BOD AND COD REDUCTION FROM SYNTHETIC SUGAR INDUSTRY WASTEWATER

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ABSTRACT

Rapid progress made in industrialization without adequate environmental safety measures lead to pollution of water, which in turn, results in lack of good quality water both for irrigation and drinking purposes. The sugar industry wastewater contains huge amount of Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) which are harmful to the environment. Therefore, wastewater from sugar industry has to be treated before being discharged into the environment. The removal of BOD and COD from wastewater using adsorption process provides an alternative treatment. This study involved the reduction of BOD and COD in synthetically prepared sugar industry wastewater by the process of adsorption using rice husk and garlic peel as adsorbents. In this study both adsorbents were studied for their adsorption capacities from wastewater. Various parameters such as pH, contact time, adsorbent dosage and initial concentration were varied and analysis for BOD and COD were carried out. And also the adsorption isotherm studies are carried out. The result shows that both adsorbents are very effective for wastewater treatment. The maximum adsorption capacity of rice husk was found to be 84.4% in COD reduction and 82.1% in BOD reduction at neutral pH. Similarly the maximum adsorption capacity of garlic peel was found to be 75.5% in COD reduction and 69.6% in BOD reduction at neutral pH. The performance of rice husk and garlic peel adsorbents is good at the pH in between 6 and 10. A contact time of 40 minutes was sufficient to reduce COD to the maximum and a contact time of 50 minutes was sufficient to reduce BOD to the maximum using rice husk adsorbent. Similarly a contact time of 50 minutes was sufficient to reduce COD to the maximum and a contact time of 40 minutes was sufficient to reduce BOD to the maximum using garlic peel adsorbent. Also an adsorbent dose of 9 g was sufficient to reduce COD to the maximum and an adsorbent dose of 12 g was sufficient to reduce BOD to the maximum using rice husk adsorbent. In the case of garlic peel adsorbent, an adsorbent dose of 12 g was sufficient to reduce COD to the maximum and an adsorbent dose of 9 g was sufficient to reduce BOD to the maximum. Optimum concentration is the lowest concentration of 300mg/l for all the experiments. When comparing both the adsorbents, rice husk has high removal efficiency than garlic peel at same operating conditions.

Keyword: - *Sugar industry wastewater, Biochemical oxygen demand, Chemical oxygen demand, Adsorption, Rice husk, Garlic peel*

1. INTRODUCTION

Water is the basic requirement for living beings. About one sixth of the world population has no access to safe drinking water. Even though two third of earth's surface is covered with water, fresh water sources accounts less than 2.5%. Out of this, only a small fraction of water is easily available for access to humans as the remaining is locked in glaciers and deep underground aquifers. Rising population and improved standard of living have escalated per capita demand for fresh water. India had more than 2500 cubic meter /annum of water per capita availability in 1950 but now it is hardly 1800 cubic meter/annum, slowly approaching water stress condition.

Water stress is defined as when annual water supplies drop below 1,700 cubic meters per person. When annual water supplies drop below 1,000 cubic meters per person, the population faces water scarcity. There are

many causes for water pollution but two general categories exist: geogenic and anthropogenic. Geogenic contamination refers to naturally occurring elements in groundwater which have a negative health effect on humans consuming this water.

Anthropogenic contamination is due to the direct input of substances from agricultural industrial or urban activities. Industrial pollution is a major challenge in conserving water, as the contaminants are to be removed before releasing industrial effluent streams to the environment. Pollutants discharged in wastewaters can be toxic to aquatic life and cause natural waters to be unfit as potable water sources

