International Journal of Science Technology and Management
Volume No.10, Issue No. 03, March 2021
www.ijstm.com
ISSN 2394 - 1537

TREATMENT OF DAIRY WASTE WATER USING NATURAL ADSORBENT LIKE FRUIT PEEL

Ms. A. Devoopriya[1]

Dr. K.M. Gopala Krishnan., M.E.,Ph.D[2]**,**

Mr. M.Dhivakar Karthick, M.E.,(Ph.D.)[3]

[1]*PG Scholar, Department of Civil Engineering,*

Erode Sengunthar Engineering College, Erode – 638057, Tamil Nadu, India

[2]*Head of the department, Department of Civil Engineering,*

Erode Sengunthar Engineering College, Erode– 638057, Tamil Nadu, India

[3]*Assistant Professor, Department of Civil Engineering,*

Erode Sengunthar Engineering College, Erode - 638057, Tamil Nadu, India

ABSTRACT

Water scarcity is among the main problems to be faced by the world in the 21century. Hence it is very important to treat the waste water from industries before it is discharged. Among various water purification and recycling technologies, adsorption is a fast, inexpensive and universal method. The development of low-cost adsorbents has led to the rapid growth of research interests. In modern days an experimental investigation was carried out for the treatment of diary wastewater using low cost adsorbents. And one such idea for reuse of waste water is "treatment of Dairy Wastewater by adsorption concept using Natural Adsorbent like fruit peel". The peels of orange and banana were used as adsorbents in this study by adsorption method the effect of pH, contact time, adsorbent dosage, and adsorbent particle size in removal of pollutants present in diary wastewater was evaluated. The studies showed that the orange peels are more effective than the banana peels in the removal of pollutants from the dairy wastewater. The optimum adsorbent dosage for the orange peel is 15 g and for banana peel is 25g. Also we tried to combine both Orange and banana peel at equal proportion and came to know that combination of both Orange and banana peel is more effective than Orange peel alone. The project describes the development of inexpensive adsorbents from waste materials, which takes only 1–2 days, and an adsorption process taking 15–120 min for the removal of pollutants. The applications of batch and column processes are discussed, along with suggestions to make this technology more popular and applicable.

***Keywords:* Dairy waste water, Adsorbent, inexpensive, Orange peel and banana peel, Adsorption, Batch and Column process.**

International Journal of Science Technology and Management
Volume No.10, Issue No. 03, March 2021
www.ijstm.com
ISSN 2394 - 1537

1. Introduction

Two third of the earth's surface covered by water and the human body consisting of 75 percent of it, it is evidently clear that water is one of the prime elements responsible for life on earth. Water scarcity already affects every continent. Around 1.2 billion people, or almost one-fifth of the world's population, live in areas of physical scarcity, and 500 million people are approaching this situation. Another 1.6 billion people, or almost one quarter of the world's population, face economic water shortage.

Development of industrial activity causes deterioration of ground water quality because of industrial effluents disposal without pretreatment on to the ground or land. Now-a-days, one of the main sources of water pollution is the waste material or effluent discharged by industrial units, known as industrial water pollution. Water resources are mostly affected by industrial pollution. Large amount of untreated sewage/industrial water is being discharged in to surface bodies for disposal. Hence it is very important to treat the waste water from industries before it is discharged. The WHO states that the management of water resources will become increasingly important in the future, and we should also look at alternative water sources, such as the reuse of waste water. And one such idea for reuse of waste water is treatment of Dairy Wastewater by adsorption concept using Natural Adsorbent like fruit peel. Earlier there are researches where the Orange and lemon peels are used, in this paper we have used banana peel as adsorbent and tried to treat the waste by combining both Orange and banana peel as adsorbent in 1:1 ratio. This chapter discusses the importance or the requirement for the dairy waste water treatment. The review of research work done is summarized to facilitate an appropriate methodology towards accomplishing the objectives under the topics.

- Renewable resource
- Reduce the organic content of the wastewater.
- Remove or reduce nutrients that could cause pollution of receiving surface waters or groundwater.
- Remove or inactivate potential pathogenic microorganisms.

2. Experimental Investigation

2.1 Material used

Materials which are adopted and the details of the experiments conducted are explained below.

- Sample dairy waste water from Nambisan's dairy private limited.
- Dried processed fruit peel as adsorbent
- Experimental setup

2.2 Experimental Setup

The following are the methodologies to be followed to purify the dairy wastewater by adsorption method using banana peel and orange peel.

