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Removal of Colour (dyes) from textile effluent by adsorption using Orange and Banana peel

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Abstract
In the present paper natural adsorbent banana and orange peel was used for removal of colour from waste effluent of textile industry. The materials were obtained and treated for the removal of colour at different doses. These materials also evaluated for the removal of colour at different pH and time. The materials are capable of removing colour from waste water, their colour removal capacity for banana peel is 87% and orange peel is 68 % respectively at normal pH and temperature conditions. The equilibrium time was found 55min for orange peel and 45min for banana peel. The experimental adsorption data fitted with Langmuir and Freundlich adsorption isotherms. The experimental result shows that the materials have good potential to remove colour from effluent and good potential as an alternate low cost adsorbent.

Keywords: Adsorption, banana peel, Colour removal, orange peel

1.0 Introduction
The textile industry require a large volume of water for their processes and the waste water discharged from the mill is equally large and of polluting nature [1]. The effluent from textile is an important source of dye pollution. Many dyes and their break down products may be toxic for living organism. Therefore, decolourisation of dyes is an important aspect of wastewater treatment before discharge. The colour removal was extensively studied with physiochemical methods such as coagulation, ultra filtration, electrochemical adsorption and photo oxidation. Among these methods, adsorption is a widely used for removal of dyes from wastewater [2]. Activated carbon is the most widely used adsorbent for this purpose because it has a high capacity for adsorption of colour but its use is limited because of high cost [3].The removals of dyes from effluent using adsorption process provide an alternative treatment, especially if the adsorbent is inexpensive and readily available. A number of non-conventional low cost adsorb ent used for dye removal, include fruit waste of Prosopisn juliflora, wood, waste orange peel, banana pith, maze cobs, barley husk, bagasse pith etc. Utilisation of agricultural waste as low cost adsorbent has great significance in India where more than 200 million tons of agricultural residues are generated annually [4].

The present study is to explore the feasibility of Orange peel and Banana peel as a low cost natural adsorbent with respect to various parameters such as colour adsorbent capacity of material with initial concentration at different doses, time, and pH. The adsorption isotherm are plotted to study the removal capacity of material. The study shows that the material has good potential for the removal of colour from textile effluent.

2. Materials and Methods
2.1 Materials
Waste orange peel and banana peel were obtained from the local fruit stall. These peels then dried in oven at 90^0 C for 24 hrs and ground to a fine powder and sieved through 600 micron and 300 micron sieves. The 600 micron particle size powder and 300 micron size powdered material of orange and Banana peel were selected for the batch adsorption and pH study. Both the materials were dipped in a 1N HCl for 5 hrs then washed with distilled water, dried and used for the study.

2.2 Methods of Analysis
The colour concentration was determined using COD plus colorimeter (model: La-motte, code-1922/1922-EX-2) . The colorimeter measures the colour in pt-cobalt scale and range is upto 1000 units. The pH is measured by using pH meter.

2.3 Batch Adsorption experiments
The batch adsorption experiments were conducted to study optimum removal of colour from textile wastewater. Required quantity of different doses of orange peel and banana peel added to polyethylene bottle with 50 ml textile industry waste effluent. The bottles were kept in orbital shaker at 30^0C temperature at 150 r.p.m. The contents were filtered using whatman filter paper no. 42. The equilibrium time and optimum dose of adsorbent were optimised by repeating the same experiment at different conditions.

2.3.1 Effect of adsorbent dose

The different doses of adsorbent namely Orange and Banana peel taken such as 0.01g to 0.08 g with 50 ml textile effluent in polyethylene bottle in orbital shaker at about 30 ^{0}C and 150 rpm.

2.3.2 Effect of time

To study the effect of time on efficient removal of colour from textile waste the study was carried out. The effect of contact time was investigated for 5 ,10 ,20 ,30 ,40 ,50 ,60 ,70 ,80 ,90 ,100 ,120 ,240 minute at pH 7 .

3. Results and Discussions

3.1 Effect of adsorbent dose

The different doses of adsorbent namely Orange and Banana peel taken such as 0.01g to 0.08g with 50 ml textile effluent in polyethylene bottle in orbital shaker at about 30^{0}C and 150 rpm. It was found that maximum colour removal efficiency for Orange peel was 68% at 0.06g dose of adsorbent for 55 minutes and for Banana peel 87% at dose of 0.05g of adsorbent when shaking time was 55 minutes. From the comparative results it was found that banana peel is more effective than orange peel. The graphical representation is shown below in Figure 1 and 2. It was found that adsorption was found decreasing further with increase in dosage in both the case of adsorbents.

