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PERFORMANCE OF MIMUSOPS ELENGI FRUIT ADSORBENT IN TEXTILE WASTEWATER TREATMENT

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ABSTRACT

Textile industry is one of the most important and rapidly developing industrial sectors. The characteristics of Textile effluent are generally high because of use of many chemical substances in Textile processing. The pH of Textile effluent is generally high because of use of many alkaline substances in Textile processing. The total dissolved solids are those solids remain as soluble form in Textile effluent. The present study involves the applicability of MimusopsElengi fruits are used as adsorbents for removal of pH, TDS and colour from textile effluent. Adsorption studies with activated carbon derived from MimusopsElengi Fruits gave comparable better performance than that of industrial grade activated carbon for pH, TDS and color removal of textile wastewater. This method is highly economic, cost effective and eco-friendly. This helps in reducing the water scarcity with the use of low cost adsorbents.

Keywords: Adsorbent ,Colour, MimusopsElengi Fruit, pH, TDS, Textile effluent.

1. INTRODUCTION

The textile and garment industry in India is one of the oldest manufacturing sectors in the country and is currently it's largest. The textile and garment industry fulfils a pivotal role in the Indian economy. Recently, it was observed that Erode district in TamilNadu were experiencing severe environmental problems due to textile dyeing, leather tanning, paper and pulp processing, sugar manufacturing industries etc. Textile industry involves wide range of raw material, machineries and processes to trick the required shape and properties of the final product. The fundamental strength of this industry flows from its strong production base of a wide range of fiber/yarn from natural fiber like cotton, jute, silk and wool to synthetic/manmade fibers like polyester, viscose, nylon and acrylic. With escalating demand for textile products, textile mills and their waste water have been increasing proportionally, causing major problem of pollution in the world. Worldwide environmental problems associated with the textile industry are typically those associated with water pollution caused by the discharge of untreated effluent and those because of toxic chemicals especially during the processing.

1.1 TEXTILE WASTEWATER GENERATION

The wastewater from the textile mills comes from the following operations,

1. Sizing (caboxymethyl cellulose (CMC), polyvinyl alcohol (PVA)
2. Desizing (mineral acid)
3. Scouring (Caustic soda, soda ash, detergent)
4. Bleaching(sodium hypochlorite (NaOCl) or hydrogen peroxide (H_20_2))
5. Mercerizing (caustic soda solution)
6. Dyeing (vat dyes, developing dyes, naphthol dyes, sulfur dyes, basic dye, direct dyes etc.)
7. Finishing (starches, dextrines, natural and synthetic waxes, synthetic resins)

Textile wastewater contains a large variety of dyes and chemical that make the environmental hazardous for textile industry not only as liquid waste but also in its chemical composition. Dyeing and finishing industry are mainly responsible to produce a large amount of waste water. These processes done by the input of a wide range of chemicals and dyestuffs or pigments, which generally are organic or inorganic compounds in nature. Water is applied as the medium to apply dyes and various chemicals for finishes. Most of the pollutants in textile wastewater from textile industry are high suspended solids, chemical oxygen demand, heat, color, acidity, and other soluble substances. Materials which need to be eliminated from textile wastewater are mainly COD, BOD, TDS, pH, nitrogen, heavy metals and dyestuffs or colorants.

1.2 ENVIRONMENTAL HEALTH EFFECTS OF TEXTILE WASTEWATER

Many chemicals used in the textile industry cause environmental and health problems. Among the many chemicals in textile wastewater, dyes are considered important pollutants. Worldwide environmental problems associated with the textile industry are typically those associated with water pollution caused by the discharge of untreated effluent and those because of use of toxic chemicals especially during processing. The effluent is of critical environmental concern since it drastically decreases oxygen concentration due to the presence of hydrosulfides and blocks the passage of light through water body which is detrimental to the water ecosystem. Textile effluent is a cause of significant amount of environmental degradation and human illnesses. About 40 % of globally used colorants contain organically bound chlorine, a known carcinogen. Chemicals evaporate into the air we breathe or are absorbed through our skin; they show up as allergic reactions and may cause harm to children even before birth. Due to this chemical pollution, the normal functioning of cells is disturbed and this, in turn, may cause alteration in the physiology and biochemical mechanisms of animals resulting in impairment of important functions like respiration, osmo regulation, reproduction, and even mortality. Heavy metals, present in textile industry effluent, are not biodegradable; hence, they accumulate in primary organs in the body and over time begin to fester, leading to various symptoms of diseases. Thus, untreated or incompletely

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treated textile effluent can be harmful to both aquatic and terrestrial life by adversely affecting the natural ecosystem and causing long-term health effects.

