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OPTIMIZATION OF BIOSORPTION OF SAFFRANIN DYE BY USING PINEAPPLE (*ANANAS COMOSUS*) PEEL WASTE

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ABSTRACT

Biosorption may be simply defined as the removal of substances from solution by biological material. Substances can be organic and inorganic, and in gaseous, soluble or insoluble forms. Biosorption processes are particularly suitable for effluent treatment containing low dye concentrations. Towards attaining a sustainable engineered chemical processes, pineapple peel waste (*Ananas comoscus*), a low cost agricultural waste material was investigated to serve as an adsorbent for removal of saffranin dye from wastewater. The process was carried out as a batch process. The main aim of this study was to investigate the adsorption of Saffranin onto pineapple peel. The effects of operating conditions such as initial dye concentration, contact time, pH effect, and temperature on adsorption of saffranin were studied. The optimum conditions for the same using pineapple peels were found to be as follows: pH 8, agitation 80 rpm, time 60 minutes, biomass concentration 100mg/L and dye concentration 25mg/L.

KEYWORDS: Saffranin Dye, Biosorption, Pineapple peel Waste (biomass), pH water.

1. INTRODUCTION

Adsorption is a surface phenomenon in which a multi components fluid (gas or liquid) mixture is attached to the surface of a solid adsorbent to form attachments via physical or chemical bond. The adsorption process of dye molecules usually consists of four consecutive steps. The first step involves the diffusion of dye molecules through the bulk of solution. In the next stage, the dye molecules will diffuse through a diffusional boundary layer (film diffusion). Biosorption may be defined as the removal/binding of desired substances from aqueous solution by biological material. Such substances can be organic and inorganic and are either soluble or insoluble forms. For biosorption, defined as a physicochemical process independent of metabolism, such mechanisms as adsorption, ion exchange and complexation/coordination maybe important and, in these cases, biosorption can be rapid and reversible with biomass properties analogous to conventional ion exchange resins. Biosorption can be defined as the selective sequestering of metal soluble species that result in the immobilization of the metals by microbial cells. Biosorption is a metabolically passive process, means it does not require energy, and the amount of contaminants a sorbent can remove is dependent on kinetic equilibrium and the composition of the sorbents cellular surface (Crini *et. al* 2006; Sulaiman M. S. *et.al* 2015; Gadd *et.al* 2008).

2. MATERIALS AND METHODS

All the chemicals were obtained from SRL and Himedia. Growth media and glassware were sterilized at 121°C for 20 mins. Counter space and other laboratory surfaces were disinfected by wiping using a solution of 70% ethanol.

2.1. Preparation of biosorbent

Materials: Pineapple peels, water, tray, hot air oven, grinder.

Methodology: Pineapple peels were collected from the fruit vendor in Pune. The peels were properly cleaned with water and bloat dried. Further drying was done in the oven at 60^0C for 2-3 days. The peels were ground in fine powder and used in the experiment (Fig 1 and 2) (Ming, 2011).

Fig. 1: Pineapple peel waste.

Fig. 2: Pineapple peel Powder.

2.2. Preparation of stock solution

Materials: Saffranine, Distilled water, Pipettes

Method: Saffranine was procured from Himedia. Stock solution (1000 mg/L) of the dye was prepared by dissolving 100 mg of the dye in 100 mL distilled water. The stock solutions were then diluted to get the test solutions of the desired strength. (Selvanathan, 2015; Patole 2020).

2.3. Preparation of pH water

Materials: pH meter (Model genial), distilled water, conical flask, 1N NaOH and HCl, R-bottles.

Methodology: 500ml distilled water was taken using measuring cylinder in 5 different flasks. The pH of the water was adjusted using pH meter. Water of 5 different pH i.e 2,4 6,8,10 was prepared by the addition of varying amounts of 1N NaOH and 1N HCl. The water was stored for further use (Deokar 2016).

