ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Treating dairy industry effluent using orange peel powder

Sivakumar D[1*], Shankar D[2], Janaki Sundaram S[3]
[1]Department of Civil Engineering, Vel Tech High Tech Dr.RangarajanDr.Sakunthala Engineering College, Avadi, Chennai 600 062, Tamil Nadu, India
Department of Pharmaceutical Chemistry, K.M. College of Pharmacy, Uthangudi, Madurai, Tamil Nadu, India.
***Corresponding author:E.Mail:shri.sivakumar1974@gmail.com**

ABSTRACT

This study mainly concentrated for removing COD and TDS from dairy industry effluent using orange peel powder, a cheap agro-based product. Experiments were evaluated against the influence of different dosages, rapid mixing and slow mixing contact time. In this study an optimum dosage of 80 g/l, rapid mixing contact time of 25 min. and slow mixing contact time of 50 min. was found for COD and TDS maximum removal from dairy industry effluent. The results revealed that the maximum reduction of COD and TDS using orange peel powder is about 85.5 % and 81.6 % respectively. Thus, this study concluded that use of orange peel powder as adsorbent for removing COD and TDS from dairy industry effluent is effective.

KEY WORDS: Dairy Industry Effluent, Orange Peel Powder, Chemical Oxygen Demand, Total Dissolved Solids

1. INTRODUCTION

The effluent generated from dairy industries are important key source for contaminating the environment. It contains high organic matter due to availability of different milk products. The dairy industry in India is generated 6-10 litres of effluent per litre of the milk processed. Though the management of dairy industrial effluent was documented, there is problem existing for production and disposal issues.

The past works indicated that the suitability of variety of agro-based materials like moringa oleifera seed corncob, groundnut husk, rice husk, coconut coir pith, tamarind kernel, tea leaves carbon, saw dust to treat the industrial effluent. The bioremediation studies also done by several researchers to mitigate the industrial contaminants. The main aim of this present study is that identify the efficiency of removal for orange peel powder as adsorbent to remove COD and TDS from dairy industry effluent against the influence of different dosages, rapid mixing and slow mixing contact time. The experimental values were simulated using the model and the same were checked for reproducibility.

2. MATERIALS AND METHODS

Adsorbent Preparation: Orange peel was washed with deionized water to remove particulate material from their surface. After that, they were dried in sun. The dried materials were ground using pulverizer. The ground orange peel was then sieved through 400 microns sieve to get uniform geometrical size for use. Then, they were dried in an oven at 100^{o}C for 4 h. The dried orange peel powder was kept for experimental use.

Collection and Analysis of Sample: In this study, the dairy industry effluent samples were collected using air tight sterilized bottles. Immediately, the samples were stored in the laboratory at 5^{o}C for analyzing COD and TDS concentrations in a dairy industry effluent in later stage. The initial COD and TDS values for a dairy industry effluent were determined as per standard procedure given by APHA, (2005) and found to be 7895 mg/l and 3055 mg/l respectively. The Phipps and Bird jar test apparatus used in this study. The experiments were conducted as batch experiments involving rapid mixing speed of 100 rpm and slow mixing speed of 20 rpm for enhancing flocculation process and sedimentation for a period of 60 min. Dairy industry effluent was filled in four glass beakers of 1 litre capacity and was kept in the Phipps and Bird jar test apparatus for agitation.

The experiments were performed at different dosages (from 20 to 140 g/l), different rapid mixing contact time (from 5 to 30 min.) and different slow mixing contact time (from 10 to 60 min.). Clear effluent from each beaker after settlement of 60 min. was collected and filtered further with Whatman filter paper for removing impurities and then the cleared effluent was taken for analyzing COD and TDS as per standard procedure given by APHA (2005). The adsorption removal percentage of COD and TDS from dairy industry effluent by orange peel powder was calculated by using the following formula:

$$\text{Percentage Removal} = \frac{C_1 - C_2}{C_1} \times 100 \qquad (1)$$

in which C1 is the concentration of COD in mg/l and TDS in mg/l before treatment with orange peel powder and C2 is the concentration of COD in mg/l and TDS in mg/l after treatment with orange peel powder.