1.3 SCOPE OF THE STUDY

Wastewater released from the textile dyeing industry contains different group of dyes and chemicals that may directly or indirectly destroy the ecosystem. The effluent also contaminate the groundwater and cause soil pollution in the surrounding environment. The Large-scale industry use combination of two different techniques to reduce the dye load in their effluent.However, the practical operation high cost of these methods limit their application in small- scale units. Hence there is need to develop an inexpensive and effective technology for removing dyes from textile effluents, probably one that does not produce sludge. In tune with the need for a sustainable ecosystem, researches have focused on eco-friendly methods for the treatment of textile dyeing effluents.Although the benefits of adsorption process are well known, the use of eco friendly, inexpensive, stable and effective adsorption is important for sustainable development and implementation of this technique in small-scale textile dyeing units.

1.4 OBJECTIVE OF THE STUDY

- To study of physico-chemical characterization of textile wastewater.
- To prepare the natural adsorbent MimusopsElengi Fruits (Mahizam fruit).
- To determine the adsorption capacity of natural adsorbent.
- To study the effect of different experimental parameters on the adsorption process and to study different models of adsorption isotherms of the process.

2. MODES OF OPERATION

2.1 BATCH FLOW SYSTEM

In batch type contact operation, quantity of carbon is mixed continuously with the specific volume of waste water until the pollutant in that solution has been decreased to a desired level. The carbon is then removed and either discarded or regenerated for use with another volume of solution. Batch type process are usually limited to the treatment of small volume of effluents.

2.2 COLUMN FLOW SYSTEM

Column type continuous flow operation appears to have distinct advantages over batch operation, because rates of adsorption depend on the concentration of the solute in solution being treated. For column operation, the carbon is continuously in contact with the solution consequently the concentration in the solution in contact with the given layer of carbon in a column is relatively constant.

3. ADSORPTION PROCESS

Adsorption is a process that occurs when a gas or liquid solute, accumulates on the surface of solid, forming a film of molecule or atoms. The phenomenon of adsorption also known as surface phenomenon. Before a molecule of gas adsorbs on a solid particles, it must be transported from the well mixed gas phase to the exterior surface of the adsorbent and, if the material is porous, further into the pore system. Adsorption has been proved to be an excellent way to treat industrial wastewater, offering significant advantages like low cost, profitability, availability, ease of operation and efficiency.

3.1ADSORPTION PRINCIPLES

Adsorption is the adhesion of atoms, ions, biomolecules or molecules of gas, liquid, or dissolved solids to a surface and this process creates a film of the adsorbate (the molecules or atoms being accumulated) on the surface of the adsorbent.

- **Physicsorption:** It is a type of adsorption in which the adsorbate adheres to the surface through Van der Walls (weak intermolecular) interactions. It is a surface phenomenon and a consequence of surface energy. The atoms on the surface of the adsorbent are not wholly surrounded by other atoms and thus, can attract adsorbates. The exact nature of the bonding depends on the details of the species involved, but the adsorption process is generally classified as follows:
- **Chemisorption:** It is a type of adsorption whereby a molecule adheres to a surface through the formation of a chemical bond.Adsorption takes place primarily on the walls of the pores or at specific sites inside the particle. As the pores are generally small, the internal surface area is greater than the external area. Separation occurs because differences in molecular weight, shape or polarity cause some molecules to be held more strongly on the surface than others. In many cases, the adsorbateis held strongly enough to allow complete removal of that component from the fluid.

3.2 ADSORPTION ISOTHERMS

The analysis of the isotherm data by fitting them to different isotherm model is an important step to find the suitable model that can be used for design of adsorption systems. Two isotherm models Langmuir and Freundlichwere used in this work. Adsorption isotherm play a very important for understanding adsorption mechanism.

3.2.1 Langmuir Isotherm

The Langmuir isotherm assumes monolayer adsorption onto a surface containing a finite number of adsorption sites of uniform strategies of adsorption with no transmigration of adsorbents in the plane of surface. The Langmuir equation can be expressed in mathematical form as shown in equation

$$Ce / (x / m) = (1/ a b) + (Ce/a)$$

Where,

Ce is the equilibrium concentration (mg/l)

x / m is the amount of absorbed at equilibrium (mg/g)

a is the adsorption capacity (mg/g)

b is the energy of adsorption (Langmuir constant)

The maximum adsorption of Langmuir isotherm constant were calculated from the linear plots Ce / (x / m) versus Ce. To determine the values of a and b, which gives a straight line of slope 1/a, corresponding to complete monolayer coverage (mg/g) and the intercept is 1/ab.

