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Treatment of Synthetic Greywater by Using Banana, Orange and Sapodilla Peels as a Low Cost Activated Carbon

Muhammad Yousuf Jat Baloch [1]* & Sajid Hussain Mangi [2]

[1] *School of Environmental Studies, China University of Geosciences Wuhan, Hubei Province, 430074, P.R. China*
[2] *Institute of Environmental Engineering and Management, Mehran University of Engineering & Technology, Jamshoro, Sindh, Pakistan*

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** Corresponding Author*
Muhammad Yousuf Jat Baloch
engr.yousuf@yahoo.com
Phone: +8615623282576;

Abstract

Adsorption technology is accepted worldwide because of its application in environmental engineering. Different fruit peels were used as activated carbon for the treatment of synthetic greywater. The activated carbon was prepared from the peels of banana, orange and sapodilla. The fruit peels were collected from the three juice shops and fifteen houses of Qasimabad Hyderabad. Based on one-month data, the fruit waste generation was calculated per day, per week and month. The treatment of synthetic greywater using fruit peels as an adsorbent and the treatment efficiency of orange peels adsorbent, banana peels adsorbent, and sapodilla peels adsorbent were observed. The peels were first segregated and washed several times to remove dirt, and other impurities then dried in an oven at a temperature of 105˚C for 24 hours to remove the moisture content. The synthetic greywater was prepared by different constituents to check its physicochemical parameters. The activated carbon agent phosphoric acid was used to prepare activated carbon then it was used as a coagulant for the removal of different impurities present in synthetic greywater. An effort has been made to give a brief idea of an approach to wastewater treatment, particularly discussing and highlighting, in brief, the low-cost alternative adsorbents to utilize these waste/low-cost materials.

1. Introduction

Water is the basic need for survival of human beings. The scarcity of fresh water is increasing day by day. Fruit wastes (like Banana, Orange, etc.) are agricultural waste which is discarded as a waste material in all over the world [1]. The grey water is the waste water that is generated in the offices buildings, household and from streams without fecal contamination. Greywater also called as sullage and it contains lesser pathogens as compared to domestic wastewater. Water from sinks, laundry showers, baths, washing machine and kitchen are the sources of greywater. It is generally easier to treat, safer to handle and reuse onsite for landscape or crop irrigation. The reuse of greywater also reduces the demand for fresh water supply. Water pollution is a global problem and its control has become increasingly important in recent years [2]. Greywater treatment and reuse is becoming a significant field of research in a worldwide context of increasing water shortage. Dissolved pollutants (organic and inorganic) of water can be removed through an effective adsorption technique. Activated carbon (AC) is very familiar with all types of adsorbents due to high adsorption capacity. The adsorption frequency of activated charcoal relates to its great surface area, high pores distribution, and rapid grade of external reactivity [3]. Activated carbons are mostly extracted from raw materials in an environment through carbonization and followed by the activation process of the charcoal material. The activation process can be carried out by chemical or physical activation [4]. Activated carbon technology treats mostly the organic pollutants like VOCs etc. The US Environmental Protection Agency cited the activated carbon adsorption as one of the best control technologies available.[5] The wastewater consists of different types of waste like organic substances (Proteins, carbohydrates and lipids), total solids, nitrates, metals, etc. [6]. There are many technologies to treat the water, bio-adsorption technique is also one of them. Wastewater treatment plants concerning cost involvement and these plants have also problems related to disposal [7]. To overcome this issue fruit waste is used as an adsorbent for the treatment of wastewater. Adsorption is that type of technique which is the most economic and efficient and does not require any type of energy for the treatment of wastewater; this technology is environment-friendly[8]. Various agro-wastes and fruit waste are used as adsorbents for the treatment of water, such as banana peel [9,10], orange peel [11], pomegranate [12], caulerpa lentillifera [13,14] Corn Cob [15-17] and agricultural wastes [18-20]. As fruit waste is easy to available and biodegradable material, which may cause leachate when it is discarded in an open atmosphere. Adsorption is the process in which matter is extracted from one phase and concentrated at the surface of a second phase [21]. Nowadays, the population of Pakistan burgeoning day by day and industries have also been increased, which has caused a severe problem regarding the availability of fresh water in the country [22]. Various researchers have conducted studies on drinking water quality throughout the different regions of Pakistan. In, Pakistan, 20% population have access to safe drinking water [22], which is an alarming situation for the future generation that's why it was decided to treat the wastewater using such technology which should be economical, cost effective and efficient for the removal of physicochemical parameters of greywater. The scope of this research is to compare the treatment efficiency of different fruit peels used as an adsorbent for the treatment of domestic greywater. As fruit waste is dumped openly in our country which may cause leachate and leachate will degrade our earth. The lab study on the treatment of domestic greywater from fruit peels will give the idea for the treatment of domestic wastewater at large scale.

2 Materials & Methods

2.1 Preparation of Domestic Greywater

Greywater is a type of wastewater used for various activities like washing purpose, kitchen, and showers etc. excluding excreta arise from toilets. Hair's traces food constituents, household products and dirt can be observed in the composition of greywater. It may even appear unclean, but at the same time in some cases, it can be valuable for plants. The availability of nutritious elements in greywater released from homes are the basic cause of pollution, and these nutritious elements can be a productive fertilizer for plants [23]. In this study, the synthetic greywater was prepared from components usually present in greywater. The constituents including 85 mg/L of dextrin, 75 mg/L of ammonium chloride, 70 mg/L of yeast extract, 55 mg/L of soluble starch, 30 mg/L of washing powder, 11.5 mg/L of sodium dihydrogen phosphate, 4.5 mg/L of Potassium sulphate, 10 ml/L of settled sewage and 0.1 ml/L of shampoo and oil as shown in Table 1. The domestic greywater recipe was prepared by the following constituents [24]

Table 1 Synthetic wastewater preparation recipe

SR#	Substances	Concentration mg/L & ml/L	Formula
01	Dextrin	85mg/L	$(C_6H_{10}O_5)n$
02	Ammonium Chloride	75mg/L	NH_4Cl
03	Yeast Extract	70mg/L	N-A
04	Soluble Starch	55mg/L	$C_{12}H_{12}O_{11}$
05	Sodium Carbonate	55mg/L	Na_2CO_3
06	Washing powder	30mg/L	N-A
07	Sodium di-hydrogen phosphate	11.5mg/L	NaH_2PO_4
08	Potassium sulphate	4.5mg/L	K_2SO_4
09	Settled Sewage	10ml/L	N-A
10	Shampoo	0.1ml/L	N-A
11	Waste Cooking oil	0.1ml/L	N-A

2.2 Preparation of Adsorbent

Mixed fruit waste was collected from 15 houses and three juice shops of Qasimabad Hyderabad as shown in figure 1. 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.

Banana peels Orange peels Sapodilla peels

Figure 1: Fruit waste was collected from houses and juice shops

2.3 Making of activated carbon from Fruit peels (Carbonization process)

Carbonization with Phosphoric Acid H_3PO_4:

The material was soaked in 30% solution of phosphoric acid for 24 hours. After saturation, the liquid portion was drawn off and then dried. The dried mass was subjected to carbonization process at 400˚C, powdered well and finally activated at 800˚C for 10 minutes [8]. After the processes of de-hydration and carbonization fruit peels were grinded into electric grinder to make it into powder form which was called as adsorbent. Figure 2 shows, the complete process of preparation of adsorbent from the fruit peels.