Increased demand for food and the need to sustain the ever increasing world population have led to massive increase in both agricultural and industrial activities. Agriculture is one of the most significant sectors of the Indian Economy. Agriculture is the only means of living for almost two thirds of the workers in India. Agriculture still contributes significantly to India's GDP despite decline of its share in India's GDP. There are number of crops grown by farmers. Sugar Industry is one of the agricultural based industries. Today, India is one of the first ten industrialized countries of the world. India, like any other developing countries, is faced with problems arising from the negative impact of economic development due to water or industrial pollution. Rapid progress made in industrialization without adequate environmental safety measures lead to pollution of water, which in turn, results in lack of good quality water both for irrigation and drinking purposes. Awareness of environmental problems and the potential hazards caused by industrial wastewater has promoted many countries to limit the discharge of polluting effluents stratum and reaches the groundwater table, which may cause impact to the aquifer and thereby pose a potential risk to human health as well as the surrounding environment

Generally effluent generated from sugarcane industry is disposed off on land. While moving on land, part of pollutants in the effluent may be migrated and deposited between the gaps of soil stratum and adsorbed on the soil particles surface, resulting in pollution of soil. Furthermore, the migrated effluent flows through the gaps in the soil

A significant growth has occurred in the industries of developing countries in the recent years. Many industries discharge wastewaters which may have high Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). These effluents should be treated for safe disposals which meets the regulations imposed on industrial sectors. Industrial wastewaters have high concentrations of total dissolved solids (TDS) and it has been a difficult task for engineers to remove them from industrial wastewaters .TDS values can exceed 100000 mg/L. Other characteristics such as high values of BOD and COD are common problems associated with industrial wastewater. BOD values can exceed 200000 mg/L. Food processing industries are one of the major sectors which consume a huge amount of water for their production process. Such industries consist of different kinds of production like dairy products, beverages, vegetables and fruits, and meat. Wastewater produced by food processing industries do not have high amount of toxic pollutants, however, they are high in concentrations BOD and COD.

2. METHODOLOGY

2.1 Preparation of activated rice husk

Powdered rice husk were sieved in 0.3mm sieve. Sieved adsorbent were first washed well with distilled water to remove the dirt and the dust particles and dried at a temperature of 80°C for a period of 4 – 5 hours. Dried adsorbent were then soaked separately in NaOH solution overnight. Then it is soaked in sulfuric acid for a period of 2-3 hours. Then washed well and dried in sunlight. This pretreated material was used as adsorbent.

2.2 Preparation of activated garlic peel

Powdered garlic peel was sieved in 0.3mm sieve. Sieved adsorbent were first washed well with distilled water to remove the dirt and the dust particles and dried at a temperature of 80°C for a period of 4 – 5 hours. Dried adsorbent were then soaked separately in NaOH solution overnight. Then it is soaked in sulfuric acid for a period of 2-3 hours. Then washed well and dried in sunlight. This pretreated material was used as adsorbent.

2.3 Preparation of synthetic sugar industry wastewater

Wastewater samples were prepared in the laboratory using commercially graded sugar ($C_6H_{12}O_6$) to simulate same BOD and COD of the wastewater from sugar processing industries. 300 mg of sugar ($C_6H_{12}O_6$) was added to 1 L of distilled water.

2.4 Effect of Contact time

To study the effect of contact time, 3 gm of adsorbent was added to the wastewater of initial sugar concentration 300mg/L, at known pH 7 and constant shaking was provided for 60 minutes. The samples were collected at different time intervals such as 10, 20, 30, 40, 50 and 60 minutes and filtered. To determine the optimum contact time, BOD and COD of the samples were analyzed.

2.5 Effect of Initial concentration

To study the effect of sugar concentration, required amount of adsorbent was added to the wastewater of varying concentration and is kept shaking for optimum time. Procedure is repeated with the solution of pH 7 at the different initial concentrations 300, 600, 900, 1200 and 1500 mg/L keeping the other conditions constant. Then filtered and analyzed for BOD & COD.

2.6 Effect of Adsorbent dosage

The effect of adsorbent dosage was obtained by agitating the wastewater sample separately with 3, 6, 9, 12 and 15 grams of adsorbent for optimum shaking time by keeping the other conditions constant. Then determined the BOD and COD of each sample and hence found out optimum dosage.