- Analysis of impurities in the dairy wastewater sample
- Treatment of dairy waste water by adsorption concept
- Factors affecting adsorption
- Fruit peel as adsorbents

- Preparation of orange and banana peel as adsorbent.
- Experimental procedure to use orange peel and banana peel as adsorbent

2.2.1 Analysis of impurities in the dairy wastewater sample

Typically, dairy wastewater is white in colour (whey is yellowish-green) and has an unpleasant odour and turbid character With annual temperatures of 17–25 °C, dairy waste streams are warmer than municipal wastewater (10–20 °C), which results in faster biological degradation compared to sewage treatment plants. The average temperatures of industrial dairy effluents range from 17–18 °C in winter and 22–25 °C in summer. Using the Arrhenius equation, the biodegradation rates and oxygen consumption can be predicted to be 1.5 times higher in summer than in winter. The design winter temperature of 15 °C is adopted for this type of wastewater due to the utilization of hot water for washing and cleaning of equipment.

A crucial requirement for biological treatment of dairy wastewater is their pH value between 6 and 9. Milk and butter factories have effluents with active reaction close to neutral (pH=6.8–7.4). In plants where a certain amount of whey is discharged, the pH of the effluent is reduced to below 6.2. In cheese manufacturing, sweet whey is slightly acidic, with pH=5.9–6.6, while mineral acid coagulation gives an acidic whey with pH=4.3–4.6. Although dairy wastewaters have low concentrations of settleable solids, they may clog sewage pipes. Most of the suspension enters the initial stage of equipment cleaning. The bulk sediment (90%) of organic matter is usually of protein origin, namely particles of solid milk processing (pieces of cheese, coagulated milk, cheese, curd fines, milk film or flavouring agents, *etc*.) and other impurities (soil or sand) that get into the sewage system during equipment washing or packaging. Formation of protein and fat deposits on the inside of the pipes requires periodic cleaning with appropriate chemical or bacterial preparations. The main advantage in the application of such bacteria is that they continue acting in the next stages of wastewater treatment, increasing the purification effect. The highest amount of total solids (TS) has been reported in whey, with negligible amount of volatiles.

S.NO	Details	Value
1	PH	5.5-9.0
2	Total solids	Not to exceed 2200 mg/l
3	Total dissolved solids	Not to exceed 2100 mg/l
4	Suspended Solids	Not to exceed 100 mg/l
5	Total Chlorides	Not to exceed 600 mg/l
6	Sulfates	Not to exceed 250 mg/l
7	Chemical Oxygen Demand	Not to exceed 250 mg/l
8	Biological Oxygen demand	Not to exceed 30 mg/l
9	Oil	Not to exceed 10 mg/l
10	Grease	Not to exceed 10 mg/l

Table: Standards Norms of Pollution Control Board for Milk Dairy Effluents.

2.2.2 Treatment of wastewater by adsorption concept

Adsorption is a surface phenomenon and is defined as the increase in concentration of a particular component at the surface or interface between two phases. Compound (pollutant) that sticks or adheres to the solid surface is called an adsorbate and the solid surface is known as an adsorbent. Adsorption is affected by temperature, the nature of the adsorbate and adsorbent, the presence of other pollutants and atmospheric experimental conditions (pH, concentration of pollutants, and contact time and particle size of the adsorbent). The presence of suspended particles, oils and greases reduces the efficiency of the process and, therefore, pre-filtration is sometimes required. At this stage, the concentrations of pollutants adsorbed and in the water become constant. The relationship, at a given temperature, between the equilibrium amounts of pollutant adsorbed and in the water is called an adsorption isotherm. Development and optimization of adsorption parameters can be carried out by batch and column processes in the laboratory. The adsorption technology is then applied at industrial scales by using large columns.

2.3 Properties of banana and orange peel

Banana peels can remove wide variety of contaminants from waste water like oil spills, biological waste, carcinogenic elements, heavy metals and various dyes in water from textile and other sources.