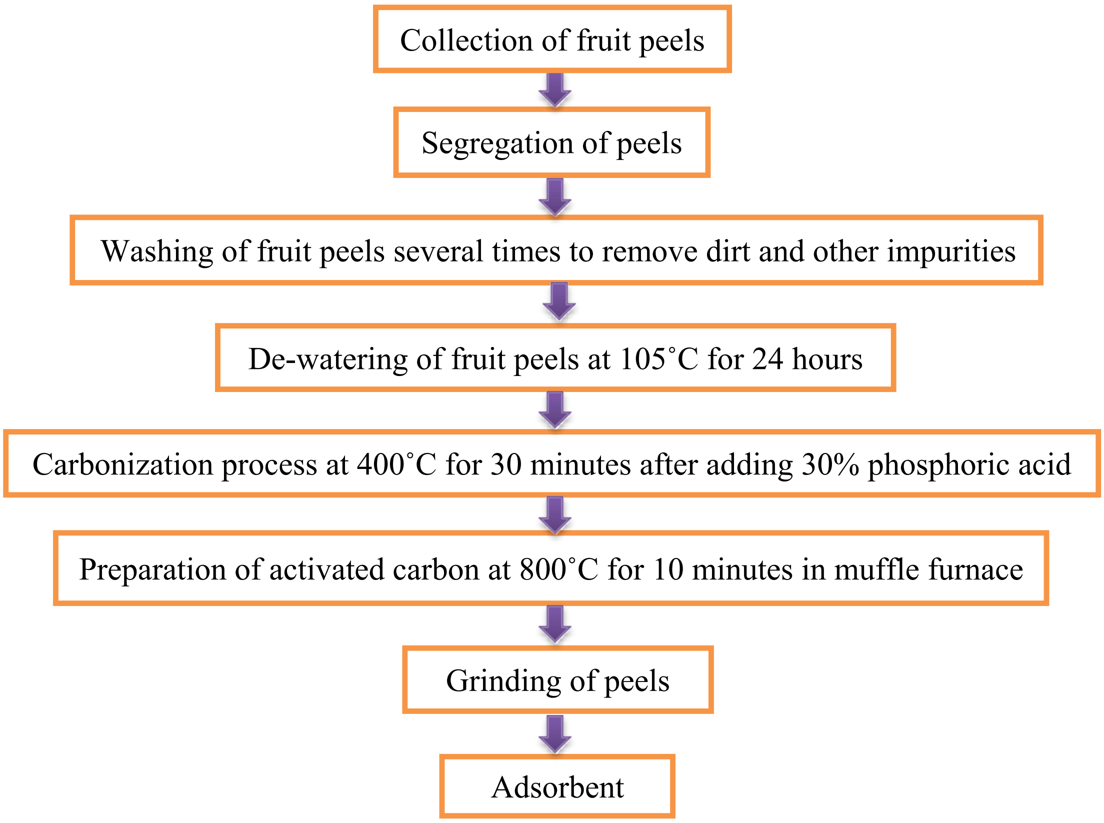

Figure 2: Complete process of preparation of adsorbent from the fruit peels

2.4 Batch Adsorption Experiment

This experimental work was carried out in the batch study, in which different samples were taken in conical flasks to measure the adsorption capacity of the adsorbent. 100 ml samples of domestic greywater were taken with 1.0g of banana, orange and sapodilla adsorbents [25] and were shacked at 180 rpm in mechanical shaker at different the stirring times (i.e. contact time) from 30 min, 1 h, 2 h, 4 h, 6 h. After shaking, the samples were filtered with Whatman filter paper No.42 to separate the adsorbent and water sample; then the sample was stored to analyze the different physio-chemical parameters before and after the adsorbent used. [21].

2.5 Adsorbent Dosages

The study was carried out at different dosages of fruit peels adsorbent to get the maximum removal efficiency of physicochemical parameters removal which were present in domestic greywater. The dosage of banana, orange and sapodilla peels in this study different dosage were taken 0.5, 1, 1.5 and 2g in four sets of the 100ml conical flask and these flasks were shaken for 1 hour with 180 rpm at a 25^{o}C temperature [25].

2.6 Laboratory Analysis

Different physicochemical parameters of domestic greywater were analyzed. Turbidity were analyzed by nephloturbidimeter method, Total Suspended Solids were analyzed by DR 2000 Spectrophotometer Method, Chemical Oxygen Demand were analyzed by APHA 5220 D (Closed Reflux, Colorimetric Method), Biochemical Oxygen Demand were analyzed by US-EPA 5210 B (5 days BOD Method), lead and chromium were analyzed by Atomic Absorption Spectrophotometer (AAS). Physicochemical parameters with their equipment name and method as shown in table 2.

Table 2 Physicochemical parameters of domestic greywater

S.R#	Parameter	Standard Method
01	Turbidity	Nephloturbidimeter Method
02	Total Suspended Solids	DR 2000 Spectrophotometer Method
03	Chemical Oxygen Demand	APHA 5220 D (Closed Reflux, Colorimetric Method)
04	Biochemical Oxygen Demand	US-EPA 5210 B (5 days BOD Method)
05	Lead	Atomic Absorption Spectrophotometer (AAS)
06	Chromium	Atomic Absorption Spectrophotometer (AAS)

Turbidity

Turbidity is the physical parameter of water quality and it is the cloudiness or dirtiness of water which is caused by fine suspended solid particles like silt, clay organic and inorganic matter etc. These fine solid particles are invisible to our naked eyes. This parameter of water is measured by nephloturbidimeter method. Turbidity is measured in Nephlo Turbidity Unit (NTU), according to NEQS the standard value of turbidity in drinking water must not be exceeded to 5 NTU. It is used to measure the presence of turbidity in domestic greywater. The main purpose of this parameter to analyze in water is to stop the growing of different micro-organisms which grow due to the turbid water. The turbid water effects not only on human health but also effects aquatic life like fish, plankton, zooplankton, etc.

Total Suspended Solids

The suspended particles are those particles which may not pass through filter paper. TSS is also called as conventional pollution according to US EPA clean water act. (Source: wikipedia.org). According to SEQS, the wastewater can be used as effluent if it has TSS up to 200 mg/L. TSS can be analyzed by two methods, one is the gravimetric method, and the other one is a colorimetric method. In this research work, TSS were analyzed through

Colorimetric (DR 2000 Spectrophotometer) method. TSS may include a wide variety of silt, clay, animal decaying and industrial waste which may cause serious problem for aquatic life and water streams.

Chemical Oxygen Demand

The Chemical Oxygen Demand (COD) is the amount of oxygen consumed by organic matter in a solution. In this research work, the closed reflux / colorimetric method was used to determine the amount of COD in domestic greywater before and after adsorbent. According to SEQS, the COD of effluent must be less than 150 mg/L. In closed reflux / colorimetric method, first of all, sample is digested through COD digester at 150°C for a time duration of 2 hours and cool it at room temperature and analyze the COD of the sample through COD photometer.

Biochemical Oxygen Demand

The Biochemical Oxygen Demand is the amount of oxygen required to microorganisms for the decomposition of organic matter present in wastewater. In this research work, the BOD was analyzed by 5 – days BOD method. According to SEQS the BOD of effluent must be less than 80 mg/L.

Lead

Lead is the heavy metal which is generally present in wastewater. The main sources of lead into wastewater are lead-acid batteries, ceramics and leather industries. The standard method of lead analysis is Atomic Absorption Spectrophotometer method. According to SEQS, the lead of effluent must be less than 0.5 ppm.

Chromium

Chromium is also a type of brittle, hard metal. The major source of chromium is ores of chromite. The chromium is also called as carcinogenic heavy metal [26]. According to SEQS, the chromium of effluent must be less than 0.1 ppm.

3. Results & Discussion

3.1 Fruit Waste Generation in Qasimabad Hyderabad

A survey was conducted in Qasimabad to check generation of fruit waste. In this survey 3 juice shops and 15 houses with three categories like upper class, middle class and lower class houses. From fruit juice shops, the data was collected seven days continuously, and it was calculated per day and per week.

Fruit Juice Center Qasimabad

Fruit waste generation data from fruit juice center was collected in seven days, and the total fruit waste was also calculated with each type of waste. Table No. 3 shows the total fruit waste generation Apple which 14.6 Kg/week, Banana waste 107.13 Kg/week, 71.1Kg / week and sapodilla waste 10.44 Kg/week. The average weight of Apple waste generation per day will be equal to 2.087 Kg, The average weight of Banana waste generation per day was equal to 15.30 Kg, the average weight of Orange waste generation per day was equal to 10.15 Kg and the average weight of sapodilla waste generation per day was equal to 1.49 Kg. While the average weight of Fruit waste generation of shop per day was equal to 29.027 Kg.

Table 3: Fruit waste generation of fruit juice center

Name of Fruit	Units	Day 1	Day 2	Day 3	Day4	Day 5	Day 6	Day 7	Total weight
Apple	Kg	3.2	1.7	0.6	0.7	2.3	3.7	2.4	14.6
Banana	Kg	17.4	15.8	12.5	14.23	15.4	19.5	12.3	107.13
Orange	Kg	10.4	11	13.1	5.8	12.4	8.8	9.6	71.1
Sapodilla	Kg	1.75	2.25	1	0.65	1.57	1.35	1.87	10.44

Al – Shahbaz Juice Center Qasimabad Hyderabad

From this fruit juice shop, the data of fruit waste generation were collected for seven days. As shown in table no. 4 the generation of total fruit waste of apple was 9.9 Kg, banana waste was 37 Kg, orange waste 28.3 Kg and sapodilla waste was 5.26 Kg.

Table 4 Fruit waste generation of Al - Shahbaz juice center

Name of Fruit	Units	Day 1	Day 2	Day 3	Day4	Day 5	Day 6	Day 7	Total weight
Apple	Kg	0.8	1.1	0.9	1.5	2.3	1.7	1.6	9.9
Banana	Kg	2.3	7.8	5.3	2.7	5.4	6.2	7.3	37
Orange	Kg	6.1	2.1	3.3	6.1	5.1	3.4	2.2	28.3
Sapodilla	Kg	0.56	1.1	1.24	0.87	0.5	0.32	0.67	5.26

The average fruit waste of Al – Shahbaz juice center per day was estimated 11.48 kg/day. The average weight of Apple waste generation per day was equal to 1.41 Kg, the average weight of Banana waste generation per day was equal to 5.28 Kg, the average weight of Orange waste generation per day was equal to 4.04 Kg and the average weight of sapodilla waste generation per day was equal to 0.75 Kg.

Masha Allah Fruit Juice Center Qasimabad Hyderabad

Table No. 5 shows the data of fruit waste generation from Masha Allah fruit juice center Qasimabad.

Table 5: Fruit waste generation of Masha Allah juice center

Name of Fruit	Units	Day 1	Day 2	Day 3	Day4	Day 5	Day 6	Day 7	Total weight
Apple	Kg	4.3	3.2	1.1	1.2	2.5	3.8	2.7	18.8
Banana	Kg	8	8.89	9.01	5.5	10.2	7.75	7.32	56.67
Orange	Kg	3.41	6.89	6.91	3.31	10	9.75	7.68	47.95
sapodilla	Kg	1.68	2.2	1.32	0.89	1.10	0.34	0.46	7.99

The average weight of Apple waste generation per day was equal to 2.68 Kg, the average weight of Banana waste generation per day was equal to 8.09 Kg, the average weight of Orange waste generation per day was equal to 6.85 Kg and the average weight of sapodilla waste generation per day was equal to 1.14 Kg while the average weight of Fruit waste generation of shop per day was equal to 18.76 Kg.

