from turbid waste water. Lotus flower powder is an effective adsorbent which can be used for removal of turbidity to a large extent.

Nelumbo nucifera, also known as Indian lotus, sacred lotus, bean of India, Egyptian bean or simply lotus, is one of two extant species of aquatic plant in the family Nelumbonaceae, commonly cultivated in water gardens. It is also the national flower of India, and Vietnam. India is a land of festivals where lotus flower are traditionally used for religious ceremonies & floral ornamentations and are discarded all over.

It has a lot of medicinal value from time immemorial. In Ayurveda this plant is used as a diuretic and anthelmintic and in the treatment of strangury, vomiting, leprosy, skin diseases and nervous exhaustion. In popular medicine it is used in the treatment of tissue inflammation, cancer, skin diseases, leprosy and as a poison antidote.

Fig 1. (a)Nelumbo nucifera (Lotus) Flower **(b) Nelumbo nucifera (Lotus) Fruit**

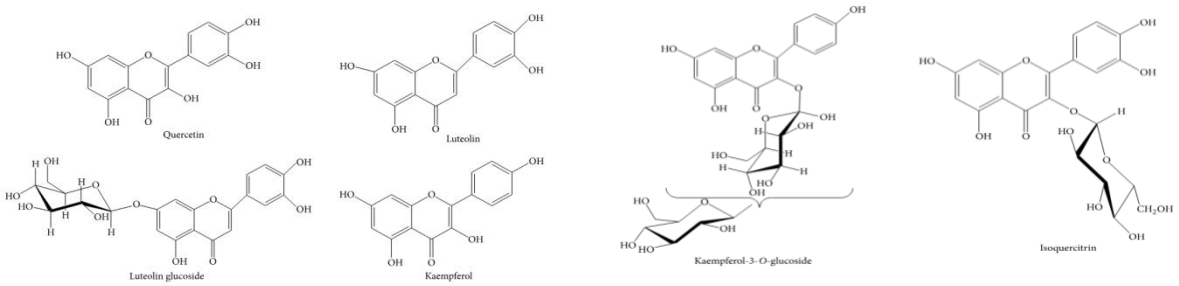

Fig 2 Major Chemical constituents found in Nelumbo nucifera Flower

The phytochemicals reported in flower of Nelumbo nucifera are Quercetin, Luteolin, Luteolin glucoside, Kaempferol-3-glucoside, Isoquercitrin (Fig.3).

The purpose of this study is to investigate and design a novel and cost effective natural method to reduce turbidity in water by using lotus flower powder as a natural adsorbant by adsorption technique.

Materials and Method

A. Material

1. Selection of Adsorbent:

The experiments were carried out using the natural adsorbent lotus flower. The adsorbent samples were collected from the nearby locality and washed several times with distilled water to remove dust and other impurities. After drying it was grinded using domestic mixer and sieved to 250 mesh size. The sample was washed with distilled water to remove color and dried in an oven at 80^{o}C for 24 hours. The dried samples were roughly grinded and stored in airtight bottles for further use without any chemical or physical treatment.

Fig 3. Lotus Flower Powder

2. Preparation of Synthetic Turbid Solution:

Benthonite is a natural coagulant which contains essential components like aluminium, iron, clay etc. It is a highly colloidal clay and forms a clay suspension by coagulation under easy conditions. Moreover it is economically available and thus can be easily used as a natural coagulant for preparing synthetic turbid solution.
Benthonite solution was prepared from analytical grade Benthonite Powder (SDFCL). Turbid water was synthetically prepared by adding bentonite powder in 1 liter of distilled water. The resulting bentonite solution was suspended for 1-2 days after vigorous shaking followed by slow mixing to obtain uniform dispersion of Bentonite particles. Stock solution of 100 NTU was prepared. The working solutions were prepared from the stock solutions by diluting it to appropriate volumes to get the desired solutions of effective concentrations.