2.7 Effect of pH

To determine the effect of pH , wastewater sample of optimum sugar concentration were taken and acid were added in order to reduce pH value to 2,4,6 and base were added to increase the pH to 8 and 10. Freshly prepared hydrochloric acid and sodium hydroxide were used to change the pH. After setting the pH of the ranges 2,4,6,8 and 10, optimum dose of adsorbents were added to it and allowed to undergo shaking for optimum time. Then determined the BOD and COD of each samples and hence found out optimum pH.

3. RESULTS AND DISCUSSION

Activated rice husk and activated garlic peel powder were used as adsorbents in the present study to reduce COD and BOD from synthetic sugar industry wastewater. The results of this study are discussed in the following section.

3.1 Effect of contact time

The table below shows variation of COD and BOD with contact time of rice husk and garlic peel adsorbents. The data obtained showed that a contact time of 40 minutes was sufficient to reduce COD to the maximum and a contact time of 50 minutes was sufficient to reduce BOD to the maximum using rice husk adsorbent.ie, COD and BOD was reduced to 76.8% and 71.6% respectively. In the case of garlic peel adsorbent, a contact time of 50 minutes was sufficient to reduce COD to the maximum and a contact time of 40 minutes was sufficient to reduce BOD to the maximum. ie, COD and BOD was reduced to 64.4% and 66.9% respectively. The study had shown that rice husk have high percentage of COD and BOD reducing efficiency. The chart 1 and chart 2 represents the graph of variation of COD and BOD with contact time of rice husk and garlic peel respectively.

Table-1: Effect of contact time on adsorbents

Sl no	Time (minutes)	% COD reduction		% BOD reduction	
		Rice husk adsorbent	Garlic peel adsorbent	Rice husk adsorbent	Garlic peel adsorbent
1	10	21.5	15.9	28.9	22.6
2	20	38.6	32.7	50.4	45
3	30	59.6	48.1	64.3	58.8
4	40	76.8	57	68.6	66.9
5	50	76.8	64.4	71.6	66.9
6	60	76.8	64.4	71.6	66.9