Fruit waste generation of upper-class houses

The generation of fruit waste data was collected four weeks continuously. The waste was collected at every last day of the week and then was segregated and measured the amount of different type of waste. Table No. 6 to 9 shows the data of fruit waste generation in four weeks. Table no. 10 shows the fruit waste generation of a house per day, per week and month.

Table 6: Fruit waste generation of upper class houses 1st week

House No.	Units	Orange	Grey fruit	Pomegranate	Apple	Sapodilla	Papaya	Banana	Total weight
01	Kg	0.5	0.35	0.7	0.4	0.2	0.15	0.7	3
02	Kg	0.3	-	0.4	0.2	0.1	0.6	0.4	2
03	Kg	0.4	0.2	-	-	0.4	0.3	0.8	2.1
04	Kg	0.2		0.1	-	0.3	0.2	0.2	1
05	Kg	0.6	0.4	0.6	-	0.4	-	0.9	2.9

Table 7: Fruit waste generation of upper class houses 2nd week

House No.	Units	Orange	Grey fruit	Pomegranate	Apple	Sapodilla	Papaya	Banana	Total weight
01	Kg	0.3	-	-	0.1	0.3	0.3	0.3	1
02	Kg	0.4	0.3	0.4	-	0.2	0.15	0.2	1.75
03	Kg	0.2	0.2	0.3	-	0.25	-	-	1.15
04	Kg	0.4	-	0.25	0.2	-	0.4	0.1	1.25
05	Kg	0.6	0.4	0.4	-	0.1	-	-	1.6

Table 8: Fruit waste generation of upper class houses 3rd week

House No.	Units	Orange	Grey fruit	Pomegranate	Apple	Sapodilla	Papaya	Banana	Total weight
01	Kg	0.4	-	0.45	-	0.1	-	0.5	1.45
02	Kg	0.5	0.7	0.6	0.2	0.4	-	0.4	2.8
03	Kg	-	0.6	0.4	0.15	0.15	0.35	-	1.65
04	Kg	0.4	-	-	0.1	-	0.2	0.3	1.0
05	Kg	0.4	0.6	0.4	-	200	0.45	0.5	2.55

Table 9: Fruit waste generation of upper class houses 4th week

House No.	Units	Orange	Grey fruit	Pomegranate	Apple	Sapodilla	Papaya	Banana	Total weight
01	Kg	0.35	0.2	0.6	0.4	0.35	0.1	0.6	0.26
02	Kg	0.25	0.1	0.25	0.1	0.2	0.45	0.4	1.75
03	Kg	0.6	0.1	0.6	-	0.4	0.4	0.9	3.0
04	Kg	0.2	-	0.1	0.15	0.3	0.2	0.55	1.5
05	Kg	0.4	0.2	0.4	0.1	0.1	-	0.4	1.6

Table 10: Fruit waste generation of each house in per day, per week and month

House No.	Average Fruit waste generation per day (Kg)	Average Fruit waste generation per week (Kg)	Average Fruit waste generation per month (Kg)
01	0.190	1.430	5.71
02	0.277	2.075	8.3
03	0.263	1.975	7.9
04	0.158	1.188	4.75
05	0.288	2.163	8.65

Fruit waste generation of middle-class houses

The same practice was repeated in middle-class houses at the beginning of the week the plastic shoppers were handed over to each house and last day of week fruit waste collected from the houses and segregated and then measured each type of fruit waste. Table no. 11 to 13 shows the generation of fruit waste of each house in kilograms.

Table 11: Fruit waste generation of middle class houses 1st week

House No.	Units	Orange	Pomegranate	Apple	Sapodilla	Banana	Total weight
01	Kg	0.4	-	-	0.1	0.5	1
02	Kg	0.3	0.2	-	0.1	0.4	1
03	Kg	0.1	0.2	0.1	0.2	0.2	0.8
04	Kg	0.15	0.1	0.1	0.1	0.25	0.7
05	Kg	0.1	-	-	0.15	0.25	0.5

Table 12: Fruit waste generation of middle class houses 2nd week

House No.	Units	Orange	Pomegranate	Apple	Sapodilla	Banana	Total weight
01	Kg	0.35	0.2	0.15	0.2	0.5	1.4
02	Kg	0.17	-	-	0.15	0.18	0.5
03	Kg	0.2	-	-	0.1	0.3	0.6
04	Kg	0.3	0.5	0.2	-	-	1
05	Kg	0.6	0.2	0.3	0.2	0.2	1.6

Table 13: Fruit waste generation of middle class houses 3rd week

House No.	Units	Orange	Pomegranate	Apple	Sapodilla	Banana	Total weight
01	Kg	0.15	0.12	0.04	0.06	0.13	0.5
02	Kg	0.5	0.2	0.1	0.2	-	1
03	Kg	0.2	-	0.08	0.1	0.16	0.54
04	Kg	-	0.2	-	0.1	-	0.3
05	Kg	0.2	0.1	-	0.1	0.2	0.6

Fruit waste generation of lower class houses

Fruit waste generation from lower class houses also was done by the same procedure as in upper and middle-class house. In this class of houses only two weeks data was collected and in the third week, no any data was obtained. Table no. 14 and 15 show the fruit waste generation of lower class houses.

Table 14: Fruit waste generation of lower class houses 1st week

House No.	Units	Orange	Apple	Sapodilla	Banana	Total weight
01	Kg	0.2	-	0.1	0.2	0.5
02	Kg	0.1	-	0.1	0.28	0.48
03	Kg	0.1	0.1	-	0.2	0.4
04	Kg	0.13	-	0.1	0.15	0.38
05	Kg	0.2	-	0.1	0.3	0.6

Table 15: Fruit waste generation of lower class houses 2nd week

House No.	Units	Orange	Apple	Sapodilla	Banana	Total weight
01	Kg	0.15	-	0.1	0.3	0.55
02	Kg	0.1	-	0.1	0.2	0.4
03	Kg	0.15	-	0.05	0.4	0.6
04	Kg	0.11	0.07	0.1	0.2	0.48
05	Kg	0.14	0.1	-	0.3	0.54

3.2 Treatment of Domestic Greywater by Using Activated Carbon as an Adsorbent

The general water quality parameters like Turbidity, Total Suspended Solids, COD, BOD, Chromium and Lead were tested for domestic greywater before and after adsorbent. For the analysis of different physicochemical parameters, 12 samples of synthetic wastewater were prepared under different experimental conditions.

3.3 Effect of Bio-adsorbent Dosages

Various dosage of the prepared banana peels, orange peels and sapodilla peels bio-adsorbent used to treat the domestic greywater. The parameters such as Turbidity, TSS, BOD, COD, Chromium and Lead have been changed with the increase in the bio-adsorbent dosage. The effects of adsorbent dosage were varied from 0.5 to 2 g for banana peel, orange peel and sapodilla peel individually. Hence 1 g was found to be the optimum dosage in treating the domestic greywater for banana and orange adsorbent.[27]

Removal of Turbidity concentration using Banana powder 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 90%, the removal percentage of turbidity from orange adsorbent is 86% and from sapodilla adsorbent is 83%. Figures no. 3, 4 and 5 shows the various dose of banana, orange and sapodilla adsorbent and removal percentage of turbidity.