- Both banana and orange peels are low cost and cheap, environment friendly bio-material.
- Banana peels have good antioxidant potential and can be used for water purification, for the removal of many toxic metals like copper, lead, cadmium, chromium and Nano-particles etc.
- This banana peel based bio sorbent was evaluated for adsorptive removal of copper from water and its desorption capability

Mashed up Banana peel can remove heavy metals

Heavy metals in water are generally positively charged acid ions and Banana peels, evidently, are rich in negatively charged molecules, so they attract the heavy and positively charged metal pollutants in water. The two compounds are drawn towards each other just like with a magnet

Banana peels contain nitrogen, sulfur, and carboxylic acids; the acids are responsible for the peel's ability to bind the toxic metals and remove them from the water. Because of the high number of these acids in the peels Specifically, banana peels contain nitrogen, carboxylic acid, carbohydrate, fiber, potassium, manganese, iron, sodium. Traces of polyphenols, ether extractives and that function pretty much the same way magnets do in terms of attracting heavy metal. Orange peel has good adsorption capacities and require little treatment.

Not only can fruit peels remove the contaminants, but they can do it just as well, and in some cases better, than more expensive technological options and it's easy. Without any technical preparation, dried banana and orange peels successfully remove metals.

2.4 Fruit peel as adsorbents

The use of raw FPW as an adsorbent can give rise to problems such as (1) low adsorption capacity, (2) high COD, (3)high BOD, and (4) high total organic carbon (TOC) due to leaching of soluble organic compounds present in the FPW.

The increase of COD, BOD, and TOC leads to hyper trophication. So, FPW needs to be treated or modified before use. The treatment of FPW can alter its physical and chemical properties, along with its adsorption capacity. Different physical, chemical, and other treatment or modification methods are listed in the literature.

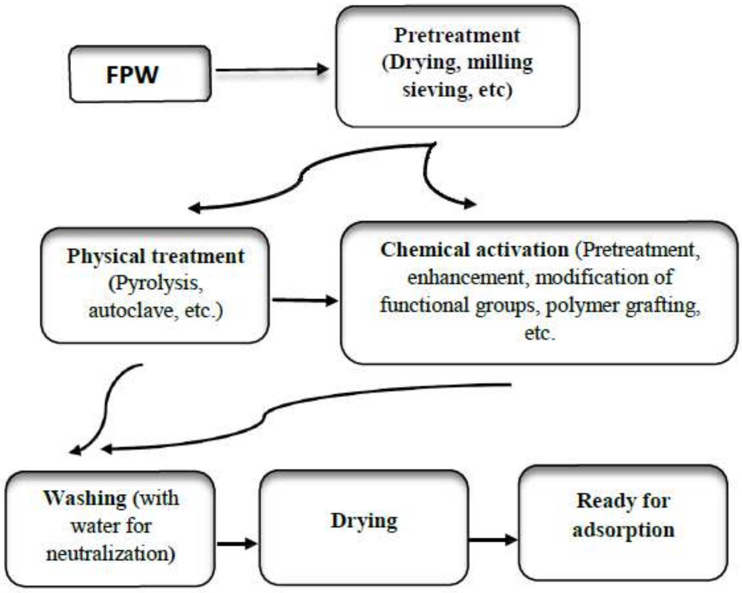


Figure 4.1 Schematic diagram for processing different types of native FPW

After the collection of fruit waste, the waste was separated and peels were collected of required fruit waste after the separation, fruit peels were washed several times to remove dirt and other impurities, then dried for 24 hours into oven at a temperature of 105˚C to remove the moisture content.

2.5 Experimental procedure to use orange peel and banana peel as adsorbent

PROCEDURE:

1. **Conversion of waste materials into inexpensive adsorbents**
   - Collect selected waste material and sieve to remove other particles such as stone, soil, paper etc. Wash with ddH2O and dry in an oven at 100 1C for about 2 h
   - Carbonize organic precursors by heating to 400–800 1C for 5–24 h
   - Treat with hydrogen peroxide at 60 1C for 24 h to remove adhered organic matter
   - Wash with ddH2O three times to remove hydrogen peroxide and dry in an oven at 100 1C for B2
   - Heat to 500 1C in a furnace for 6–12 h to activate the adsorbent.
   - Determine density, porosity and ignition loss by the usual methods.
   - Establish the stability of the adsorbent by suspending in ddH2O, HCl and NaOH (0.1 to 1.0 M) for about 1–2 h.
   - Establish mineral and crystal structure by X-ray diffractometry and SEM, usingCarry out elemental analysis by chemical methods, as described.
   - Collect adsorbent of different particle sizes by sieving and keep in a vacuum desiccator.