3. RESULTS AND DISCUSSION

Influence of Rapid Mixing Contact Time: Fig.1 shows the influence of rapid mixing contact time for reducing COD and TDS from dairy industry effluent using orange peel powder as an adsorbent of 20 mg/l and a slow mixing contact time of 20 min. against the rapid mixing contact time of 5, 10, 15, 20, 25, and 30 min. From Fig.1, it may be observed that COD and TDS increase up to 25 min. rapid mixing contact time, beyond 25 min., they decrease. The percentage reduction of COD was observed as 28.2, 38.6, 56.6, 69.2, 79.5, 72.9 and 66.2 % respectively for a

rapid mixing contact time of 5, 10, 15, 20, 25, 30 and 35 min. Similarly, the percentage reduction of TDS were observed as 28.2, 44.4, 59.6, 68.2, 74.6, 69.7 and 62.3 % respectively for a rapid mixing contact time of 5, 10, 15, 20, 25, 30 and 35 min. Thus, an optimum rapid mixing contact time leading to maximum COD and TDS removal is 25 min. (Fig.1) and the maximum removal was 6276.53 mg/l and 2279.03 mg/l respectively. Thus, the lowest residual of COD and TDS in a dairy industry effluent was 1618.48 mg/l and 775.97 mg/l respectively.

Influence of Slow Mixing Contact Time: Fig.2 shows the influence of slow mixing contact time for reducing COD and TDS from dairy industry effluent using an orange peel powder as an adsorbent of 20 mg/l and an optimum rapid mixing contact time of 25 min. against the slow mixing contact time of 10, 20, 30, 40, 50, 60 and 70 min. It can be observed from Fig.2 that the reduction of COD and TDS increase up to 50 min. and beyond which they decrease. The percentage reduction of COD for a slow mixing contact time of 10, 20, 30, 40, 50, 60 and 70 min. was observed as 34.5, 44.7, 61.9, 73.4, 82.9, 75.2 and 69.8 % respectively.

Similarly, the percentage reduction of TDS for a slow mixing contact time of 10, 20, 30, 40, 50, 60 and 70 min. were observed as 32.2, 47.4, 64.6, 72.8, 78.3, 73.5 and 66.1 % respectively. Thus an optimum slow mixing contact time for which the maximum COD and TDS removal occurs is 50 min. (Fig.2) and the maximum removal was 6544.96 mg/l and 2392.07 mg/l respectively, as a result, the residual of COD and TDS found in a dairy industry effluent was 1350.05 mg/l and 662.94 mg/l respectively.

Influence of Orange peel Powder Dosage: Fig.3 shows the influence of orange peel powder for removing COD and TDS from dairy industry effluent with an optimum rapid mixing contact time of 25 min. and a slow mixing contact time of 50 min. against the different adsorbent dosage of 20, 40, 60, 80, 100, 120 and 140 g/l. From Fig.3, it may be observed that, the reduction of COD and TDS from dairy industry effluent increase up to 80 g/l, beyond which they decrease. The percentage reduction of COD was observed as 41.2, 62.4, 76.6, 85.3, 80.8, 75.3, and 69.5 % for an orange peel powder dosage of 20, 40, 60, 80, 100, 120, and 140 g/l respectively.

Similarly, the percentage reduction of TDS was observed as 37.3, 59.5, 72.9, 81.6, 76.2, 71.8 and 65.8 % for the dosage of 20, 40, 60, 80, 100, 120, 140 g/l, respectively. Thus, an optimum dosage for which 80 g/l (Fig.3) and the maximum removal was 6764.44 mg/l and 2492.88 mg/l respectively. Thus, the lowest residual of COD and TDS found in a dairy industry effluent was 1160.57 mg/l and 562.12 mg/l respectively.

Model Development: In this study, the experimental data are fitted with second order polynomial regression model. The polynomial models are used to identify which input factors drive the responses and in what direction. A quadratic (second-order) polynomial model consists of single x-term is called as main effects and the squared terms are called as quadratic effects. The cross-product terms are used to model interactions between the explanatory variables. The polynomial regression model is given by

$$y=a + bx + cx^2 \quad (2)$$

in which 'y' is predicted value parameters, 'x' is experimental value of parameters, a, b and c are the constants. The polynomial equation found from the experimental datafor the removal of COD and TDSin a dairy industry effluent by orange peel powder is

$$y = 0.0039x^2 + 0.7999x - 0.6242 \text{ (COD – Orange peel powder)} \quad (3)$$

$$y = 0.0053x^2 + 0.6465x - 0.9794 \text{ (TDS – Orange peel powder)} \quad (4)$$

The second order polynomial regression model developed for this study is shown in Fig.4. The R^2 values obtained from Fig.4 is 0.9968, 0.9949, respectively for COD and TDS from dairy industry effluent by orange peel powder. From Fig.4, it may be found that the second order polynomial regression model is fitted well with the experimental data. This observation was made for the optimum rapid mixing contact time of 25 min., slow mixing contact time of 50 min., and adsorption dosage of 80 g/l. Thus, the model study concluded that the second order polynomial regression model was fitted well with the experimental data observed in a dairy industry effluent.