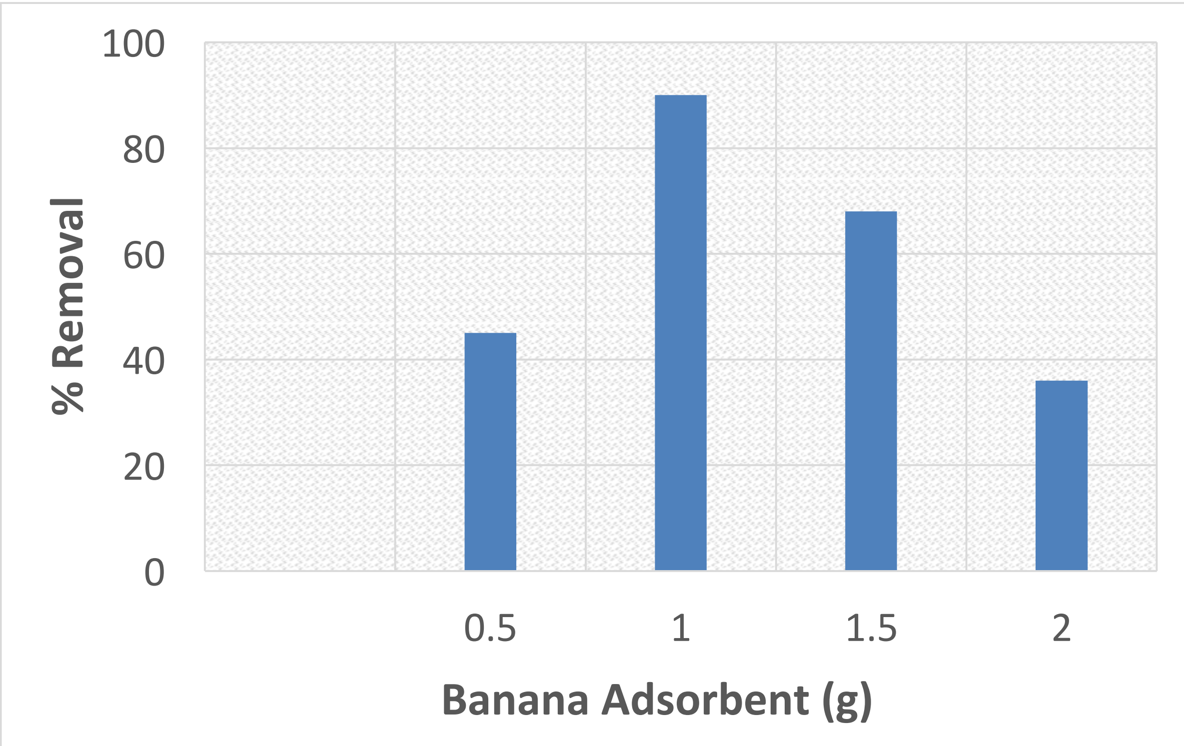

Figure: 3 Turbidity removal using various dosage of Banana adsorbent

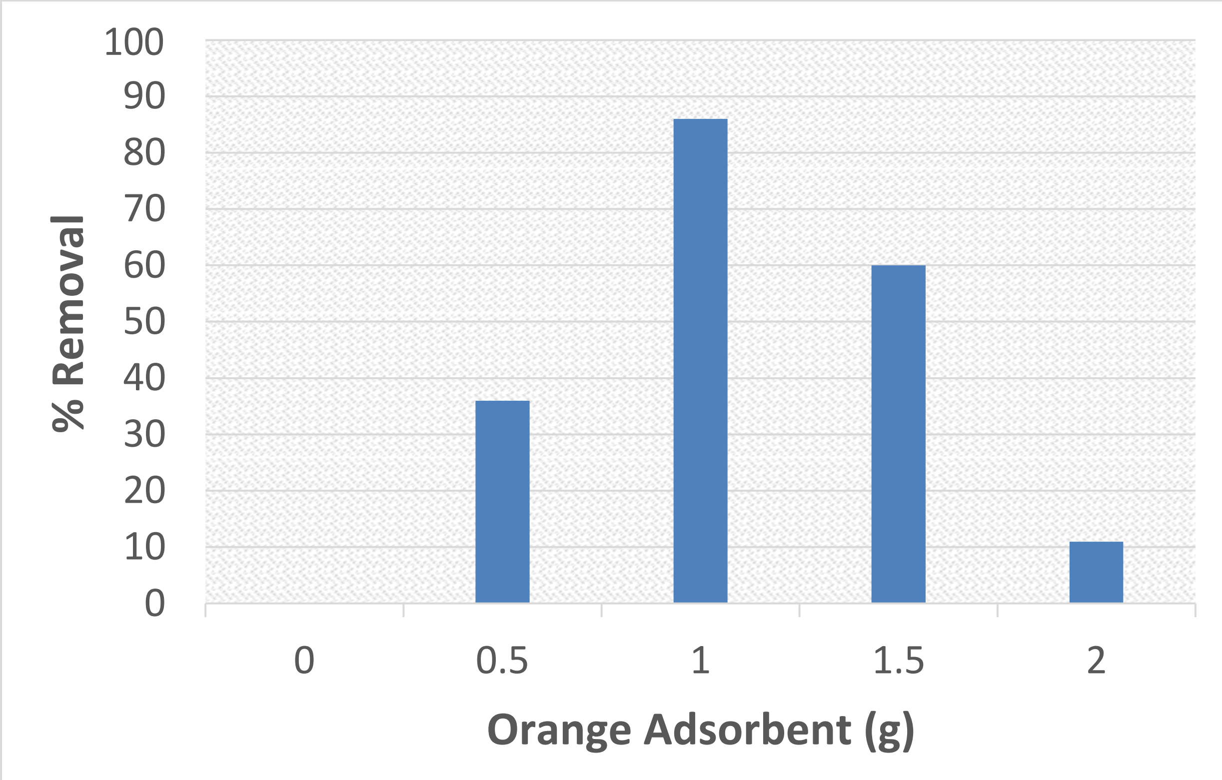

Figure 4: Turbidity removal using various dosage of Orange adsorbent

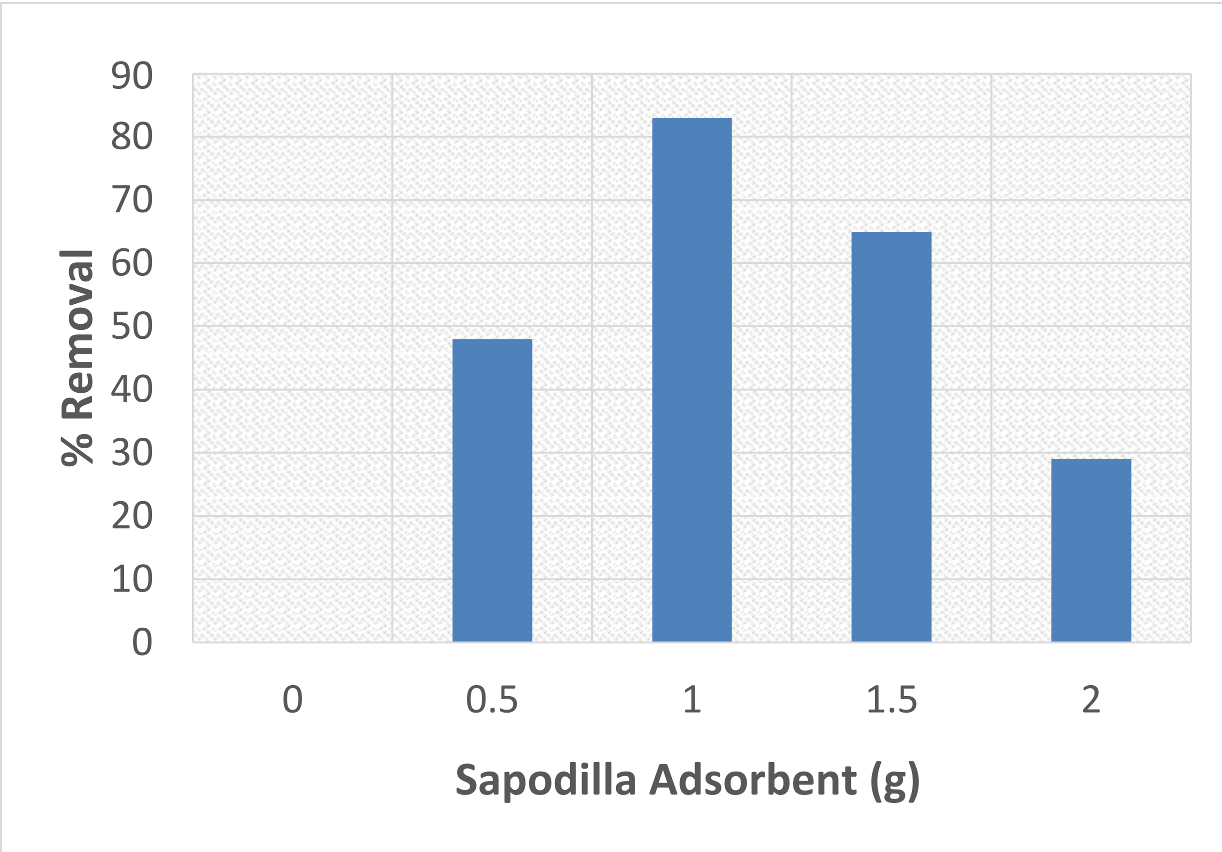

Figure 5: Turbidity removal using various dosage of sapodilla adsorbent

Removal of Total Suspended Solids concentration using Banana powder 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 87% and from sapodilla adsorbent the removal of TSS is 75%. Figure 6, 7 and 8 shows the removal percentage of Total Suspended Solids by using banana, orange and sapodilla powder as an adsorbent in domestic greywater.