3.2 Effect of time

To study the effect of time on efficient removal of colour from textile waste the study was carried out. The wastewater sample was taken in a 500 ml beaker and kept in a orbital shaker at temperature 30^{0}Cand 150 r.p.m. The sample was withdrawn from the beaker at pre-determined time interval of 10 min each and results are compared with original colour concentration of waste water to know the colour removal efficiency of adsorbents. It is clear from the results that time plays an important role is colour removal for Orange and Banana peel. The optimum time duration required for colour removal is 45mins for banana peel and 55min for orange peel. The comparative results for efficiency of various adsorbents with respect to time are given in Figure 3 and 4.

3.3 Effect of pH

To study the effect of pH on colour removal capacity of Banana and Orange peel , Colour removal was studied at pH ranging between 4 and 10 by maintaining pH of waste water sample with dil HCL and NaOH solution. The maximum removal of colour from waste water is at 7 pH. The removal slightly depend on pH and it is found that many adsorbent shows change in adsorption capacity with variation in pH. .At acidic and alkaline pH new colour of higher wavelength was found and hence the pH study was found insignificant. The graphical representation is shown in Figure.5

3.4 Adsorption Isotherm

The adsorption of dyes can be mathematically expressed in terms of adsorption isotherms. Adsorption isotherm data are commonly fitted to the Langmuir model (equation 1) and the Freundlich model (equation 2)

$$q_e = bQ^o C_e/(1+bC_e) \text{---------- (1)}$$

$$q_e = KC_e^{(1/n)} \text{---------- (2)}$$

Where:

q = amount of dye adsorbed on the adsorbent (mg/g)

C_e = dye concentration at equilibrium (mg/dm^3)

b and K_L = Langmuir constants

n and K_F = Freundlich constants

These models are rearranged to the linear form as follows:

$$1/q_e = 1/Q^o + 1/(bQ^o C_e) \text{---------- (3)}$$

$$\text{Log } (q_e) = \log (K) + (1/n) \text{ lo---------- (4)}$$

The plots of 1/qe against 1/C_e (figure and), and log (q_e) against log (C_e) (figure and), for orange and banana peel, gave a straight line. The correlation coefficient close to 1 indicates that the adsorption process confirms to both adsorption isotherms. Langmuir and Freundlich adsorption isotherms for orange and banana peel are shown in fig 6, 7.8 and 9 respectively

4. Conclusion

The modification of Banana and Orange peel with acid treatment significantly improve colour adsorption capacity as compared to raw Banana and Orange peel. It was found that colour removal efficiency was achieved maximum at very low dose of 0.06 g for Banana peel and 0.05 g of Orange peel within short time of 55 minutes. The adsorption isotherm data was best explained by Langmuir model and the adsorption capacity obtained from Langmuir isotherms for Banana peel and Orange peel wa s0.1808 and 0.0647 mg g^{-1} respectively. The result of pH study shows that the adsorbent was effective at neutral pH. The Banana and Orange peel can be used for removal of colour from the waste water and increasing use of agro based bioadsorbent can be seen in coming decade for removal of dyes from wastewater. Banana and Orange peel have good potential as a low cost adsorbent for improving the effectiveness of waste water treatment.