3.2.2 Freundlich Isotherm

The Langmuir isotherm describes equilibrium on heterogeneous surfaces and hence does not assume monolayer capacity and used to describe the adsorption, it relates the adsorbed concentration as the power function of solute concentration. One of the limitation of the Freundlich model is that the amount of absorbed solute increases indefinitely with the concentration of solute in the solution. This empirical equation takes the form as in equation 1

$$x / m = KpCe^{1/n}$$

The logarithmic form of the equation becomes equation 2

$$\text{Log}\,(x / m) = \text{Log}\,Kp + (1/n)\,\text{Log}\,Ce$$

Where, Kp and n are the Freundlich constant.

3.3 ADSOPTION STUDY FOR MIMUSOPS ELENGI VS SAMPLE

3.3.1 Effect of contact time on adsorption of pH

The purpose of the experiment was to determine the contact time required to reach the equilibrium between the solid phase and the liquid phase. Taking the dosage as 5g/lit. The percentage uptakes increases with time and after some time, it reaches a neutral value where no more base icon can be removed from the solution. At this point, the amount of base ions being absorbed by the adsorbent was in a state of dynamic equilibrium with the amount of base ions desorbed from the adsorbent. The time required to attain this state of equilibrium is termed the equilibrium time. The amount of base ion adsorbed at the equilibrium time reflects the maximum adsorption capacity of the adsorbent under these particular conditions.

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3.3.2 Effect of contact time on adsorption of TDS

The purpose of the experiment was to determine the contact time required to reach the equilibrium between the solid phase and the liquid phase. Taking the dosage as 5g/lit. The percentage uptakes increases with time and after some time, it reaches a standard value where no more content of all inorganic

and organic substances contained in a liquid in molecular, ionized or micro-granular suspended form can be removed from the solution. At this point, the amount of base ions being absorbed by the adsorbent was in a state of dynamic equilibrium with the amount of base ions desorbed from the adsorbent. The time required to attain this state of equilibrium is termed the equilibrium time. The amount of base ion adsorbed at the equilibrium time reflects the maximum adsorption capacity of the adsorbent under these particular conditions.

4 MATERIALS AND METHODS

4.1 TEXTILE WASTEWATER COLLECTION

Dyeing wastewater effluent collected from the ETP of Al-Lan Tex Knit Processors Sipcot-Perundurai, Erode. After collection, the wastewater was transferred immediately to the laboratory and stored at 5^0 C and the wastewater was not corrected for trace elements deficiency.

4.2 ADSORBENT COLLECTION &PREPARATION

MimusopsElengi Fruits (Mahizham fruit)

Kingdom: Planta

Order : Ericales

Genus : Mimusops

Family : Sapotaceae

Species : M.Elengi

MimusopsElengi is a medium-sized evergreen tree found in tropical forests in South Asia, Southeast Asia and northern Australia. The edible fruit is softly hairy becoming smooth, ovoid, bright red-orange when ripe. The fruit can be eaten raw, preserved or pickled. Yellow when ripe, they have a sweet flavour. The pulp is starchy with a floury texture. The fruit is insipid and/or astringent. They are said to taste like dates but to be more dry. The seed kernel contains about 22% oil. The fatty acid composition of the refined oil is: oleic acid 64%, linoleic acid 14.5%, palmitic acid 11%, stearic acid 10% and behenic acid 0.5%. The nutritional quality of the refined oil is considered to be comparable with that of groundnut oil.

Fig 1 MimusopsElengi Fruit **Fig 2 Dried MimusopsElengi Fruit**

Fig 3 Activated MimusopsElengi Fruits

MimusopsElengi fruits were collected from local area at Perundurai in Erode district and cut into small pieces and dried using hot air oven at 105^0 C for 10 hours and activated in muffle furnace at 650^0 C for a period of 30 minutes. Then, the samples are powdered and sieved by a series sieves, the powder used for the experiments having a granulation 600 micron.

4.3 PHYSICO CHEMICAL PARAMETERS

Table 1 Characterization of textile wastewater

PARAMETER	CONCENTRATION
Odour	Unpleasant
Colour	Yellow
Tubidity	20NTU
pH	11
TDS	5490 mg/l

4.4 EXPERIMENTAL PROCEDURE

By varying the contact time from 60, 120, 180, 240,300, 360, 390 minutes. At a dosage of 0.1 g/ 20ml in 26 beakers.The samples with added adsorbents are stirred for the formation of floc.The samples are kept undisturbed for varying contact time.Note the changes in pH ,TDS,colour.