International Journal of Science Technology and Management
Volume No.10, Issue No. 03, March 2021
www.ijstm.com
ISSN 2394 - 1537

2. **Batch experiments**

- Use a 250-ml Erlenmeyer flask to carry out batch experiments in a thermostatic shaking water bath. Take 100 ml of the dairy wastewater of COD, BOD and pH determined and add a dose of adsorbent. The different doses (5 g, 10 g, 15 g, 20g) of adsorbents taken for analysis. However, a suggested starting point is 0.5 g. Solution pH was adjusted with HCl or NaOH (0.1 N). pH had been measured by following electrometric method using a digital pH meter.
- Agitate at a constant speed of 150 rpm in flask mechanically in a water bath at desired temperature.
- Normally temperature is fixed between 25 and 35 ^{0}C for 1–3 h.
- Centrifuge or filter the mixture and determine the concentration of pollutant in the aqueous phase.
- Calculate the amount of pollutant adsorbed from the aqueous solution by determining the equilibrium concentration in solution.

3 Column experiments

Design a column of pyrex glass on a laboratory scale of about 50 2 cm size. Attach a manometer on the right-hand side by using two pressure points to monitor the introduction of air into the column.

Fix 250-B.S.S. (British standard size) mesh wire gauges at the pressure points to prevent entry of the adsorbent particles into these points.

Cover the upper end of the column with a tube connection to remove any air bubbles.

Attach the upper end to a head tank from which the flow of contaminated water is regulated.

Control the flow of contaminated water by a stopper point at the lower end of the column. Fix supporting medium (glass wool) at the lower end of the column by hydraulic filling. Weigh out adsorbent material and make a slurry in ddH2O. Use slurry within 24h.

Fill the column and stir using a glass rod, then leave undisturbed overnight to settle.

Load contaminated water on top of the column and adjust the flow rate to achieve maximum uptake of pollutants and use the column up to its saturation point.

Regenerate the column for recycling of adsorbents by using acid or base or buffers or organic solvents depending on the type of pollutants adsorbed on the adsorbent or decide on the management methods for used adsorbent.

Calculate the amount of pollutant adsorbed on the adsorbent and determine the capacity of the column by drawing a breakthrough capacity curve.

Design and fabricate pilot and industrial scale columns for treatment of contaminated water at larger scale.

- TIMING Preparation of adsorbents (Steps 1–11): 4–5 d
- Batch experiments (Steps 12–16): 1–2d
- Column experiments (Steps 23–34):1-2d

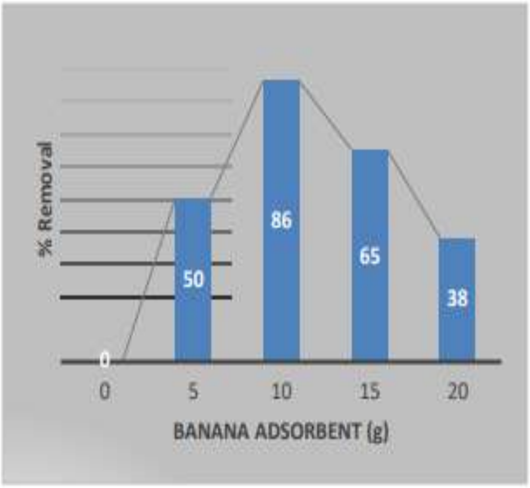
International Journal of Science Technology and Management
Volume No.10, Issue No. 03, March 2021
www.ijstm.com
ISSN 2394 - 1537