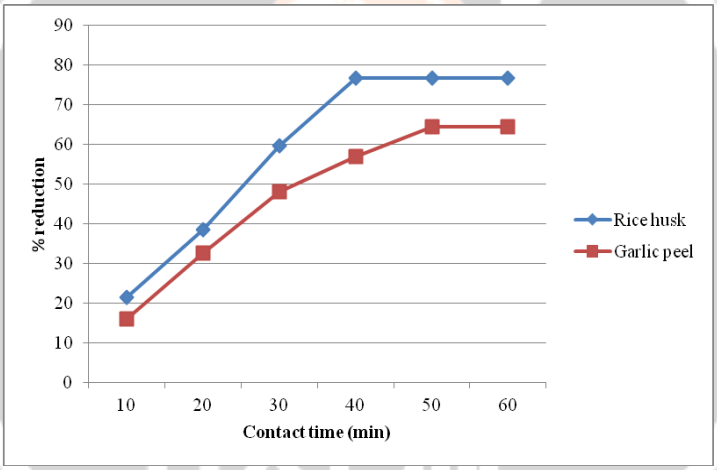

Chart-1: Effect of contact time on COD reduction

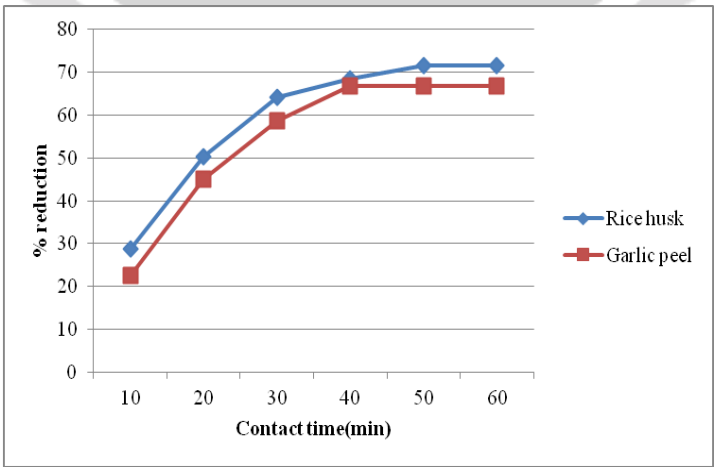

Chart-2: Effect of contact time on BOD reduction

3.2 Effect of initial concentration

The table below shows variation of COD and BOD with initial Concentration of rice husk and garlic peel adsorbents. The data obtained showed that an initial concentration of 300 mg/L was sufficient to reduce COD and BOD to the maximum using both rice husk and garlic peel adsorbents.ie, COD and BOD was reduced to 76.8% and 71.6% using rice husk adsorbent and COD and BOD was reduced to 64.4% and 66.9% using garlic peel adsorbent. The rice husk adsorbent has high percentage of COD and BOD reducing efficiency. The chart 3 and chart 4 represents the graph of variation of COD and BOD with initial concentration of rice husk and garlic peel respectively.

Table-2: Effect of initial concentration on adsorbents

Sl no	Initial concentration (mg/L)	% COD reduction		% BOD reduction	
		Rice husk adsorbent	Garlic peel adsorbent	Rice husk adsorbent	Garlic peel adsorbent
1	300	76.8	64.4	71.6	66.9
2	600	58.7	54.3	61.1	50.7
3	900	52.8	50.6	44.4	40.9
4	1200	49	43.7	40.8	35.9
5	1500	42.1	36.4	37.4	34.8