2.4. Batch biosorption studies

The biosorption experiments were carried out in 250 mL Erlenmeyer flasks with working volume of 50 mL of the reaction mixture consisting of desired concentration of dye prepared from stock solutions (1000 mg/L) and specified amount of biosorbent. The flasks were withdrawn from the rotating orbital shaker after shaking for the desired time of reaction. The residual dye concentration in the solution was determined after filtration. The concentration of the dye/s in the solution was determined from the calibration curve prepared by measuring the absorbance of known concentrations of the dye at the maximum wavelength of sorption using a UV-Vis spectrophotometer. The concentration of the dye/s on the fungal biomass at the corresponding equilibrium conditions was determined using a mass balance equation expressed as specific uptake capacity (SUC) (Mohammed, M. A, *et al* 2017).

$$Q_e = \frac{(C_0 - C_e) * V}{M} \quad (1)$$

Where, C_0 and C_e are the initial and final concentrations (mg/L), respectively, M is the biosorbent dosage (g) and V the volume of the solution (L) (Mohammed, M. A, *et al* 2017).

2.5. Optimization of conditions for biosorption of Saffranin by the suspended biosorbent

Batch biosorption experiments were conducted using one factor at a time approach.

2.5.1 Effect of pH on biosorption

Materials: 5 conical flask 100ml, Biosorbent, pH water - 2, 3,4,6,8,10, pipette, stock dye solution, shaker incubator, funnel, Bumper tube, colorimeter, tissue paper, filter paper.

Methodology: 5 conical flasks, each of 100ml were taken to evaluate the effect of 5 different pH (2,4,6,8,10). Rest all other factors were kept constant. Biosorption was measured using a colorimeter (Deokar 2016).

2.5.2. Effect of Agitation on biosorption

Materials: 100ml flasks, shaker incubator, biosorbent, stock dye solution, distilled water adjusted to pH 8, filter paper, funnel, bumper tube, pipette, measuring cylinder.

Methodology: 2 flasks of 250ml each were taken and 50mg/L stock dye solution was added in both flasks from the 100mg/L stock solution prepared. The volume was made upto 50ml using distilled water of pH 8. One flask was kept at shaker condition (80 rpm) and the second flask was kept at stationary condition. Rest all other factors were kept constant. Biosorption was measured using a colorimeter (Deokar 2016).

2.5.3. Effect of Time on Biosorption

Materials: 100ml flasks, shaker incubator, biosorbent, stock dye solution, distilled water adjusted to pH 8, filter paper, funnel, bumper tube, pipette, measuring cylinder.

Methodology: 4 flasks of 250ml each were taken and 50mg/L stock dye solution was added in both flasks from the 100mg/L stock solution prepared. The volume was made upto 50ml using distilled water of pH 8. Each flask was kept for different time interval (30 min, 60 min, 90 min, 120 min). Rest all other factors were kept constant. Biosorption was measured using a colorimeter (Deokar, 2016).

2.5.4. Effect of Biomass concentration on Biosorption

Materials: 100ml flasks, shaker incubator, biosorbent, stock dye solution, distilled water adjusted to pH 8, filter paper, funnel, bumper tube, pipette, measuring cylinder.

Methodology: 9 flasks of 100ml were taken. 50mg/L stock dye solution of concentration (100mg/L) was added to each of the flasks. The volume was made to 50ml using distilled water adjusted to pH 8. Biosorbent of 9 different concentrations were weighed and added to each of the flasks separately(100mg/L, 150mg/L, 200mg/L, 250mg/L, 300mg/L, 400mg/L, 600mg/L, 800mg/L, 1000mg/L). All the 9 flasks were kept in shaker incubator for 60 mins at 80 rpm. After 60 mins all the flasks were removed and the sample was filtered. The Absorbance of the filterate was measured using calorimeter. The readings were noted down and further calculations were carried out (Deokar 2016).