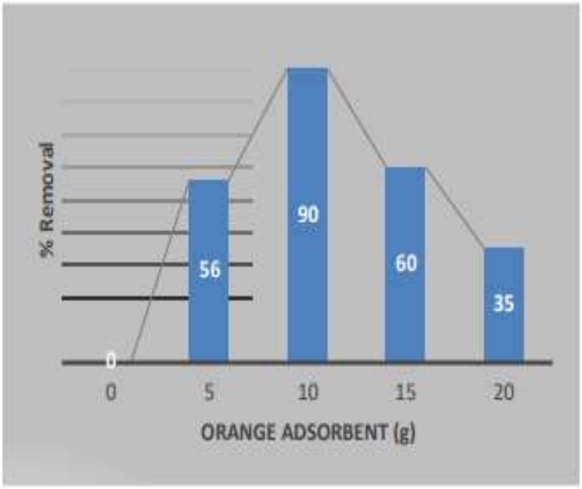
2.6 Experimental results

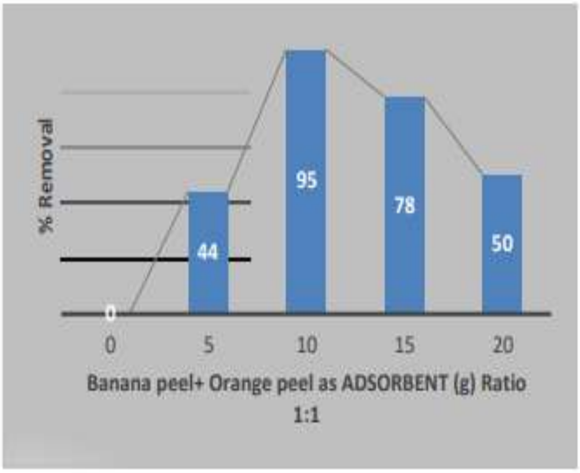
2.6.1 Removal of turbidity concentration using banana and orange adsorbent with various dosages

Turbidity is the cloudiness or dirtiness of water. This parameter was analyzed by turbid meter equipment. The turbidity removal was observed by using various dosages of banana powder as adsorbent.

The maximum removal efficiency was observed at 1 g of dosage. The removal percentage of turbidity at 1g of banana adsorbent is 86%, the removal percentage of turbidity from orange adsorbent is 90% and the highest 95% was achieved when both orange peel and banana peel was take in equal ratio.



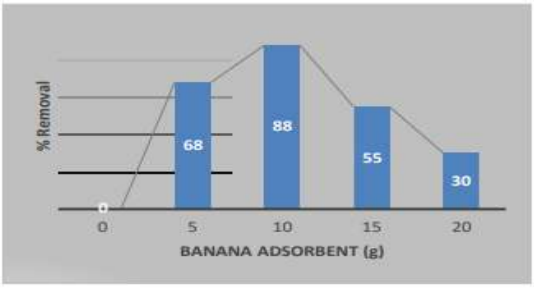


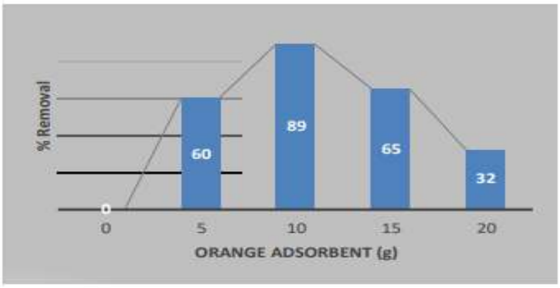


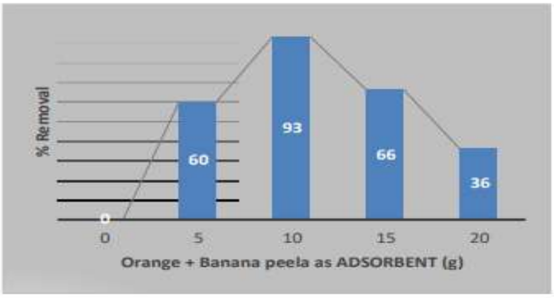
2.6.2 Removal of total suspended solids concentration using banana and orange peel with various dosage

Total Suspended Solids are those particles present in wastewater which are not filterable. The maximum removal of TSS is at 1 g of each adsorbent. From banana adsorbent, the removal of TSS is 88%, from orange adsorbent the removal of TSS is 89% and the highest 93% was achieved when both orange peel and banana peel was take in equal ratio

International Journal of Science Technology and Management
Volume No.10, Issue No. 03, March 2021
www.ijstm.com
ISSN 2394 - 1537