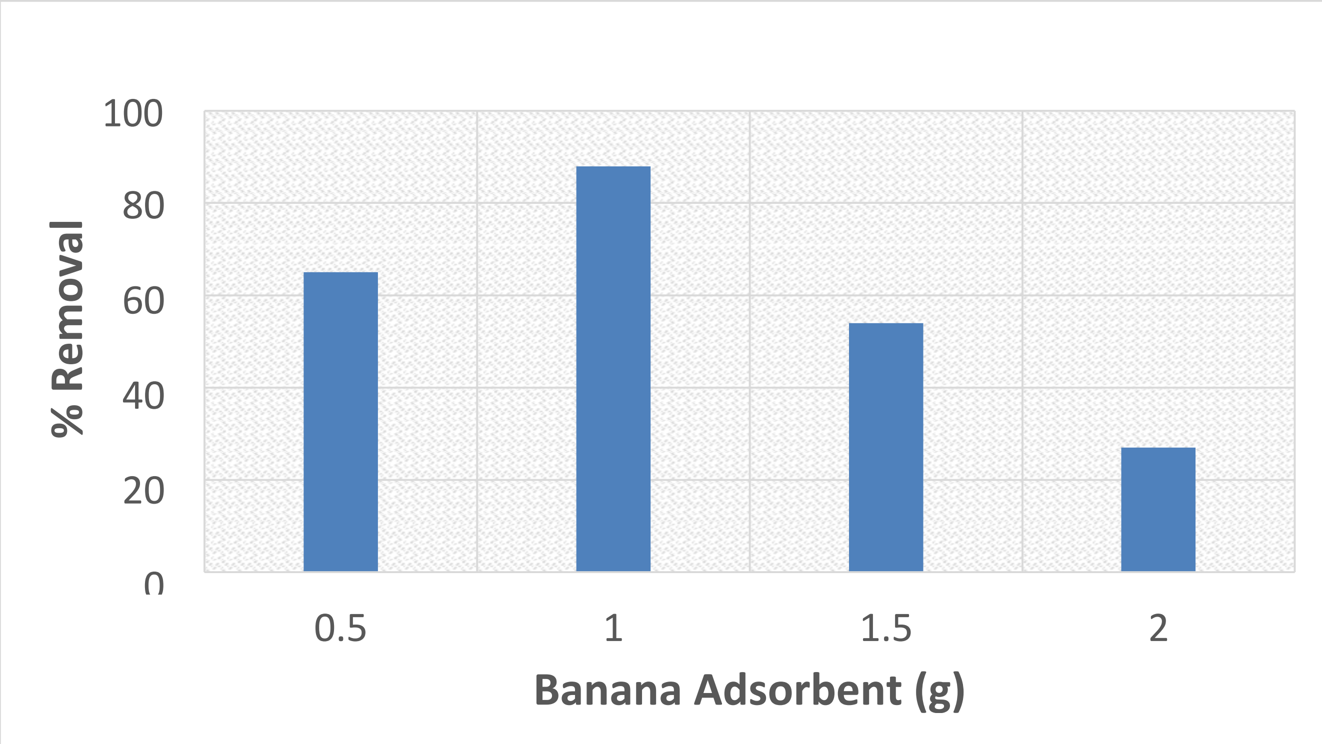

Figure 6: TSS removal using various dosage of Banana adsorbent

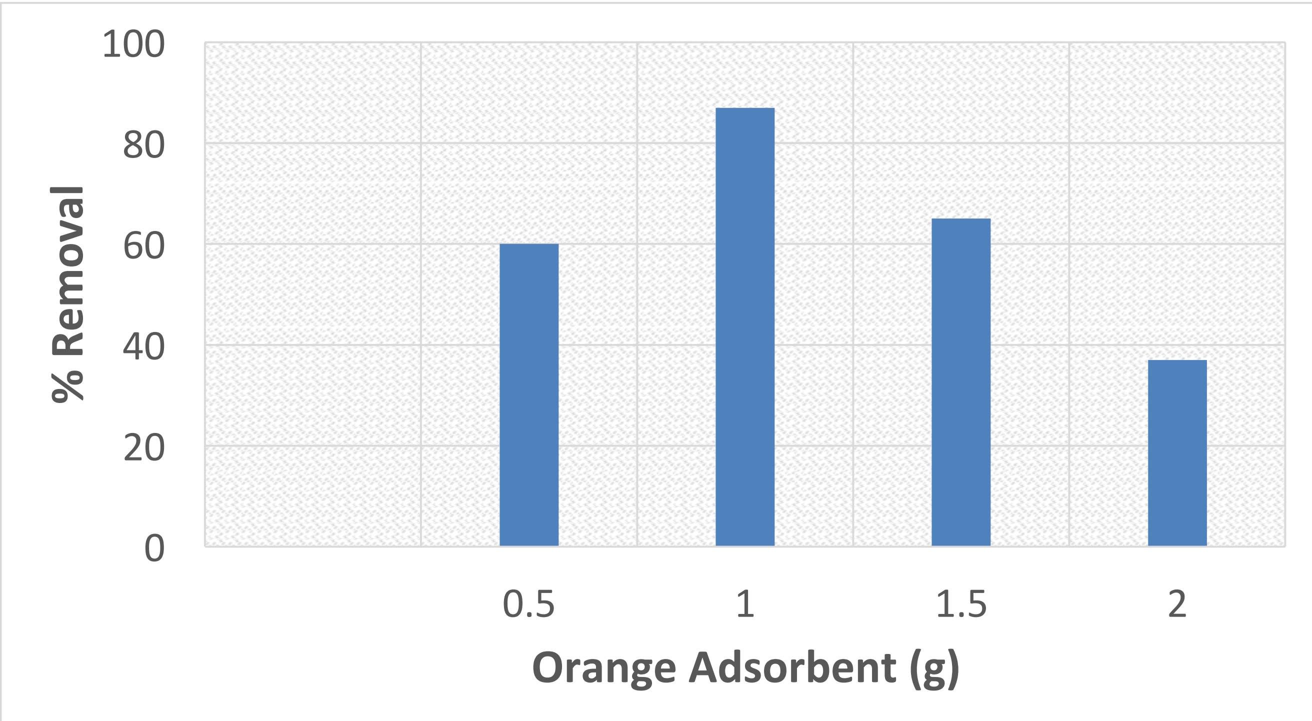

Figure 7: TSS removal using various dosage of Orange adsorbent

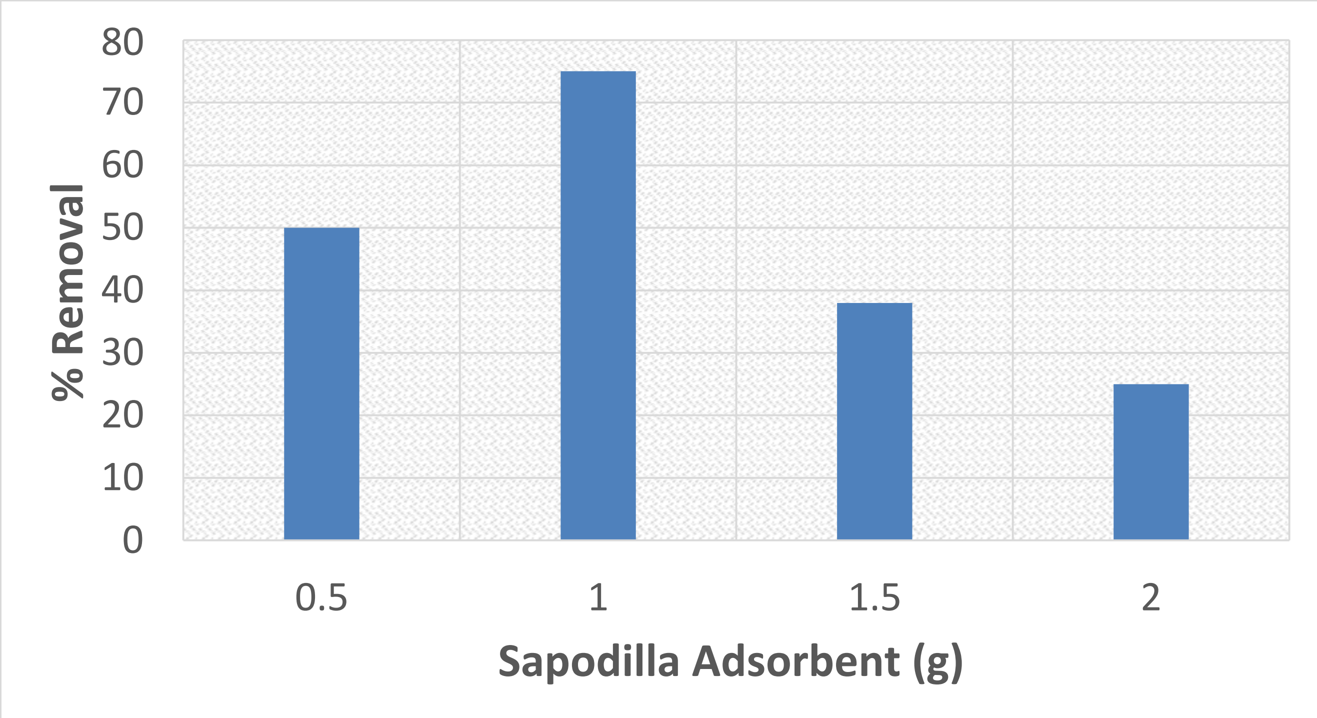

Figure 8: TSS removal using various dosage of sapodilla adsorbent

Removal of Biochemical Oxygen Demand (BOD) concentration using Banana 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 domestic greywater. In 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 93% and from sapodilla adsorbent the removal of BOD was 70%. Figure 9, 10 and 11 show the removal percentage of Biochemical Oxygen Demand by using banana, orange and sapodilla powder as an adsorbent in domestic greywater.