2.5.5. Effect of Dye concentration on Biosorption

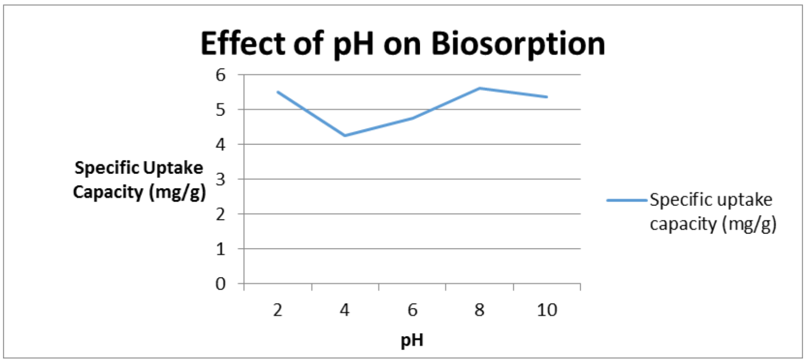
Materials: 100ml flasks, shaker incubator, biosorbent, stock dye solution, distilled water adjusted to pH 8, filter paper, funnel, bumper tube, pipette, measuring cylinder.

Methodology: 4 flasks each of 250ml were taken and dye solutions of various concentration (25mg/L, 50mg/L, 75mg/L, 100mg/L) were added in each of the flasks respectively. Rest all other factors were kept constant. Biosorption was measured using a colorimeter (Deokar 2016).

3. RESULTS AND DISCUSSION

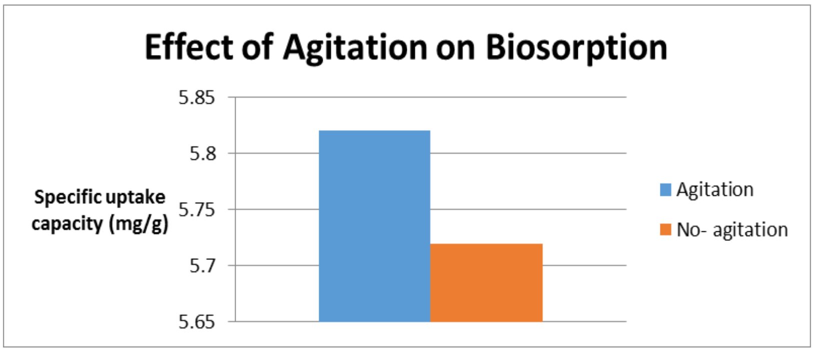
A standard experiment was performed for 8 different concentrations to check the absorbance of dye at these different concentrations.

2.5.1. Effect of pH on biosorbent – After carrying out the pH optimization it was observed that the highest absorbance of dye was at pH – 8. So further experiments were carried out using distilled water adjusted to pH 8. The SUC was found to be 5.63 mg/g. When the pH of dye solution increase, the surface tends to acquire negative charge, thereby resulting in an increased adsorption of dyes due to increasing electrostatic attraction between positively charged sorbate and negatively charged sorbent (Graph 1).



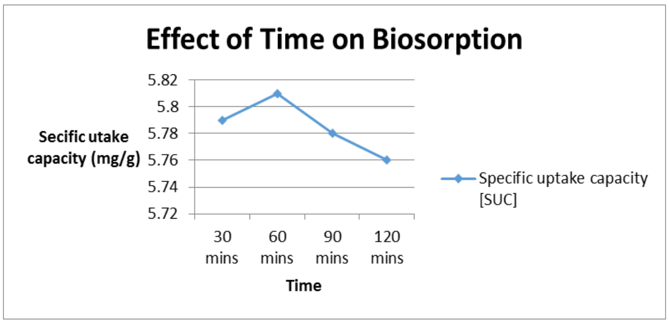
Graph 1: Effect of pH on Biosorption.