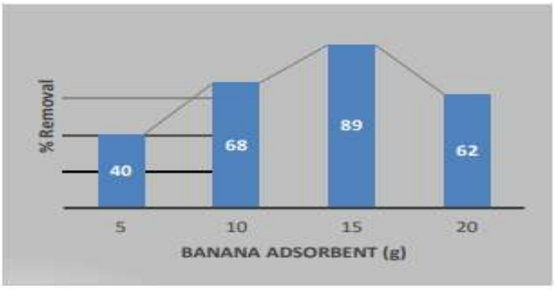


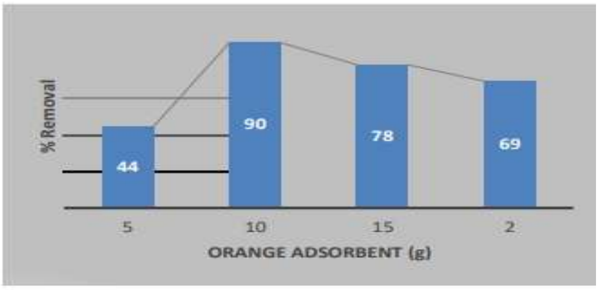


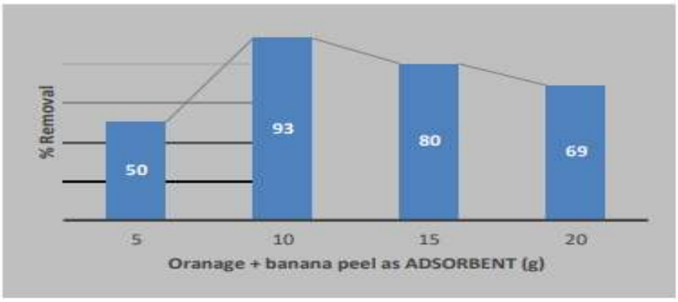
2.6.3 Removal of biochemical oxygen demand (bod) concentration using banana and orange peels with various dosage

Biochemical Oxygen Demand is the amount of oxygen required to microorganisms to decompose the organic matter. The average maximum removal of BOD was at 1.5 g of each adsorbent, but not in orange adsorbent. The removal percentage of Biochemical Oxygen Demand by using Orange powder as an adsorbent in dairy wastewater.

An orange adsorbent the maximum removal efficiency is obtained at 1 g dosage which is shown in following figure. From banana adsorbent the removal of BOD was 89%, from orange adsorbent the removal of BOD was 90% and the highest 95% was achieved when both orange peel and banana peel was take in equal ratio.



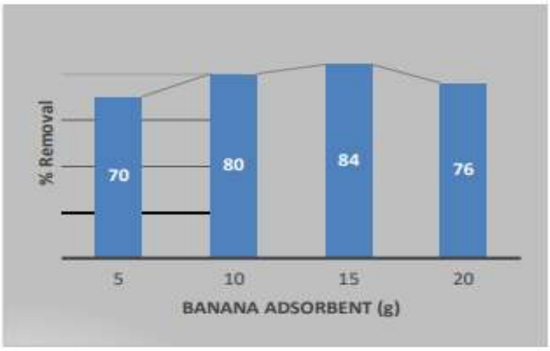


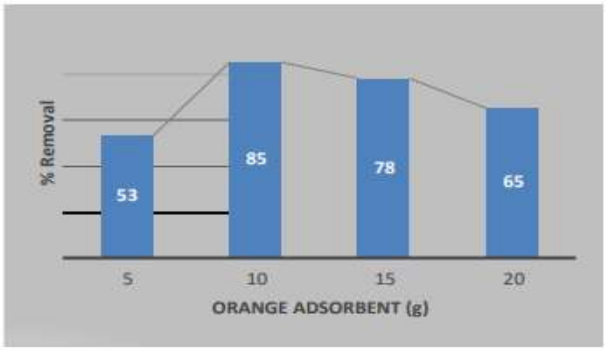


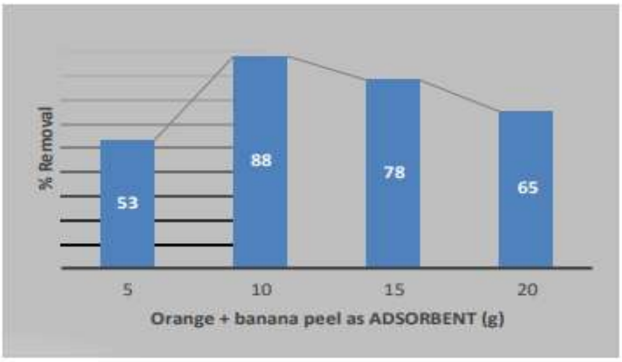
ISSN 2394 - 1537

2.6.4 Removal of chemical oxygen demand (cod) concentration using banana and orange peels with various dosage

Chemical Oxygen Demand is the amount of oxygen consumed by organic matter in a solution. The average maximum removal of COD was at 1.5 g of each adsorbent, but not in orange adsorbent. From banana adsorbent the maximum removal of COD was 84%, from orange adsorbent the maximum removal of COD was 85% and the highest 87% was achieved when both orange peel and banana peel was take in equal ratio.