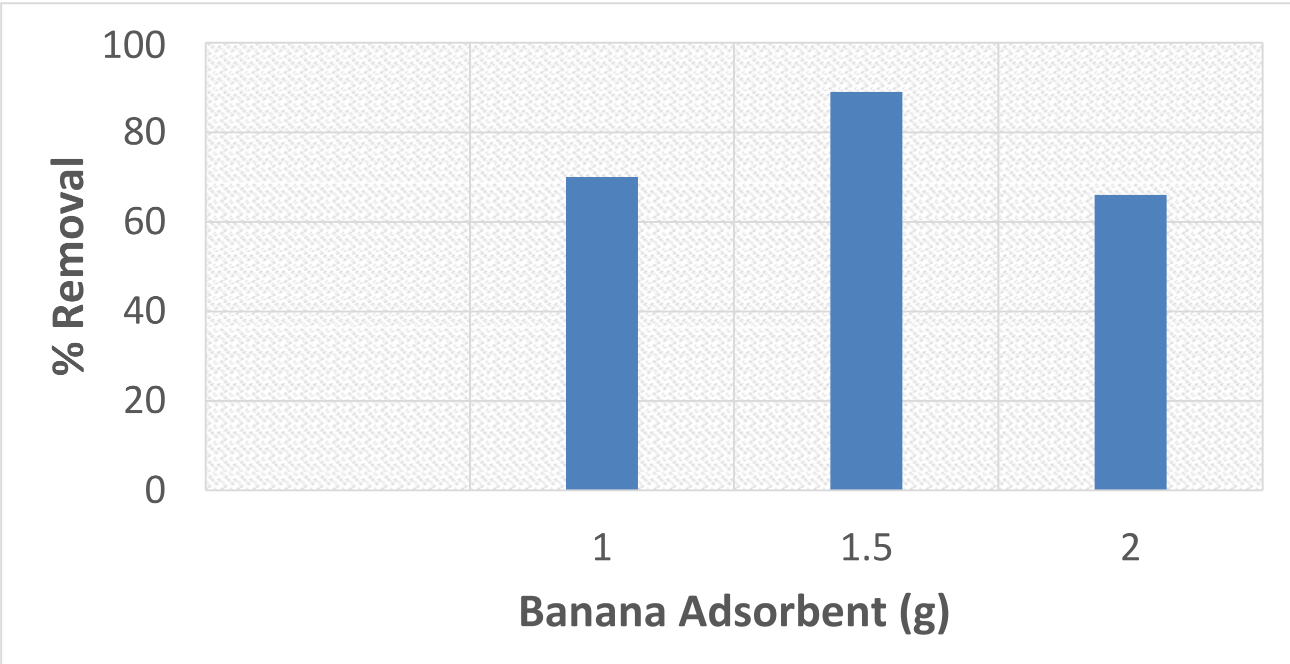

Figure 9: BOD removal using various dosage of Banana adsorbent

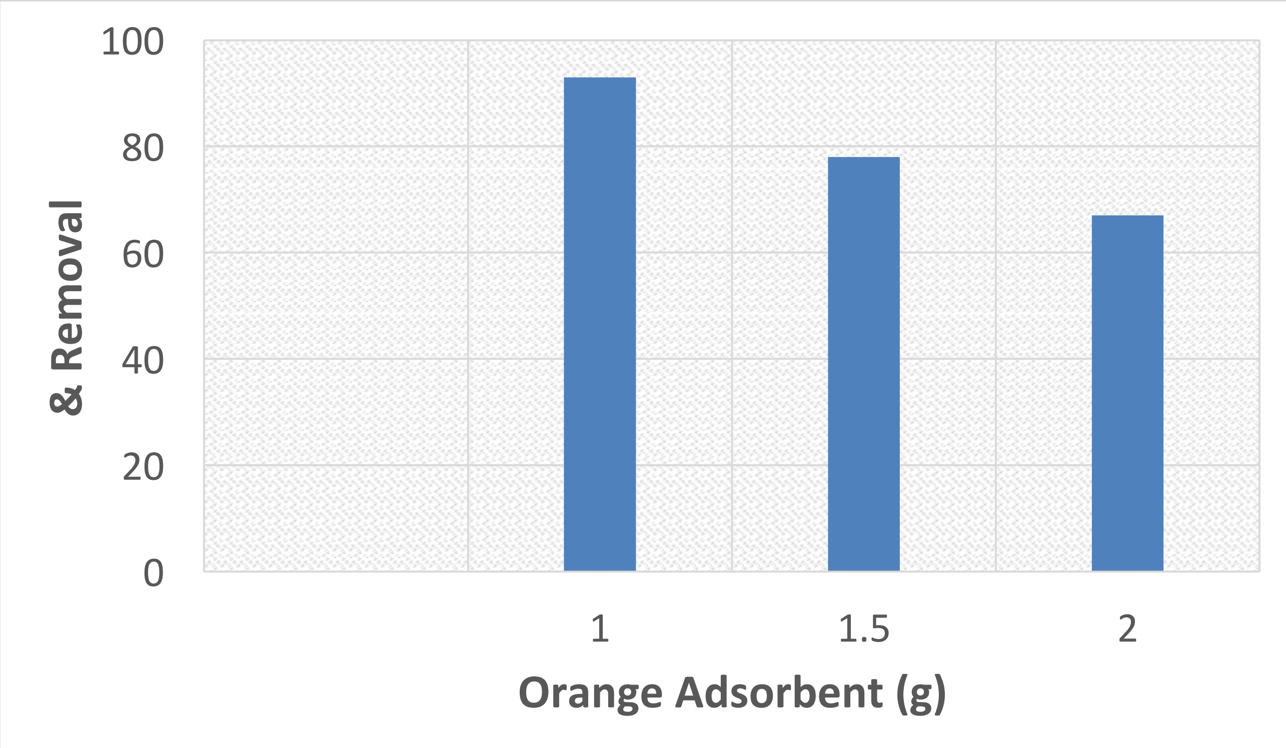

Figure 10: BOD removal using various dosage of Orange adsorbent

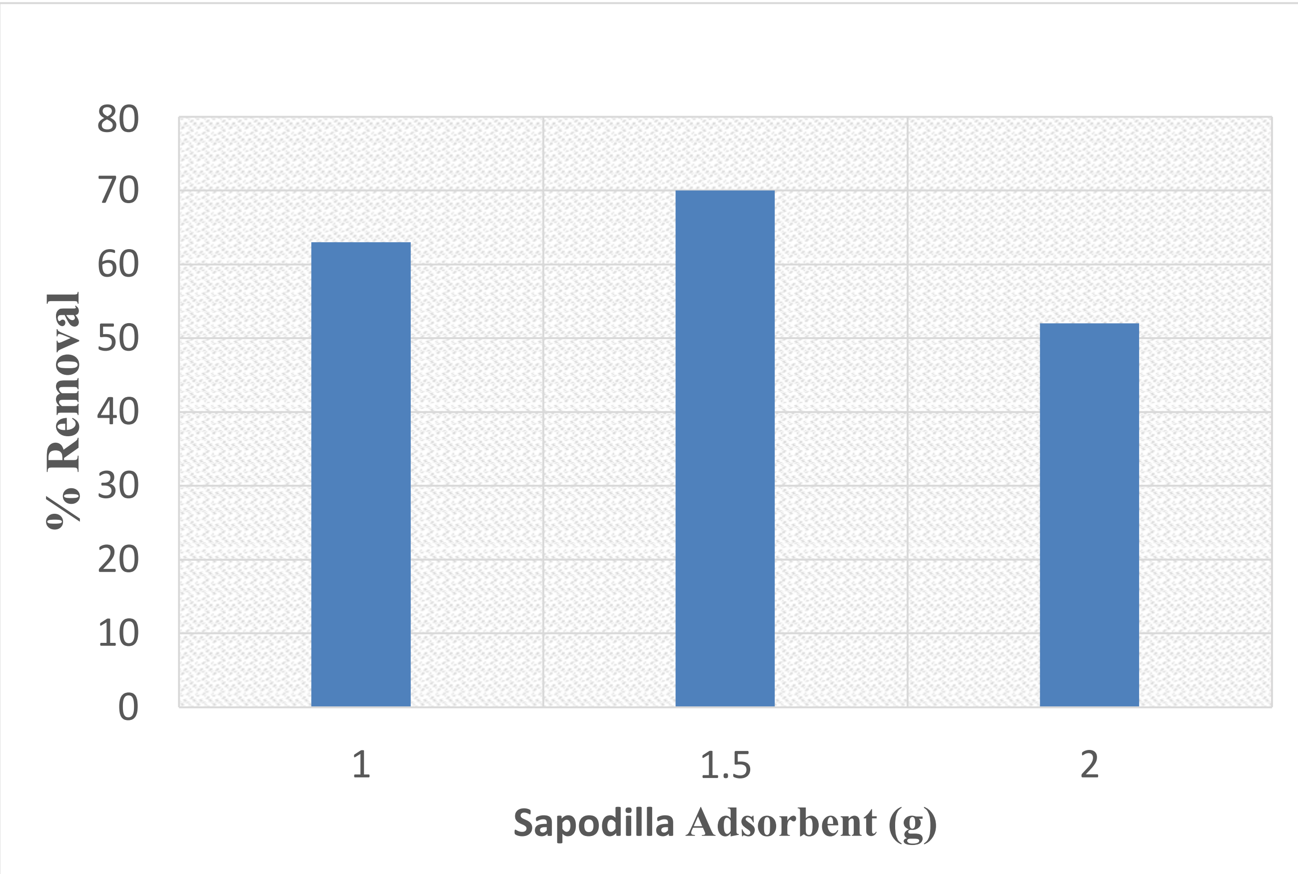

Figure 11: BOD removal using various dosage of sapodilla adsorbent

Removal of Chemical Oxygen Demand (COD) concentration using Banana 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 87% and from sapodilla adsorbent the removal of COD was 84%. Figure 12, 13 and 14 shows the removal percentage of Chemical Oxygen Demand by using banana powder as an adsorbent in domestic greywater.