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List of figures and tables

Fig.1

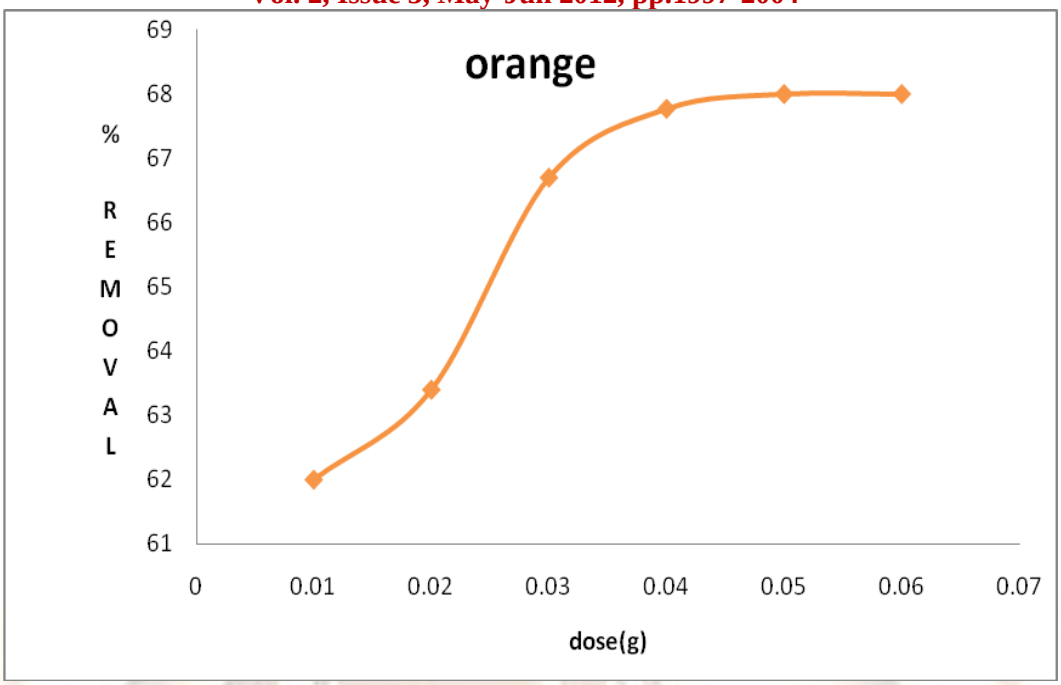

orange
% REMOVAL
69
68
67
66
65
64
63
62
61
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
dose(g)

Fig.2

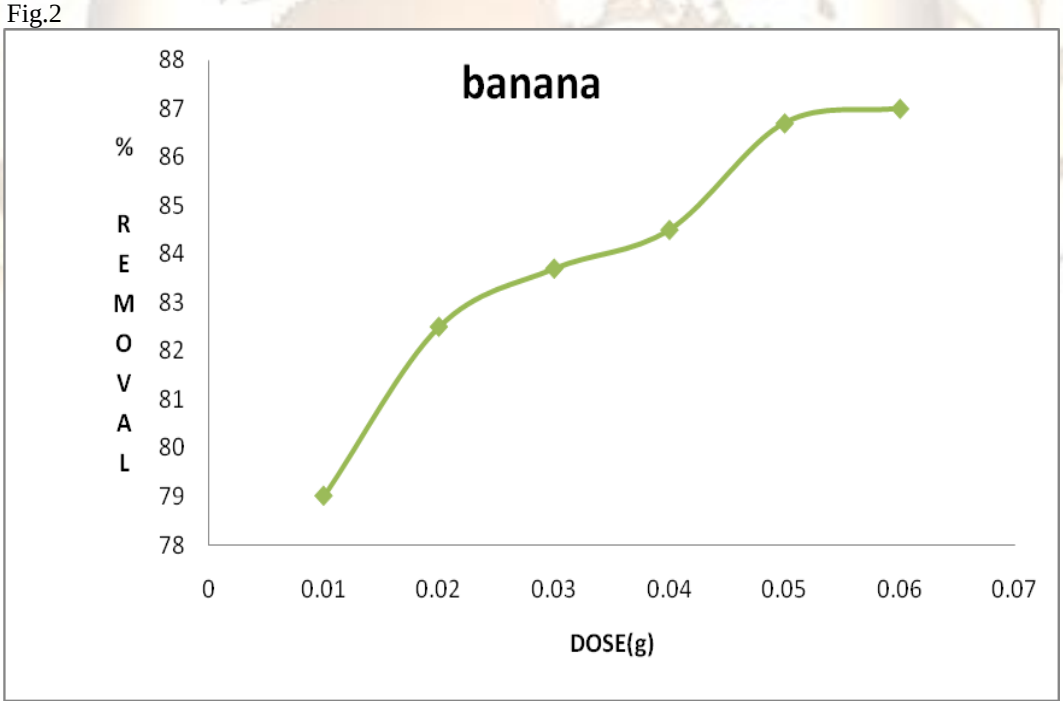

banana
% REMOVAL
88
87
86
85
84
83
82
81
80
79
78
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
DOSE(g)