2.7 Comparison of Result

Constituents	Dosage	Banana Peel	Orange peel	Banana + orange peel
Turbidity	5	50	56	44
	10	86	90	95
	15	65	60	78
	20	38	35	50
TSS	5	68	60	60
	10	88	89	95
	15	55	65	66
	20	30	32	36
BOD	5	40	44	55
	10	68	90	93
	15	89	78	80
	20	62	69	69
COD	5	70	53	53
	10	81	85	88
	15	84	78	79
	20	76	65	66

International Journal of Science Technology and Management
Volume No.10, Issue No. 03, March 2021
www.ijstm.com
ISSN 2394 - 1537

CONCLUSION

As discussed above, adsorption is an effective, efficient and universal method of water treatment providing risk-free treated water as per the guidelines of WHO and EPA. This technology has been used for water treatment by developing low-cost alternatives to activated carbon. By comparison and computation of the adsorbents, based on the performance, adsorption capabilities and cost, it was found that the most important and feasible adsorbents are orange peel and banana peel, have good adsorption capacities and require little treatment. Owing to the presence of many pollutants in our water resources, widely applicable adsorbents need to be developed that can adsorb organic and inorganic pollutants. As noted above, most researchers deal with the batch process only and, hence, there is a great need to design and develop columns for water purification and recycling purposes on a large scale.

Adsorption using FPW is a new process that has shown good promise for the removal of different organic and inorganic contaminants from aqueous effluents. In this article, FPW as an adsorbent for different organic and inorganic contaminants has been reviewed. The use of bio sorbents like FPW is suggested since they are relatively cheap and easily available, can be easily modified, and show good adsorption capacity for wide number of pollutants. Different surface modification methods as employed by researchers are useful for enhancement of adsorption capacity. This review article focuses on use of FPW in batch adsorption study, which provides basic data to design an adsorption column for industrial applications. And it is found that the combination of banana and orange peel gives highest result when compared to the result given by the adsorbents individually.

REFERENCES

[1] Carvalho F, Prazeres AR, Rivas J. Cheese whey wastewater: Characterization and treatment. Sci Tot Env. 2013;445-446:385–96

[2] Sabino De Gisi , GiusyLofrano , MariangelaGrassi"charecteristics and adsorption capacities of low- cost sorbents for wastewater treatment:A Review"2016

[3] Schifrin SM, Ivanov GV, Mishukov BG, Feodanov YuA. Wastewaters from dairy industry. In: Arkhangelskaya EP, editor. Wastewater treatment of meat and dairy industry. (pp. 11-19). Light and Food industry, Moscow; 1981. pp. 11–19 (in Russian)

[4] FAO Corporate Document Repository, n.d. Management of waste from animal product processing. [Online].Available from: http://www.fao.org/wairdocs/lead/x6114e/x6114e03.htm. [Accessed:31st May 2014]. [5] Kanawade, S.M. &Gaikwad, R.W., International Journal of Chemical Engineering and Applications.,2011, 2(3):202 – 206

6]Velmurugan, P., Rathina Kumar, V. &Dhinakaran, G., International journal of environmental sciences.,2011, 7(1):1492-1496.

[7]Banu JR, Anandan S, Kaliappan S, Yeom I-T. Two-stage anaerobic treatment of dairy wastewater using HUASB with PUF and PVC carrier. Biotech Bioproc Eng. 2007;12:257–64

[8]Omil F, Garrido JM, Arrojo B, Méndez R. Anaerobic filter reactor performance for the treatment of complex dairy wastewater at industrial scale. Water Res. 2003;37(17):4099–108

[9]Okigbo L, Richardson G, Brown R, Ernstrom C. Interactions of calcium, pH, temperature and chymosin during milk coagulation. Offic J Am Dairy Sci Assoc.1985;68:3135-42

[10] Doble M, Kumar A. Treatment of waste from food and dairy industries. In: Biotreatment of industrial effluents. Elsevier Butterworth-Heinemann, Burlington. ISBN: 0-7506-7838-0; 2005. pp. 183–5

[11]Dyrset N, Selmer-Olsen E, Havrevoll Ø, Rathaweera H, Storrø I, Birkeland S-E. Feed supplement recovered from dairy wastewater by biological and chemical pretreatment. J Chem Techn and Biotechn.1998;73(3):175-82

[12] Demirel B, Yenigun O, Onay TT (2005). Anaerobic treatment of dairy wastewaters: a review. Proc Biochem. 2005;40:2583–95.