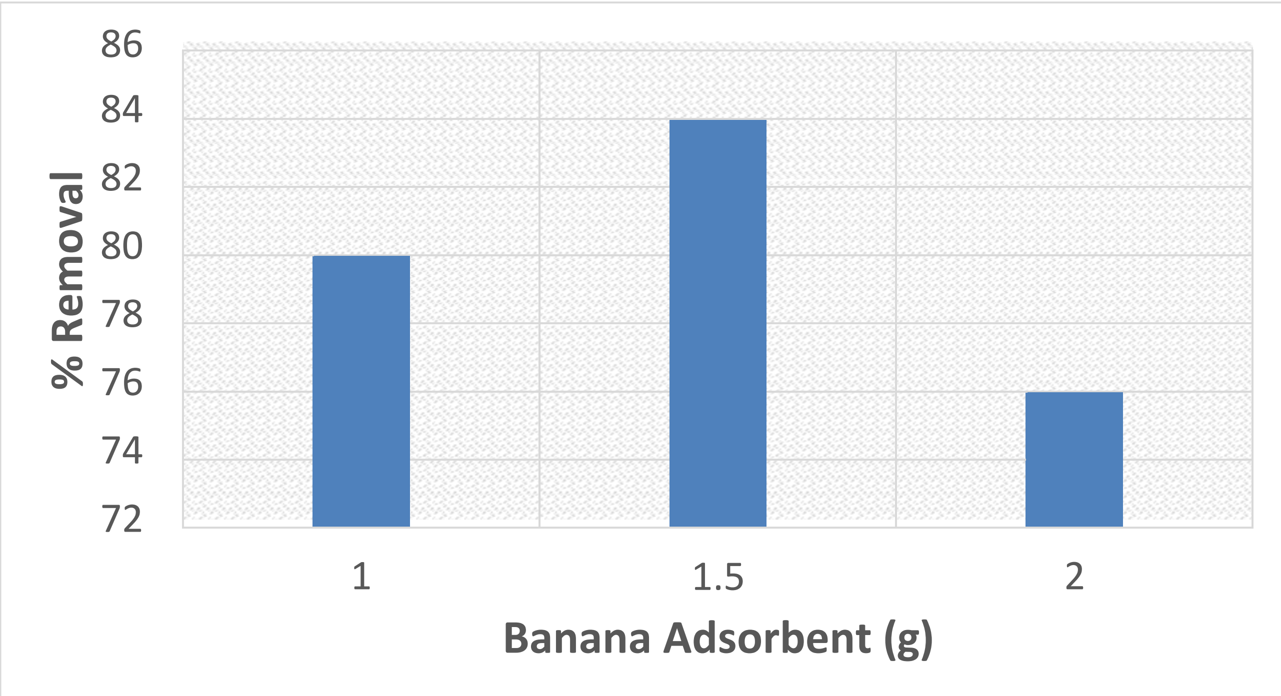

Figure 12: COD removal using various dosage of Banana adsorbent

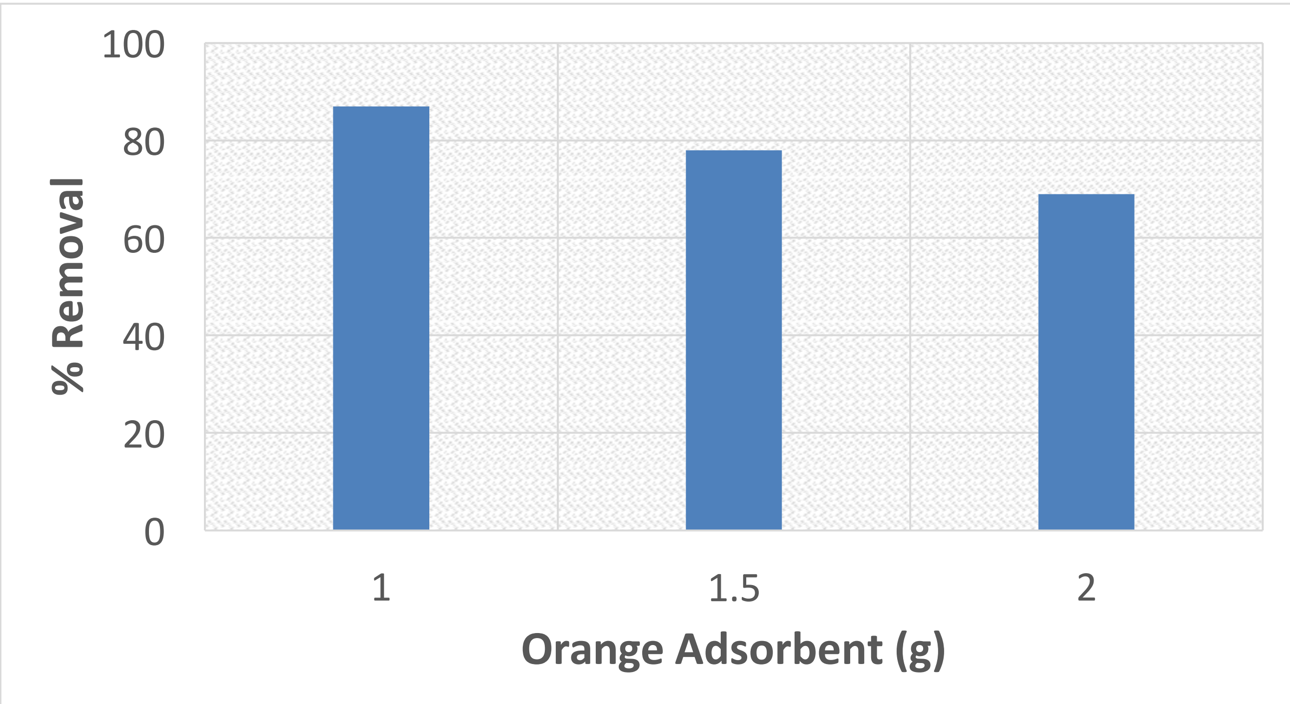

Figure 13: COD removal using various dosage of Orange adsorbent

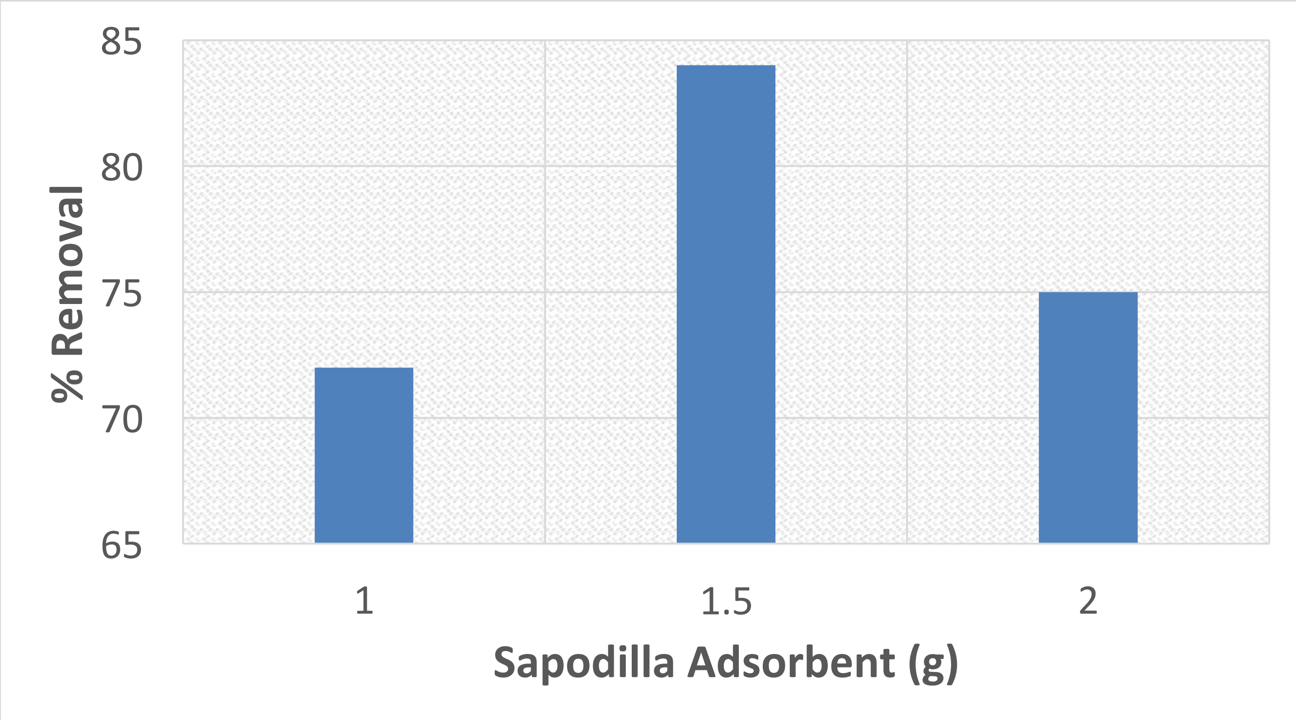

Figure 14: COD removal using various dosage of sapodilla adsorbent

Removal of Chromium concentration using Banana, Orange and Sapodilla peels with various dosages
For the analysis of chromium from domestic greywater, 10 ppm solution of chromium was prepared and was analyzed after adsorbent through Atomic adsorption spectrophotometer. Figures 15, 16 and 17 show the removal of chromium from these three adsorbent. The maximum removal of chromium was obtained at 1.5 g except for banana adsorbent, which was maximum 68% at 1 g, and the maximum removal of chromium from orange and sapodilla adsorbent were 55% and 54%.