4.4.2. Effect of Agitation on biosorption: After carrying out the Agitation & No-agitation optimization it was observed that the highest absorbance of dye was seen in the flasks which was Agitated at 80 rpm using shaker incubator. As a result, the further experiment was carried out by agitation. In the batch experiment, agitation speed acts as an important factor by affecting the external boundary film and distribution of the solute in the bulk solution (Deokar 2016) (Graph 2).



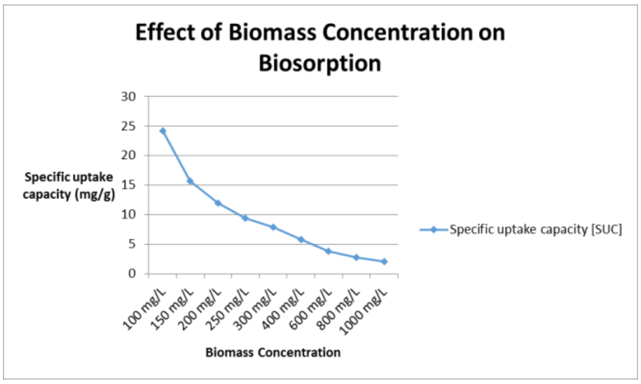
Graph 2: Effect of Agitation on Biosorption.

4.4.3. Effect of Time on Biosorption: After carrying out the experiment of optimization of time it was observed that at 60 mins maximum dye was absorbed. The further experiment was carried for 60 mins each. It was recorded using 400mg biomass in 50 mg/L aqueous Saffranin solution having pH 8 at room temperature. It was observed that adsorption of Saffranin was rapid during the first 30minutes for all materials and thereafter the rate of biosorption decreased slowly and became constant after 60 minutes. The maximum removal (92.72%) took place within 60 minutes the removal of adsorbate was initially rapid but gradually became slow and reached equilibrium after one hour. This is due to a large number of vacant surface sites available for adsorption during the initial stage. The remaining vacant surface sites are difficult to be occupied after a specific time interval due to repulsive forces between the solute molecules on solid and bulk phases. After attending the equilibrium the percent sorption of Saffranin did not change with further increase in time (Deokar 2016) (Graph 3).



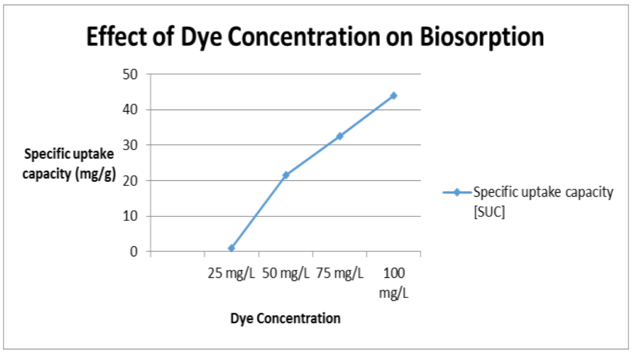
Graph 3: Effect of Time on Biosorption.

4.4.4. Effect of Biomass on biosorption: After carrying out the optimization of biomass with different concentration of biomass it was seen that maximum absorbance of dye was at 100mg/L of biosorbent concentration. Effect of biomass dose on Saffranin removal was carried out by increasing the amount of biomass from 100 to 1000mg/L at pH 8, using 50mg/L dye solution at room temperature. Dye removal increased when amount of biomass was 1000mg/L to 100mg/L. Increase in biomass did not improve the removal and uptake of Saffranin. Maximum biosorption occurred with 100 mg biomass. Percentage of dye removal varied from 96.72% to 84% (Deokar 2016) (Graph 4).



Graph 4: Effect of Biomass on Biosorption.