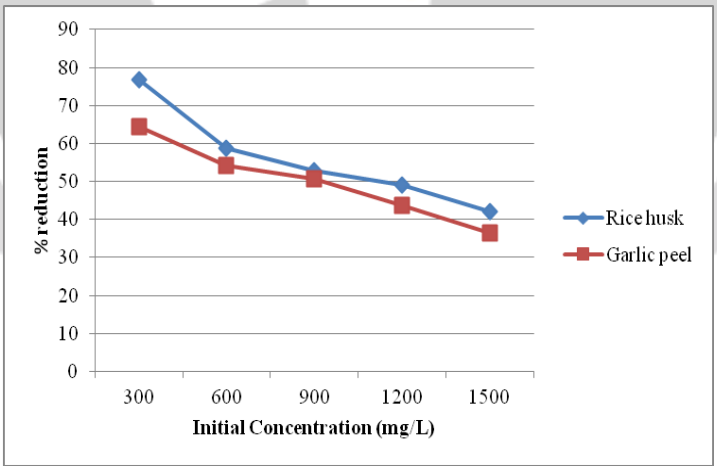

Chart-3: Effect of initial concentration on COD reduction

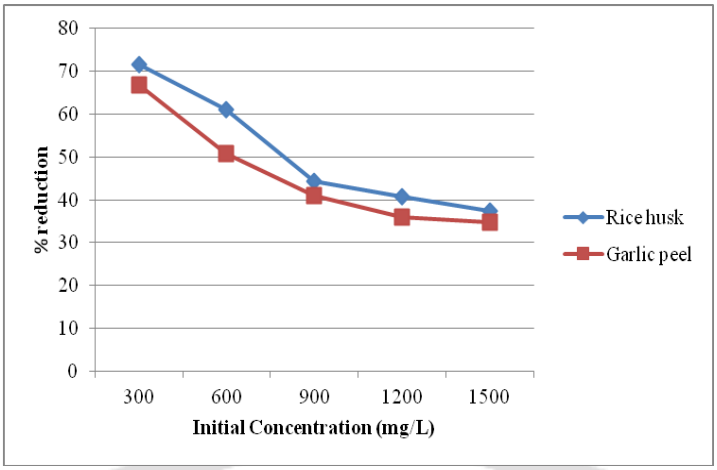

Chart-4: Effect of initial concentration on BOD reduction

3.3 Effect of adsorbent dose

The table below shows variation of COD and BOD with adsorbent dose of rice husk and garlic peel adsorbents. The data obtained showed that an adsorbent dose of 9 g was sufficient to reduce COD to the maximum and an adsorbent dose of 12 g was sufficient to reduce BOD to the maximum using rice husk adsorbent.ie, COD and BOD was reduced to 84.4% and 82.1% respectively. In the case of garlic peel adsorbent, an adsorbent dose of 12 g was sufficient to reduce COD to the maximum and an adsorbent dose of 9 g was sufficient to reduce BOD to the maximum. ie, COD and BOD was reduced to 75.5% and 69.6% respectively. The study had shown that rice husk have high percentage of COD and BOD reducing efficiency. The chart 5 and chart 6 represents the graph of variation of COD and BOD with adsorbent dose of rice husk and garlic peel respectively.

Table-3: Effect of adsorbent dose on adsorbents

Sl no	Adsorbent dose (g)	% COD reduction		% BOD reduction	
		Rice husk adsorbent	Garlic peel adsorbent	Rice husk adsorbent	Garlic peel adsorbent
1	3	76.8	64.4	71.6	66.9
2	6	80.7	67.2	77.7	67.1
3	9	84.4	73.3	78.8	69.6
4	12	84.4	75.5	82.1	69.6
5	15	84.4	75.5	82.1	69.6