B. Experimental Procedure:

The influence of parameters such as concentration, dosage, shaking time, pH, and temperature on turbidity of solution has been considered by means of batch adsorption experiments. The %Removal is calculated by using the following formula:

$$\% \text{ Removal} = \frac{Initial\ Concentration - Final\ Concentration}{Initial\ Concentration}\ X\ 100$$

1. **Effect of Dosage**

A given initial concentration of the adsorbate under the operating conditions biosorbent dose is an important parameter influencing the biosorption process. Therefore, the effect of biosorbent dose on biosorption was investigated in order to determine the biosorption capacity of biosorbent,

Benthonite Stock solution (100NTU) is taken in 6 different conical flasks and is mixed with Lotus flower powder with varying dosage values of each containing 0.1gm,0.2gm, 0.3gm, 0.4gm, 0.5gm and 0.6gm respectively. The conical flasks are subjected to uniform shaking for few minutes and then allowed to settle but not filtered. After some time the turbidity of each set is observed and % Removal is calculated. The optimum dosage value is determined by plotting a graph between %Removal of turbidity on y- axis and dosage on X-axis.(Fig. 4). Steep rise in curve indicated optimum dosage.

2. **Effect of Concentration**

The optimum dosage (0.2gm) which is effective for 70% turbidity removal is now considered to determine another parameter i.e. concentration.

From the stock solution, 10 sets of 10NTU, 20NTU, 30NTU, 40NTU, 50NTU, 60NTU, 70NTU, 80 NTU, 90NTU and 100NTU each, turbid solutions were prepared by diluting the stock solution taken in appropriate quantities to get the desired solutions of effective concentrations. Optimum dosage of 0.2gm is added to each set of conical flask and is subjected to uniform shaking for few minutes. It is then allowed to settle for few minutes but not filtered. Turbidity of each set is observed and % Removal is calculated. The optimum stirring time value is determined by plotting a graph between %Removal of turbidity on y-axis and Concentration on X-axis. (Fig.5). Steep rise in curve indicated Optimum Concentration.

3. **Effect of Contact Time**

In order to establish the equilibration time for maximum uptake effect of Lotus flower powder shaking time is observed. In this parameter, the conical flask containing solutions of bentonite (80NTU) and Lotus flower powder(0.2gm) are subjected to different stirring times(5min, 10min, 15min, 20min and 25min respectively) and the percentage removal of turbidity of the solutions is measured and %Removal is calculated. The optimum stirring time value is determined by plotting a graph between %Removal of turbidity on y- axis and stirring time on X-axis.(Fig 6). Steep rise in curve indicated optimum Contact Time.

4. **Effect of pH**

Solution pH is an important monitoring parameter influencing the adsorption behavior of adsorbate onto biosorbent surface because to its impact on both the surface binding-sites of the biosorbent and the turbid solution. In the present study, the effect of pH on biosorption onto Lotus flower powder was studied in a range of 3–9. 7 sets of solutions having same optimum concentration (80NTU), optimum dosage (0.20 gms) but different PH range varying from 3 to 9 was prepared and the percentage removal of turbidity of the solutions is measured for an optimum shaking time of 20 min. Turbidity of each set is observed and %Removal is calculated. The optimum pH value is determined by plotting a graph between %Removal of turbidity on y- axis and pH on X-axis(Fig.7). Steep rise in curve indicated optimum pH.

5. Effect of Temperature

The temperature was varied for the solution with optimum dosage, optimum concentration, optimum contact time and optimum pH. Concentration and it has been found that high and low temperature conditions has negligible effect on the removal of turbidity. Whereas the solution at 15°C is found to show effective removal of turbidity (100% removal), the temperature is considered as an optimum temperature (Fig.8).