5. RESULT AND DISCUSSION

5.1 pH EFFECT ON MIMUSOPS ELENGI FRUIT

Initial pH of the sample was 11 and it is seen that dosage of 5 g/l had a effect of final pH of the water (pH value 8).This result implements that the pH value has been gradually decreased due to the effect of MimusopsElengiin the sample.

Table 2 pH effect on MimusopsElengi fruit

CONTACT TIME (Min)	pH VALUE
60	11
120	9
180	8.5
240	8
300	8
360	8

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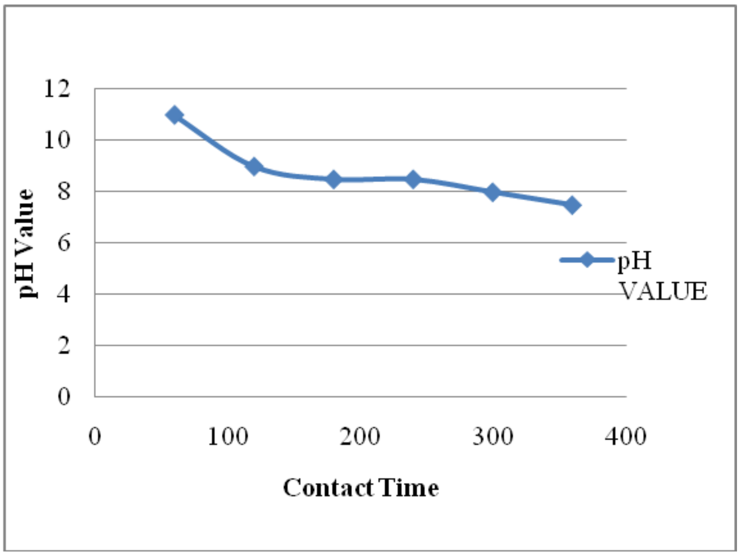

Fig 4 pH effect on MimusopsElengi Fruit

In figure 4,the result showed that using adsorbents material, the pH value decreased when the contact time increases for a dosage of 0.1g/20 ml .The optimum contact time for reducing the pH value is 240 minutes.

5.2 TDS EFFECT ON MIMUSOPS ELENGI FRUIT

TDS of the sample was 5490mg/lit and it is seen that dosage of 5 g/lit. The result that the higher.TDS removal efficiency (63.3%). This result implements that the TDS removal efficiency has been gradually increased due to the effect of MimusopsElengiin the sample.

Table 4.7 TDS effects on MimusopsElengi fruit

CONTACT TIME (Min)	TDS REMOVAL(%)
60	25.5
120	32.6
180	43.4
240	52.2
300	60.1
360	63.3

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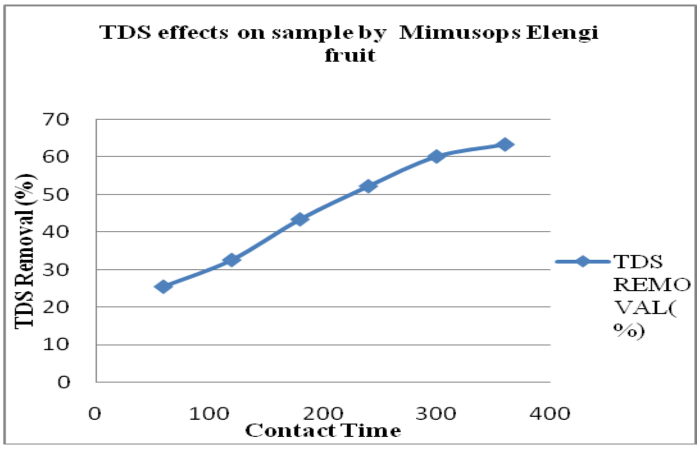

Fig 5 TDS effect on MimusopsElengi Fruit

In figure 5, the result showed that using adsorbents material, the TDS removal efficiency increases with the increase in contact time for a dosage of 0.1g/20 ml .The optimum TDS removal efficiency was 63.3% at 360 minutes.

5.3 ADSORPTION ISOTHERM MODELS

The found equilibrium data from the adsorption of pH ,TDS onto the MimusopsElengi fitted to the linear equation of Langmuir and Freundlich isotherm models.