Fig.3

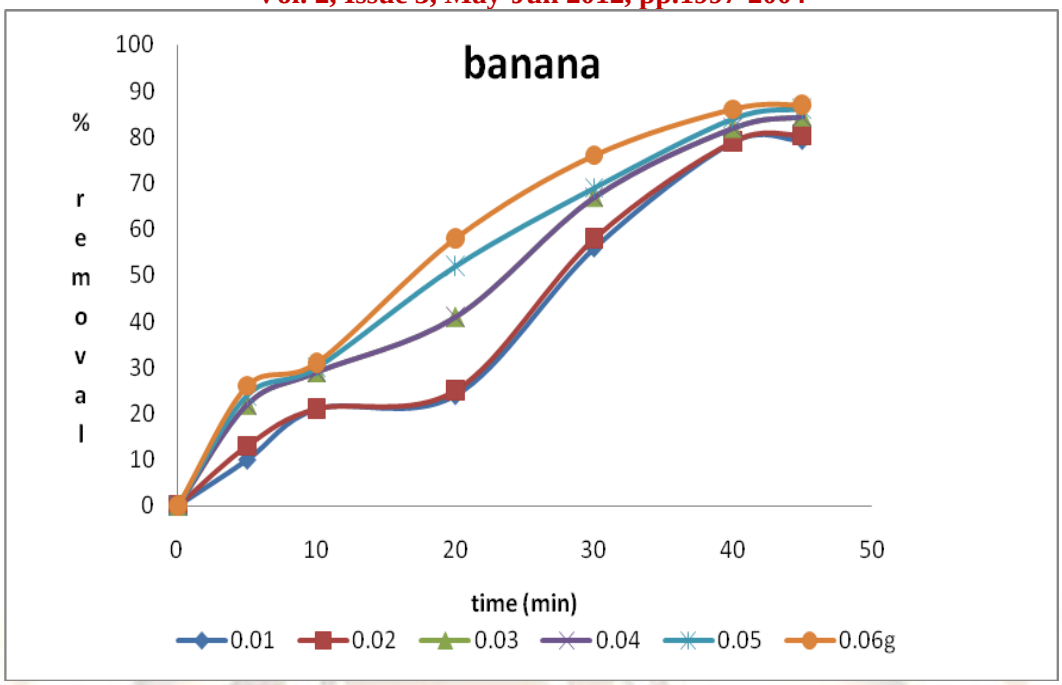

banana
% removal
time (min)
0.01
0.02
0.03
0.04
0.05
0.06g

Fig.4

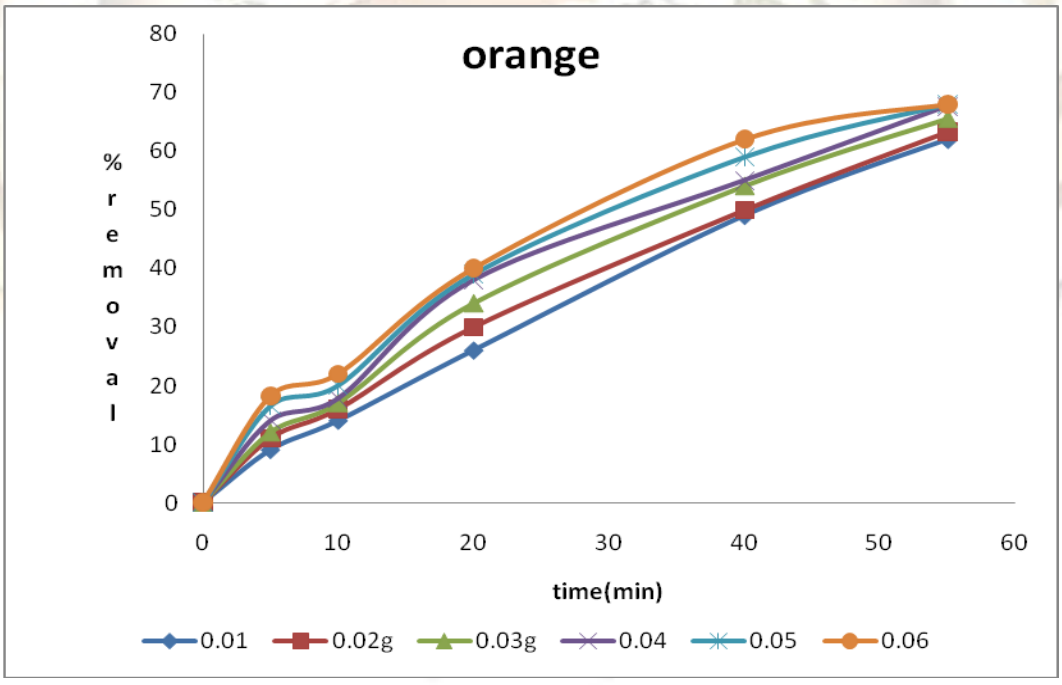

orange
% removal
time(min)
0.01
0.02g
0.03g