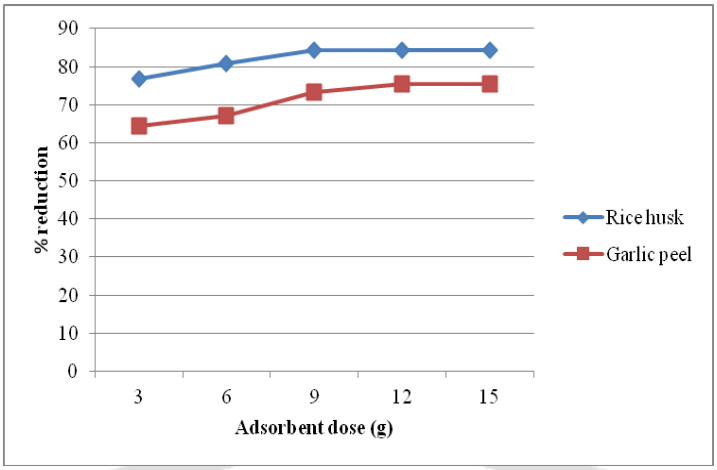

Chart-5: Effect of adsorbent dose on COD reduction

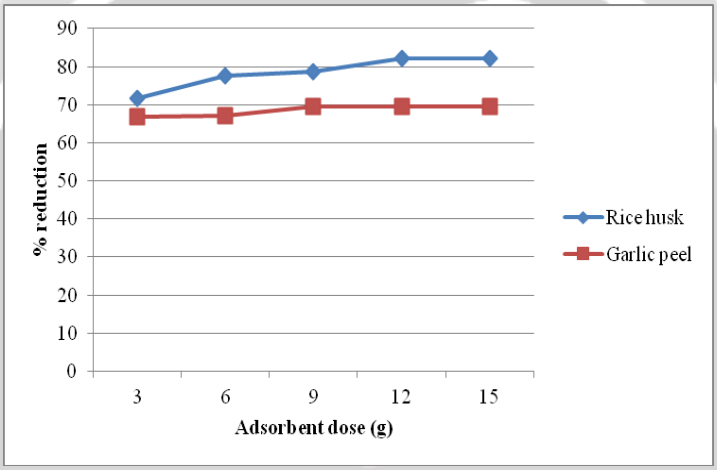

Chart-6: Effect of adsorbent dose on BOD reduction

3.4 Effect of pH

The table below shows variation of COD and BOD with pH of rice husk and garlic peel adsorbents. The data obtained showed that a pH of 6 was sufficient to reduce COD to the maximum and a pH of 8 was sufficient to reduce BOD to the maximum using rice husk adsorbent.ie, COD and BOD was reduced to 60.7% and 70.6 % respectively. In the case of garlic peel adsorbent, a pH of 8 was sufficient to reduce COD to the maximum and a pH of 10 was sufficient to reduce BOD to the maximum. ie, COD and BOD was reduced to 53.5% and 64.6 % respectively The study had shown that rice husk have high percentage of COD and BOD reducing efficiency. The chart 7 and chart 8 represents the graph of variation of COD and BOD with pH of rice husk and garlic peel respectively.

Table-4: Effect of pH on adsorbents

Sl no	pH	% COD reduction		% BOD reduction	
		Rice husk adsorbent	Garlic peel adsorbent	Rice husk adsorbent	Garlic peel adsorbent
1	2	44.7	33.61	40.71	37.1
2	4	51.73	45.7	50.4	44.7
3	6	60.7	51	63.4	52.4
4	8	56.07	53.5	70.6	63.9
5	10	50.4	48.4	66.1	64.6