4.4.5. Effect of Dye concentration on biosorption: After carrying out the optimization of dye concentration with different concentrations of dye. It was observed that maximum dye was absorbed at concentration 25mg/L. Effect of initial concentration of dye on adsorption was analyzed at optimum pH 8, using 100mg biomass and keeping 60 minutes agitation time. The concentration of dye was varied from 25mg/L. to 100 mg/L. It was observed that the adsorption was dependent on initial concentration of dye. As the concentration of Saffranin increased the uptake (q_e) also increased however removal of dye was decreased with increase in Dye concentration. Maximum removal and uptake occurred at 25mg/L concentration (Deokar 2016) (Graph 5).



Graph 5: Effect of Dye concentration on Biosorption.

CONCLUSION

Biosorbent using pineapple peels was prepared and its %Adsorption for Saffranin dye was studied. The study investigated that the removal of dyes between pH - 2 to pH - 10 and maximum adsorption of dye was at pH - 8. It has also been observed that lowest concentrations of biosorbent have been found to remove dye with efficiencies. Temperature in addition to adsorption efficiency affects the nature and mechanism of adsorption. Therefore, it can be said that waste pineapple peels can be use to remove the dye. This technique can be used to clear effluents of colour and make it clean and clear.

REFERENCE

1. Mohammed, M. A., Ibrahim, A., Shitu, A (2017). Batch Removal of Hazardous Safranin-O in Wastewater Using Pineapple Peels as an Agricultural Waste Based Adsorbent. International Journal of Environmental Monitoring and Analysis, 2014; 2(3): 128-133. doi: 10.11648/j.ijema.20140203.11
2. R.R. Krishnia, K.Y. Foob & B.H. Hameeda Environment and Occupational Health Programme, School of Health Sciences, Health Campus, Universiti Sains Malaysia, 16150 Kubang Kerian, Malaysia. Published online: (17 Jul 2013).
3. Shehdeh Jodeh1 *, Rasha Ahmad1, Mohammed Suleiman1, Smaail Radi2, Khadija M. Emran3, Rachid Salghi4, Ismail Warad1, Taibi Ben Hadda5 (2015) 1) Department of Chemistry, An-Najah national University, P. O. Box 7, Nablus, Palestine. Accepted (1 Nov 2015)
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5. M. Yusuf1, F.M. Elfghi1,2*, S. K. Mallak3 (2015) 1Malaysia Japan International Institute of Technology, Department of Environmental Engineering and Green Technology, Jalan Semarak, 54100 Kaula Lumpur, Malaysia 2Chemical Reaction Engineering Group, Faculty of Chemical and Natural Resources Engineering, University Technology Malaysia, 81310 UTM Skudai 3Department of.
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7. omar S. Bayomie1,2, Haitham Kandeel1,3, Tamer Shoeib 1, Hu Yang 4, Noha Youssef5 & Mayyada M. H. el-Sayed 2020 1Department of Chemistry, American University in Cairo, AUC Avenue, P.O. Box 74, New Cairo, 11835, Egypt. 2Department of Energy and Processes, PSL Research University, Paris, France. 3Department of Chemistry and Chemical Engineering, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland. 4State Key Laboratory of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, Nanjing, 210023, P. R. China. 5Department of Mathematics and Actuarial Science, American University in Cairo, AUC Avenue, P.O. Box 74, New Cairo, 11835, Egypt. ✉ e-mail: Mayyada@aucegypt.edu
8. Crini, G. (June 2006) Centre de Spectrométrie, SERAC, Université de Franche-Comté, 16 Route de Gray, 25000 Besançon, France Received (1 June 2004), Revised (31 January 2005), Accepted (2 May 2005): 97(9).
9. Pranav D. Pathak1, Sachin A. Mandavgane1,* and Bhaskar D. Kulkarni2 (2016) 1Department of Chemical Engineering, Visvesvaraya National Institute of Technology, Nagpur 440 010, India 2CSIR-National Chemical Laboratory, Pune 411 008, India.
10. Nagendran Selvanathan and Noor Syuhadah Subki (November, 2015) Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli, Kelantan, Malaysia, ARPN Journal of Engineering and Applied Sciences © (Vol. 10, No.20) E-Mail: syuhadah@umk.edu.my
11. Prachi D. Patole, Vinita K. Nehete and *Dr. Sukhada Akole (August 2020) World Journal of Pharmaceutical and Life Sciences WJPLS (Vol. 6, Issue 9), 205-218 Received on (05/07/2020), Accepted on (16/08/2020).
12. 2Priyantha, N. 3*Lim, L. B. L. and 3Dahri, M. K. (2014) International Food Research Journal 22(5): 2141-2148 (2015) Received: (11 December 2014) Accepted: (3 May 2015).
13. Tay Kim Ming (2011).
14. A.A. Ahmad, B.H. Hameed (2009) School of Chemical Engineering, Engineering Campus, University Sains Malaysia, 14300 NibongTebal, Penang, Malaysia.Fixed-bed adsorption of reactive azo dye onto granular activated carbonprepared from waste. Open Access Library Journal, (4 No.7), (July 25, 2017)
15. M. S. Sulaiman, (March 2015) Department of Pure and Industrial chemistry, Bayero University Kano, P.M.B 3011, Kano Nigeria FACTORS AFFECTING BIOSORPTION OF Cu (II) IONS FROM INDUSTRIAL WASTEWATER. Received, (04 june, 2015), Accepted (11 july, 2015), published online (20 july, 2015) International Journal of Data Mining & Knowledge Management Process (IJDKP), (5,2), (March 2015).
16. Singh.D.K & B.Srivastava Department of Chemistry, Harcourt Butler Technological Institute, Kanpur 208002, India. Received II (November 1999); accepted (13 November 2000) Indian Journal of Chemical Technology, March 2001; 8: 133-139.