0.04
0.05
0.06

Fig.5

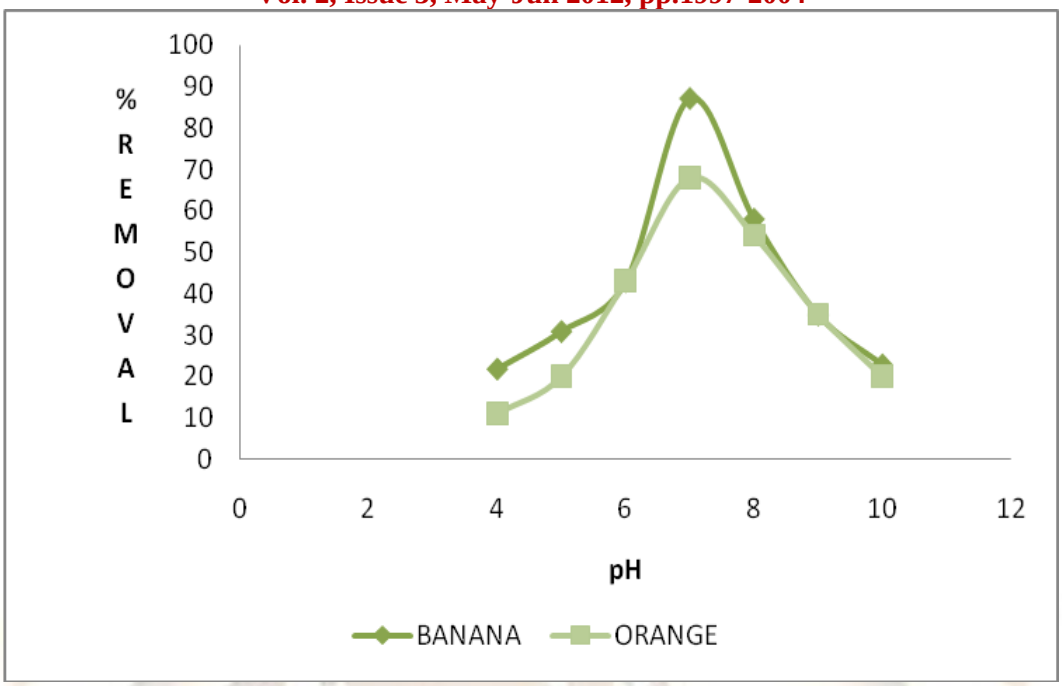

% REMOVAL
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
pH
BANANA
ORANGE

Fig.6

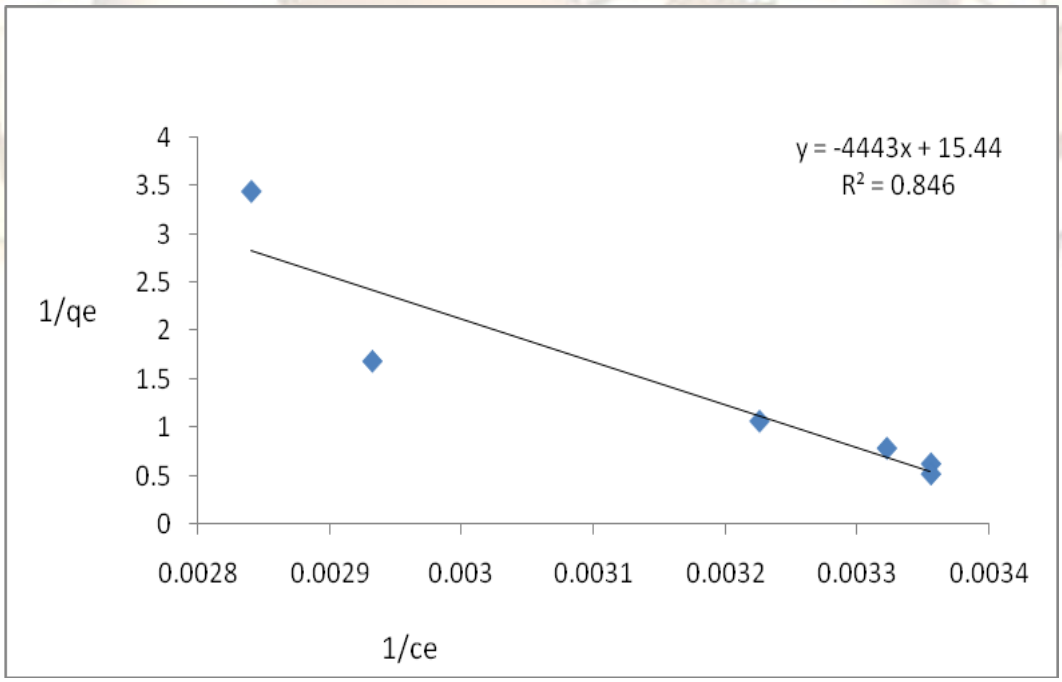