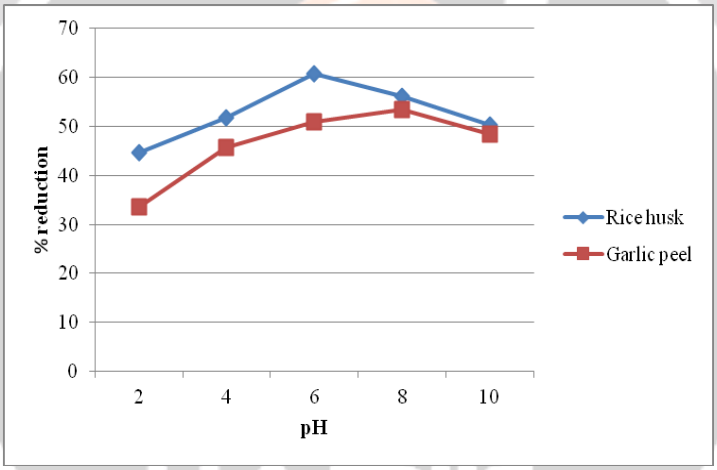

Chart-7: Effect of pH on COD reduction

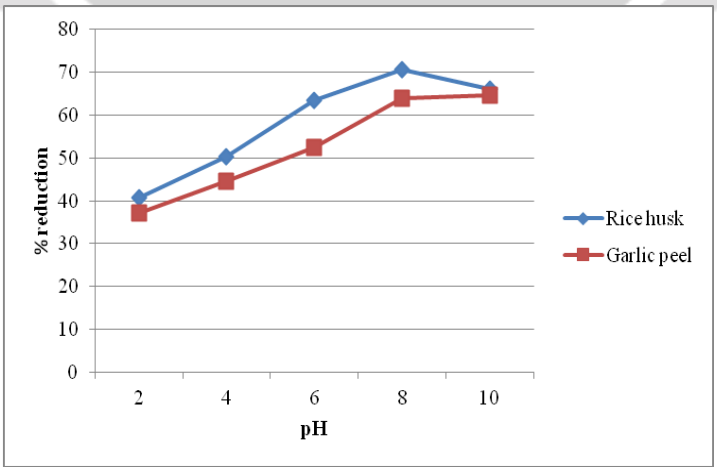

Chart-8: Effect of pH on BOD reduction

4. CONCLUSIONS

This study entailed BOD and COD reduction from synthetic sugar industry wastewater. The results showed that rice husk proved to be a very effective adsorbent for the reduction of BOD and COD synthetic sugar industry wastewater than the garlic peel adsorbent for the same experimental conditions. The maximum adsorption capacity of rice husk was found to be 84.4% in COD reduction and 82.1% in BOD reduction at neutral pH. Similarly the maximum adsorption capacity of garlic peel was found to be 75.5% in COD reduction and 69.6% in BOD reduction at neutral pH. The performance of rice husk and garlic peel adsorbents is good at the pH in between 6 and 10. A contact time of 40 minutes was sufficient to reduce COD to the maximum and a contact time of 50 minutes was sufficient to reduce BOD to the maximum using rice husk adsorbent. Similarly a contact time of 50 minutes was sufficient to reduce COD to the maximum and a contact time of 40 minutes was sufficient to reduce BOD to the maximum using garlic peel adsorbent. Also an adsorbent dose of 9 g was sufficient to reduce COD to the maximum and an adsorbent dose of 12 g was sufficient to reduce BOD to the maximum using rice husk adsorbent. In the case of garlic peel adsorbent, an adsorbent dose of 12 g was sufficient to reduce COD to the maximum and an adsorbent dose of 9 g was sufficient to reduce BOD to the maximum. Optimum concentration is the lowest concentration of 300mg/l for all the experiments.

5. REFERENCES

[1] Maruf Mortula &Sina Shabani (2012), "Removal of TDS and BOD from Synthetic Industrial Wastewater via Adsorption", International Conference on Environmental, Biomedical and Biotechnology, volume 41, pp 166-170
[2] A. Sheoran & M. Rais (2015), "Treatment of Sugarcane Industry Effluents: Science & Technology issues", Int. Journal of Engineering Research and Applications, Vol. 5, pp 11-19
[3] S.S. Inamdar (2006) , "BOD reduction using low cost adsorbents" , Journal of industrial pollution control, vol 22, pp 111-120
[4] Pawan R.Wani & Sonali B. Patil (2017), "Treatment of Dairy Waste Water by Using Groundnut Shell as Low Cost Adsorbent", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 6, Issue 7,pp 14941 - 14948
[5] Prachi dessai& Shwetha prasanna (2016), "Treatment of dairy waste water using low cost adsorbents", International journal of scientific research engineering & technology, volume 5,pp 592-593
[6] Thuraiya Mahir Al Khusaibi et.al (2015), "Treatment of Dairy Wastewater using Orange and Banana Peels" , Journal of Chemical and Pharmaceutical Research , vol 7, pp 1385-1391
[7] Bishnoi, N. R., Bajaj, M., Sharma, N. and Gupta, A., Adsorption of Cr(VI) on activated rice husk carbon and activated alumina, Biores Technol, 91 (3): 305-307, 2004.
[8] Ali, I., Mohd. Asim, Tabrez A. Khan. Low cost adsorbents for the removal of organic pollutants from wastewater. Journal of Environmental Management 2012; 170-183.
[9] Periasamy K, Srinivasan K and Murugan P.K, Studies on chromium (VI) removal by Activated Groundnut Husk Carbon, Indian J. Environ. Hlth, 31(4), 433-439 (1991)
[10] Sheetal S Karale & Mayur M Suryavanshi- "Dairy Wastewater Treatment Using Coconut Shell Activated Carbon & Laterite as Low Cost Adsorbents"- international journal of civil, structural, Environmental and Infrastructure engineering Research and development (ijcseierd) ISSN (p): 2249-6866; ISSN (e): 2249-7978 Vol. 4, issue 2, apr 2014, 9-14
[11] Neena Sunny,Fathima Shukkoor, Fathimath Nuzrin N R ,Muhsina Moideen, Nehla Moideen- " Treatment Of Dairy Waste" - International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online) Vol. 2, Issue 2, pp: (140-144), Month: October 2014 - March 2015.
[12] Mohammad Ajmal, R. A. K. Rao, Jameel Ahmad and Rais Ahmad- "The Use of Testa of Groundnut Shell (Arachis hypogea) for the Adsorption of Ni(II) from the Aqueous System"- Journal Of Environmental Science & Engg, Vol 478, No 43, Pp: 322261- -323254, 2006.
[13] Prof. Chidanand Patil, Ms. Manika Hugar – "Treatment of dairy wastewater by natural coagulants"- International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 02 Issue: 04 | July-2015 www.irjet.net p-ISSN: 2395-0072.
[14] Ashutosh Tripathi and Manju Rawat Ranjan – "Heavy Metal Removal from Wastewater Using Low Cost Adsorbents"- Bioremed Biodeg Volume 6, Issue 6.
[15] Prabha R.T., Dr. Udayashankara T.H- "Removal of heavy metal from synthetic wastewater using Rice husk and Groundnut shell as adsorbents" - IOSR Journal of Environmental Science, Toxicology and Food