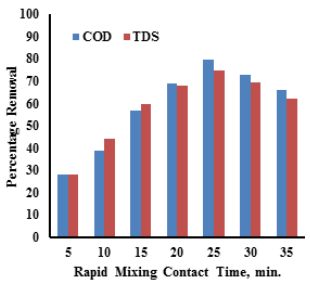

Figure.1.Influence of rapid mixing contact time by orange peel powder

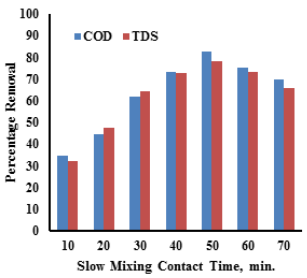

Figure.2.Influence of slow mixing contact time by orange peel powder

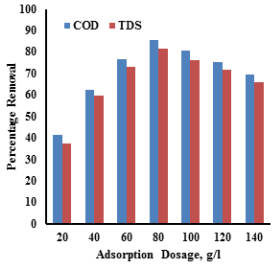

Figure.3.Influence of adsorbent dosage by orange peel powder

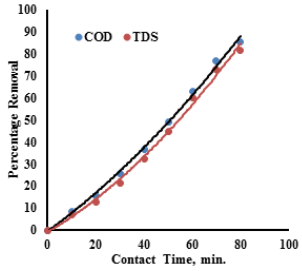

Figure.4.The second order polynomial regression model data by orange peel powder

4. CONCLUSION

The adsorption (orange peel powder) experiments have been conducted for removing COD and TDS from dairy industry effluent. Influence of different orange peel powder dosages, rapid mixing and slow mixing contact time was studied. The results showed that maximum percentage removal was obtained at an optimum dosage of 80 g/l, rapid mixing contact time of 25 min. and slow mixing contact time of 50 min. The experimental results on removal of COD and TDS from dairy industry effluent were validated with second order polynomial model and the model study concluded that the developed model is having reproducing capacity of the experimental data.

REFERENCES

APHA, (2005). Standard methods for the examination of water and effluent. 20th ed., APHA Publication, Washington D.C.

Sivakumar D, and Shankar D, Effect of aeration on colour removal from textile industry effluent, International Journal of Environmental Sciences, 2(3), 2012, 1386-1397.

Sivakumar Durairaj, Experimental and analytical model studies on leachate volume computation from solid waste, Int. J. Environ. Sci. Tech., 10, 2013, 903–916.

Sivakumar D, A study on contaminant migration of sugarcane effluent through porous soil medium, Int. J. Environ. Sci. Tech., 8, 2011, 593–604.

Sivakumar Durairaj, Shankar Durairaj, Colour removal from textile industry effluent using low cost adsorbents, International Journal of Chemical, Environmental and Pharmaceutical Research, 3, 2012, 52–57.

Sivakumar D, Murugan N, Rajeshwaran R, Shobana T, Soundarya C, Vanitha VS, Role of rice husk silica powder for removing Cr(VI) in a tannery industry effluent, International Journal of ChemTech Research, 6, 2014, 4373–4378.

Sivakumar D, Thiruvengadam M, Manojkumar M, Colour removal in a textile industry effluent using coconut coir pith, Pollution Research, 33, 2014, 490–503.

Sivakumar D, Balasundaram V, Venkatesan G, Saravanan SP, Effect of tamarind kernelpowder for treating dairy industry effluent, Pollution Research, 33, 2014, 519–523.

Sivakumar, Role of low cost agro-based adsorbent to treat hospital effluent, Pollution Research, 33, 2014, 573–576.

Sivakumar D, Shankar D, Nithya S, Rajaganapathy J, Reduction of contaminants from leachate using moringa oleifera– A kinetic study, Pollution Research, 33, 2014, 529-529.

Sivakumar Durairaj, Adsorption study on municipal solid waste leachate using moringa oleifera seed, Int. J. Environ. Sci. Technol., 10, 2013, 113–124.

Sivakumar D, Kandaswamy AN, Gomathi V, Rajeshwaran R and Murugan N, Bioremediation studies on reduction of heavy metals toxicity, Pollution Research, 33, 2014, 553–558.

Shankar D, Sivakumar D, Yuvashree R, Chromium (VI) removal from tannery industry effluent using fungi species, Pollution Research, 33, 2014, 505–510.

Sivakumar D, Gayathri G, Nishanthi R, Vijayabharathi V, Sudeshna Das, Kavitha R, Role of fungi species in colour removal from textile industry effluent, International Journal of ChemTech Research, 6, 2014, 4366–4372.

Shanthi S, and Mahalakshmi T, Studies on the removal of malachite green and Methylene blue dyes from aqueous solutions of their Binary mixture by adsorption over commercial Activated carbon and tamarind kernel powder", International Journal of Research in Pharmacy and Chemistry, 2(2), 2012, 289-298.