y = -4443x + 15.44
R² = 0.846
1/qe
4
3.5
3
2.5
2
1.5
1
0.5
0
0.0028
0.0029
0.003
0.0031
0.0032
0.0033
0.0034
1/ce

Fig.7

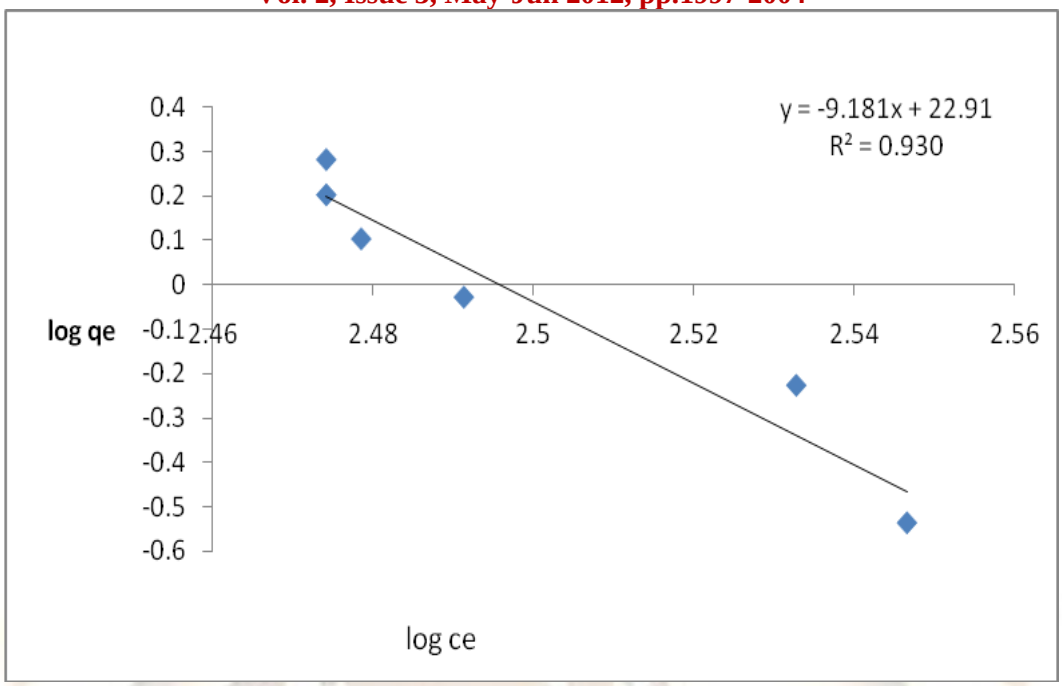
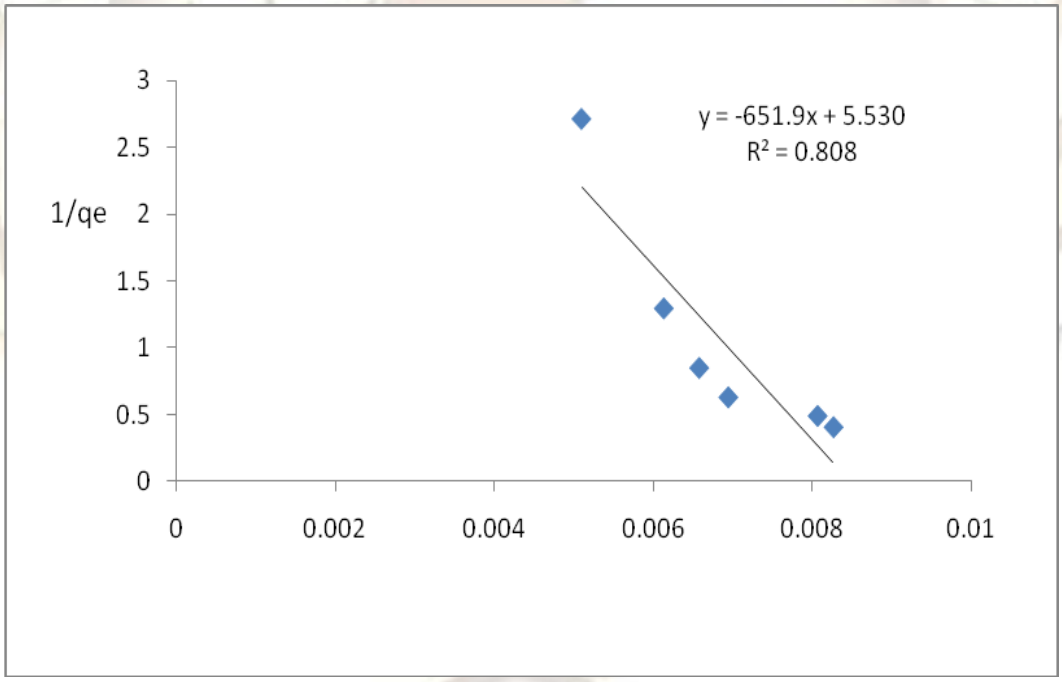