Technology (IOSR-JESTFT) e-ISSN: 2319-2402,pp - ISSN: 2319-2399.Volume 8, Issue 7 Ver. II (July. 2014), PP 26-34.
[16] Nammam Ali Azadi, Reza Ali Falahzadeh, Shahram Sadeghi –"Dairy Wastewater Treatment Plant In Removal Of Organic Pollution: A Case Study in Sanandaj, Iran" -Environmental Health Engineering and Management Journal 2015, 2(2), 73–77.
[17] Isah U. A. and Yusuf A.I.-"Adsorption Of Lead Ions On Groundnut Shell Activated Carbon"- Pelagia Research Library Der Chemica Sinica, 2012, 3(6):1511-1515
[18] S. Idris1, Y. A. Iyaka, B. E. N. Dauda, M. M. Ndamits and M. T. Umar –"Kinetic Study of Utilizing Groundnut Shell as an Adsorbent in Removing Chromium and Nickel from Dye Effluent"- American Chemical Science Journal 2(1): 12-24, 2012 SCIENCEDOMAIN international www.sciencedomain.org.
[19] Uttarini Pathak, Papita Das, Prasanta Banerjee, and Siddhartha Datta – "Treatment of Wastewater from a Dairy Industry Using Rice Husk as Adsorbent: Treatment Efficiency, Isotherm, Thermodynamics, and Kinetics modelling" - Hindawi Publishing Corporation Journal of thermodynamics Volume 2016
[20] Thuraiya Mahir Al Khusaibi, Joefel Jessica Dumaran, M. Geetha Devi, L. Nageswara Rao and S. Feroz –" Treatment of Dairy Wastewater Using Orange And Banana Peels"- Journal of Chemical and Pharmaceutical Research, 2015, 7(4):1385-1391.
[21] Dimitrios Kalderis, Sophia Bethanis, Panagiota Paraskeva,Production of activated carbon from bagasse and rice husk by a single-stage chemical activation method at low retention times ,Bioresource Technology,2008,99:6809-6816
[22] K.Y. Foo, B.H. Hameed,Utilization of rice husks as a feedstock for preparation of activated carbon by microwave induced KOH and K_2CO_3 activation, Bioresource Technology,2011,102: 9814-9817
[23] Gao pin,Liu Zhenhong,Xue Gang,et al.Adsorption of phenol by Activated Carbon prepared from Waste Rice Straw by Chemical Activation with (NH4)2HPO4, Journal of Donghua University(Eng).2011, 28(6):552-558.
[24] Deng X H, Yue Y H, Gao Z. New Carbon-silica Composite Adsorbents from Elutrilithe, Catalysis Today,1993,17:41-42
[25] Ramanu J R, Purusho T M, Chia M H. Processing and Characterization of Activated Carbon Coated Magnetic Particles for Biomedical Applications[J]. Materials Science and Engineering, 2007, 27(4): 659-664.