5.3.1 Langmuir Isotherm for MimusopsElengi fruit

The Langmuir equation can be expressed in mathematical form as shown in equation

$$Ce / (x / m) = (1 / ab) + (Ce / a)$$

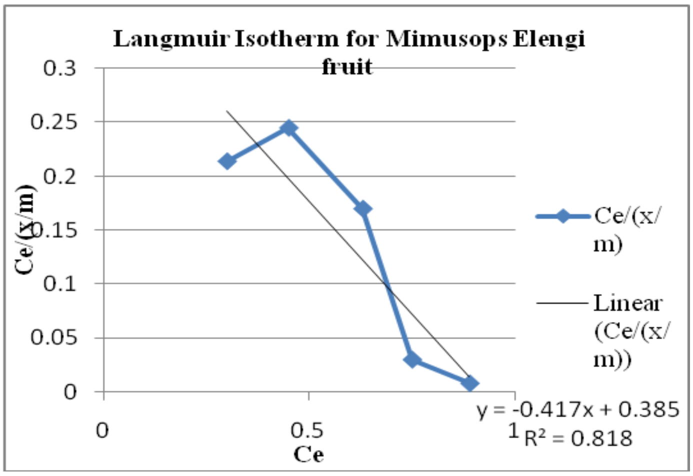

Fig 5 Langmuir Isotherm for MimusopsElengi fruit

The Langmuir Isotherm constants were found to be about a = 0.52 mg/g and b = 0.5.The value shows unfavourable adsorption.

5.3.2 Freundlich Isotherm MimusopsElengi Fruit

This empirical equation takes the form as in equation 1

$$X/m = KpCe^{1/n}$$

The logarithmic form of the equation becomes equation 2

$$\text{Log}\ (x/m) = \text{Log}\ Kp+(1/n)\text{Log}\ Ce$$

Where ,Kp and n are the Freundlich constant.

The lox(x/m) are calculated from the above equation and are plotted to identify the condition is favourable or unfavourable for the Freundlich isotherm to occur.

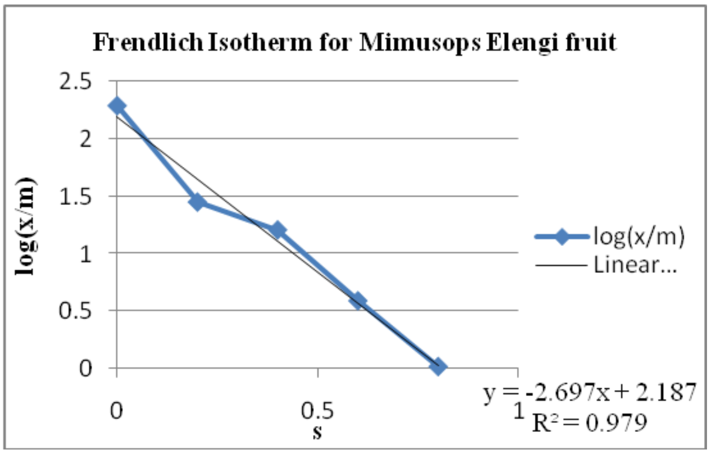

Fig 5 Freundlich Isotherm for MimusopsElengi fruit

The K value found to be 2 and 1/n was found to be 0.7 which shows the favourable condition for the Freundlich isotherm to occur.

6.CONCLUSION

In this paper attempt have been made for studying the removal of pH, TDS and Colour from textile effluent by using MimusopsElengi as adsorbent. The optimum contact time for removal of pH from the wastewater with the adsorbent MimusopsElengi fruit is 240 minutes. It is found that pH is decreased from 11 to 8. The removal efficiency of TDS from wastewater with the adsorbent MimusopsElengi is 63.3% at 360 minutes. Also the Colour of textile effluent changes from Yellow to Pale Yellow. The equilibrium data were well modeled by both the Freundlich and Langmuir isotherms, but the data fit slightly better under the Freundlich model. The adsorption data correlated well with the Freundlich model as compared to the Langmuir isotherm model.From the experimental finding it has been observed that MimusopsElengi fruits can be used as an effective adsorbent for removal of TDS and Color from textile effluent.The expensive adsorbents can be replaced by the low cost adsorbents for the removal of pollutant from wastewater. It is revealed that the agricultural waste of MimusopsElengiwere used as low-cost alternatives in wastewater treatment.This result would be useful for the small scale wastewater treatment plants for removal of pH, TDS and Colour.

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