y = -9.181x + 22.91
R² = 0.930
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
log qe
2.46
2.48
2.5
2.52
2.54
2.56
log ce

Fig.8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R² = 0.808
3
2.5
2
1.5
1
0.5
0
1/qe
0
0.002
0.004
0.006
0.008
0.01

Fig.9

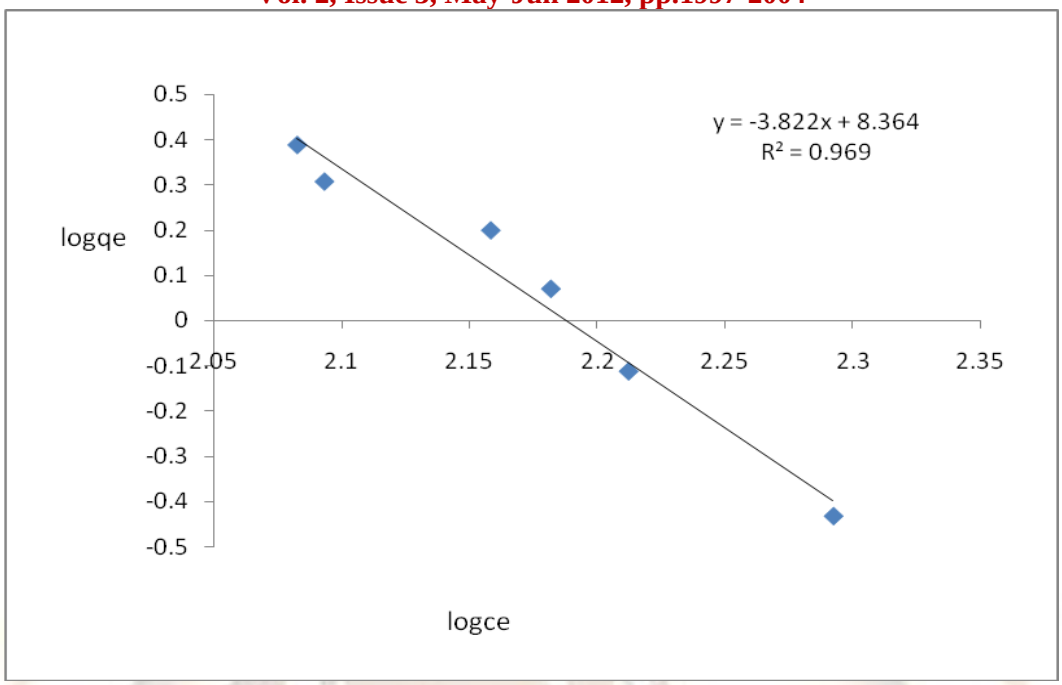

Table 1

Adsorbent	Langmuir			Freundlich		
	Qmax	KL	R^2	KF	1/n	R^2
Orange peel	0.0647	-0.00347	0.846	-2.495	0.1089206	0.93
Banana peel	0.1808	-0.00848	0.808	-2.18838	0.2616431	0.96