17. Rekha R. Deokar Enteromorpha Intestinals: Low cost Biosorbents for Biosorption Methylene Blue, International Journal of Recent Scientific Research, March, 2016; 7(3): 9291-9297.
18. P. D. Ashtaputrey and S. D. Ashtaputrey (2016) Department of Chemistry, Institute of Science, Nagpur, MS, India, 440001.
19. I. Enniya*, A. Jourani (2017) Laboratory of Physical Chemistry of Processes and Materials (PCPM), University Hassan 1st, FST Settat, Morocco Received: (26 Avr 2016) Revised: (9 Nov 2016) Accepted: (16 Nov 2016)
20. Rahman F The Treatment of Industrial Effluents for the Discharge of Textile Dyes Using by Techniques and Adsorbents, Department of Petroleum and Chemical Engineering, Faculty of Engineering, Institute Technology Brunei, Brunei, 2016.
21. Grierson, S. Dyeing and Dyestuffs. Aylesbury, Bucks: Shire Album 229, Shire Publications Ltd, 1989.
22. 1,2Priyantha, N. 3*Lim, L. B. L. and 3Dahri, M. K.(2015) 1Department of Chemistry, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka 2Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka 3Department of Chemistry, Faculty of Science, Universiti Brunei Darussalam, Jalan Tungku Link, Gadong, Brunei Darussalam. International Food Research Journal 22(5): 2141-2148 (2015) Received: (11 December 2014) Accepted: (3 May 2015)
23. Shehdeh Jodeh1 *, Rasha Ahmad1, Mohammed Suleiman1, Smaail Radi2, Khadija M. Emran3, Rachid Salghi4, Ismail Warad1, Taibi Ben Hadda5 1) Department of Chemistry, An-Najah national University, P. O. Box 7, Nablus, Palestine. 2) LCAE-URAC18, Faculty of Science, University of Mohammed Premier, Oujda, 60000, Morocco. 3) Chemistry Department, Faculty of Science, Taibah University, Al-Medina Al-Monawara, Saudi Arabia. Received (4 Sept 2015), Revised, Accepted (1 Nov 2015).