Results and Discussion:

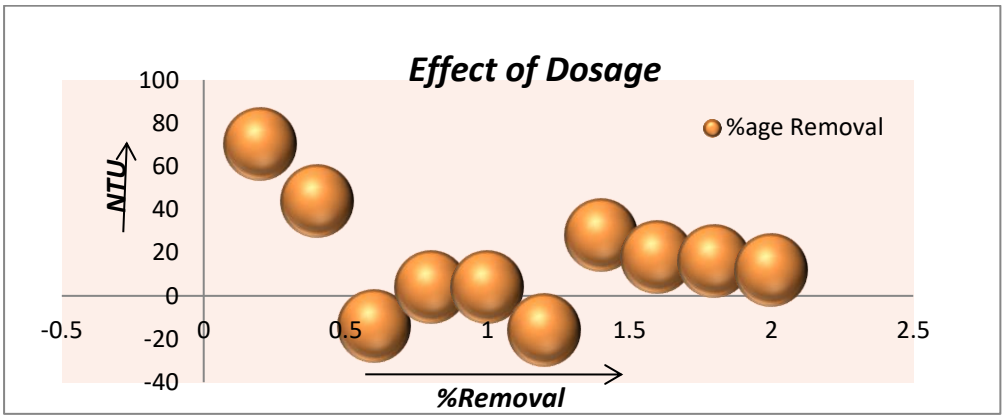

Figure 4 Effect of Dosage Removal of Turbidity by Lotus Flower Powder

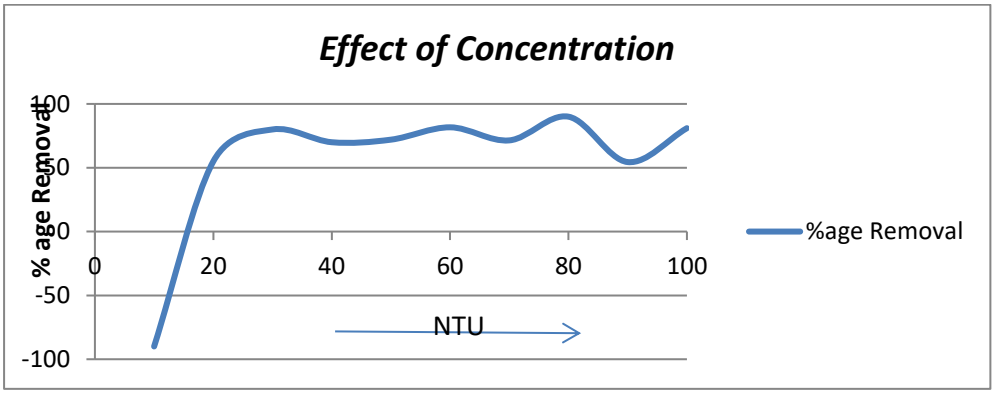

Figure 5 Effect of Concentration Removal of Turbidity by Lotus Flower Powder

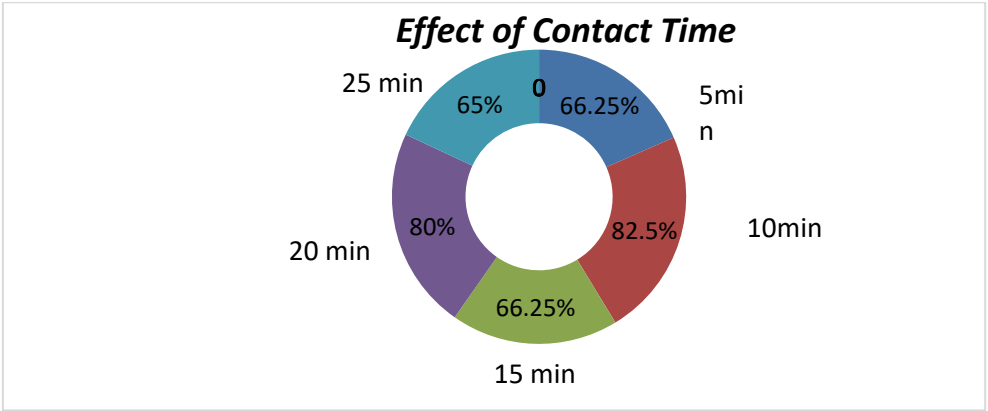

Figure 6 Effect of Contact Time Removal of Turbidity by Lotus Flower Powder

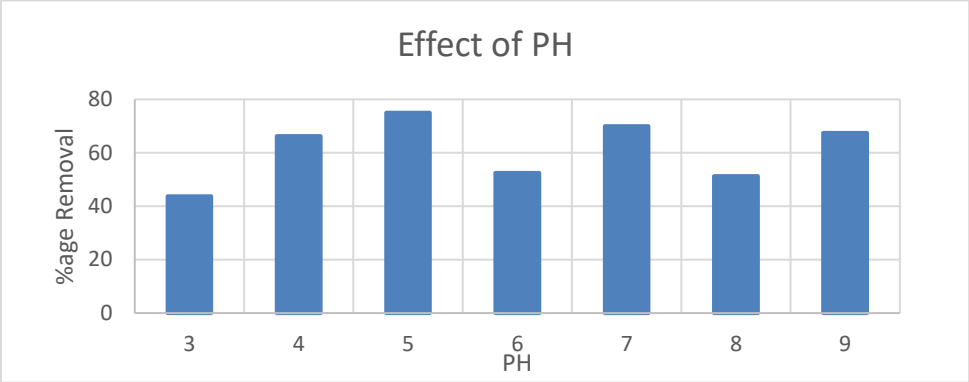

Figure 7 Effect of pH Removal of Turbidity by Lotus Flower Powder

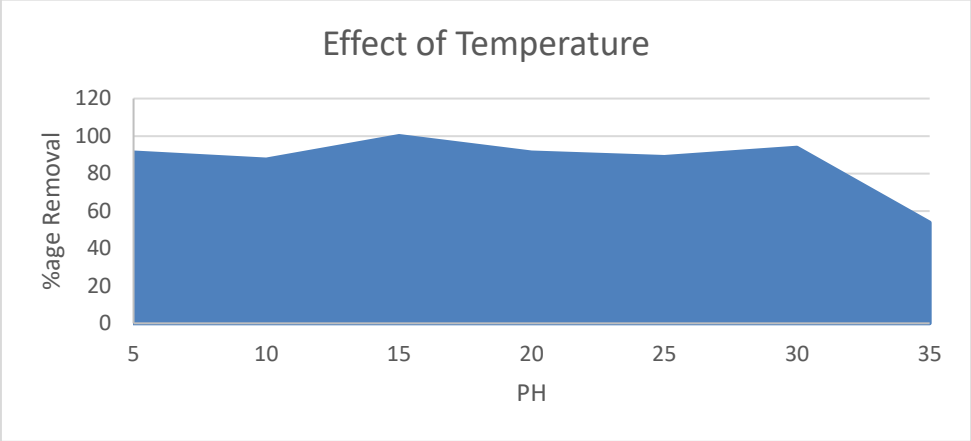

Figure 8 Effect of Temperature Removal of Turbidity by Lotus Flower Powder

The obtained results reveal that the low-cost adsorbent (Lotus flower powder) can be used for the removal of turbidity from waste water solution. The adsorption capacity of Lotus flower powder for removal of turbidity was found to dependent on dosage, concentration, contact time and pH.

The effect of biosorbent(Lotus Powder) dose on biosorption was investigated in order to determine the biosorption capacity of biosorbent, and it was found that at an effective concentration of 80 NTU benthonite solution, lotus powder was highly effective in removal of turbidity at an optimum dosage of 0.20gms. Further maximum percentage removal of turbidity of 82.5% is seen at 10 minutes of stirring.

Conclusion

We report a novel cost effective, natural and green route to remove the level of turbidity in water. This study was initiated to study the removal of turbidity of water using Lotus flower powder by adsorption technique. The effect of adsorbent dosage, concentration, pH and stirring time and temperature were investigated.

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