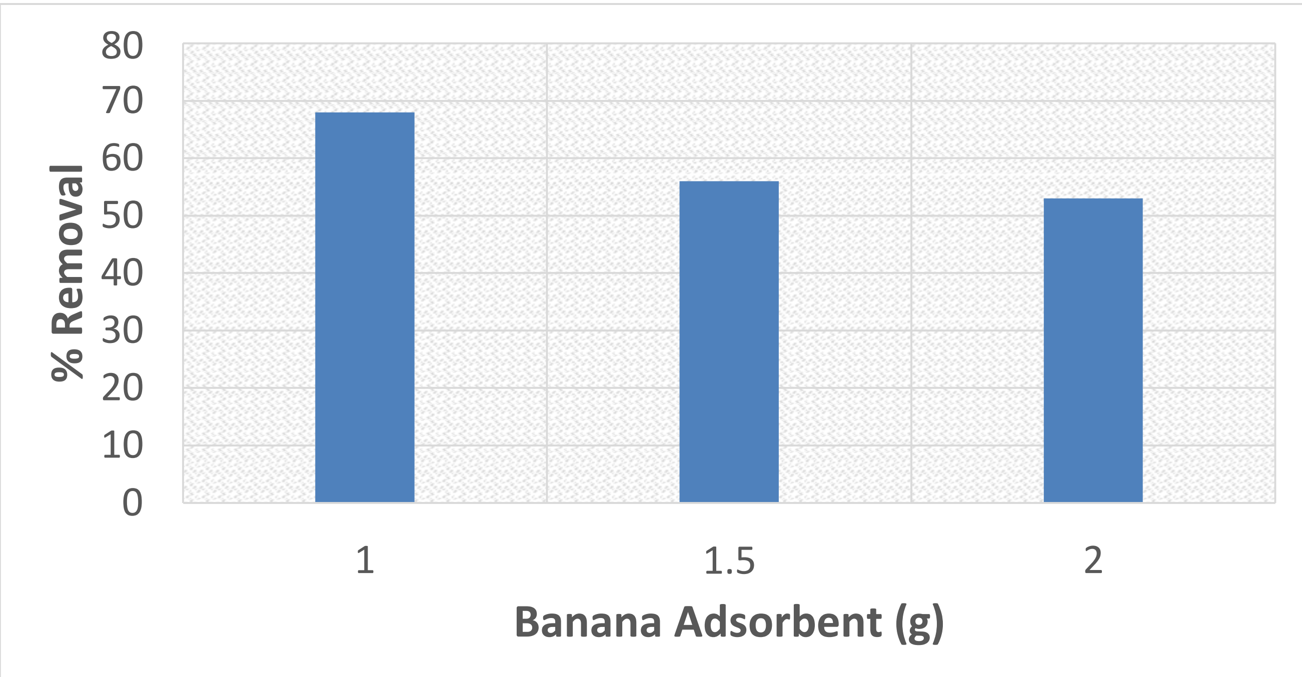

Figure 15: Chromium removal using various dosage of banana adsorbent

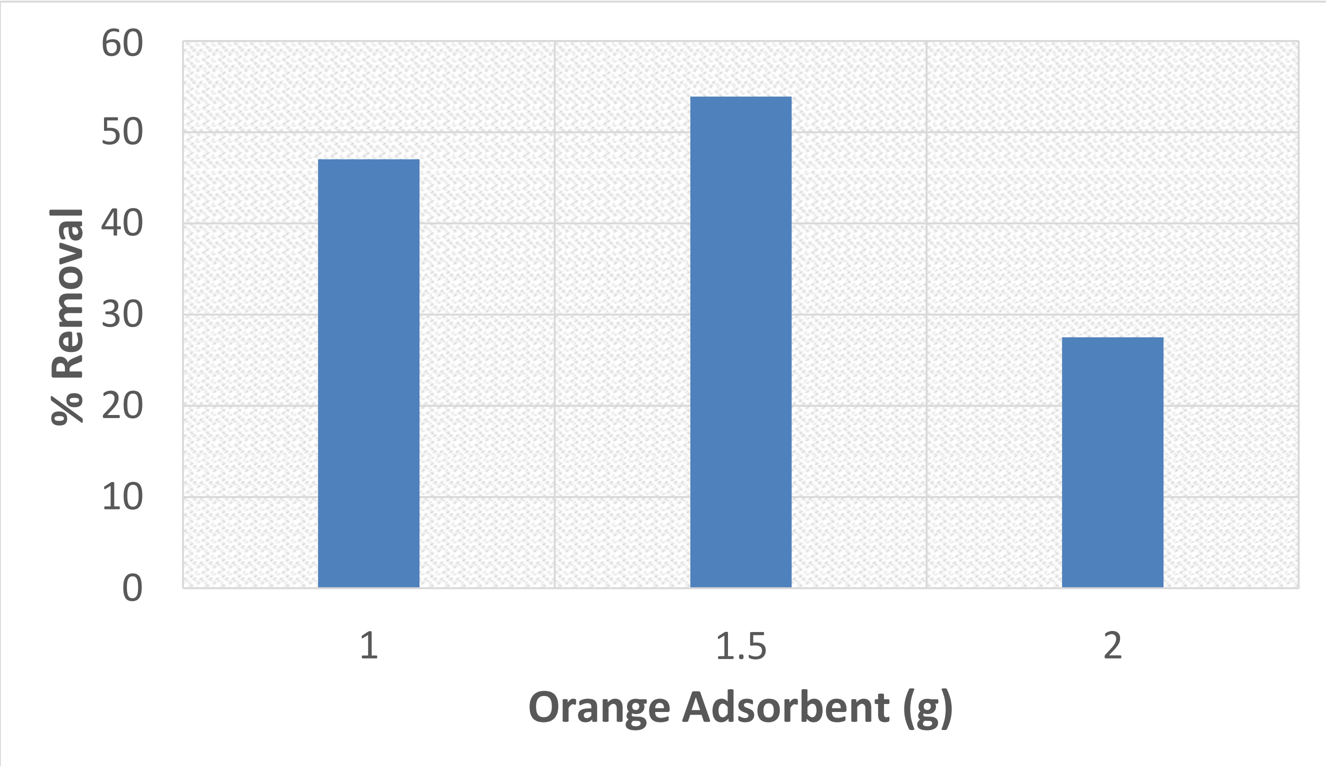

Figure 16: Chromium removal using various dosage of orange adsorbent

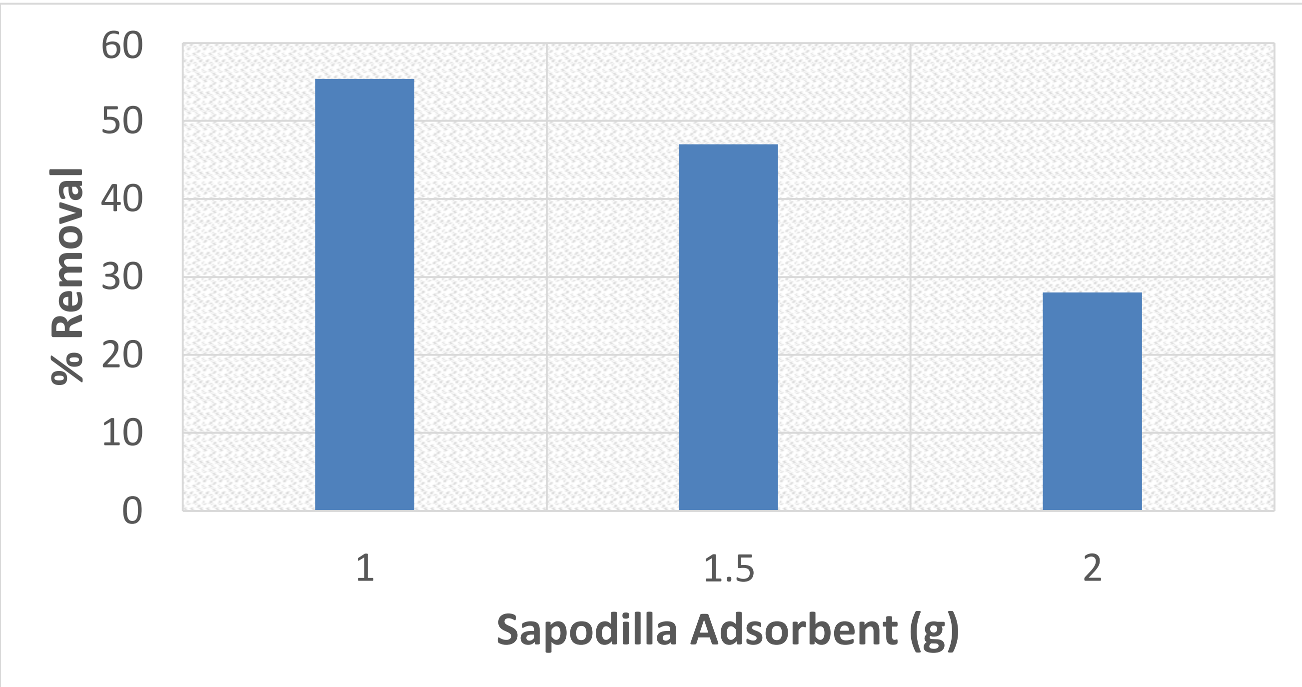

Figure 17: Chromium removal using various dosage of sapodilla adsorbent

Removal of Lead concentration using Banana, Orange and Sapodilla peels with various dosages
For the analysis of Lead from domestic greywater, same like chromium 10 ppm solution of lead was prepared and was analyzed after adsorbent through Atomic adsorption spectrophotometer. Figures 18, 19 and 20 show the removal of lead from these three adsorbent. The maximum removal of lead was obtained at 1g. The maximum removal of lead from banana, orange and sapodilla adsorbent were 94.5%, 87.5% and 81%.

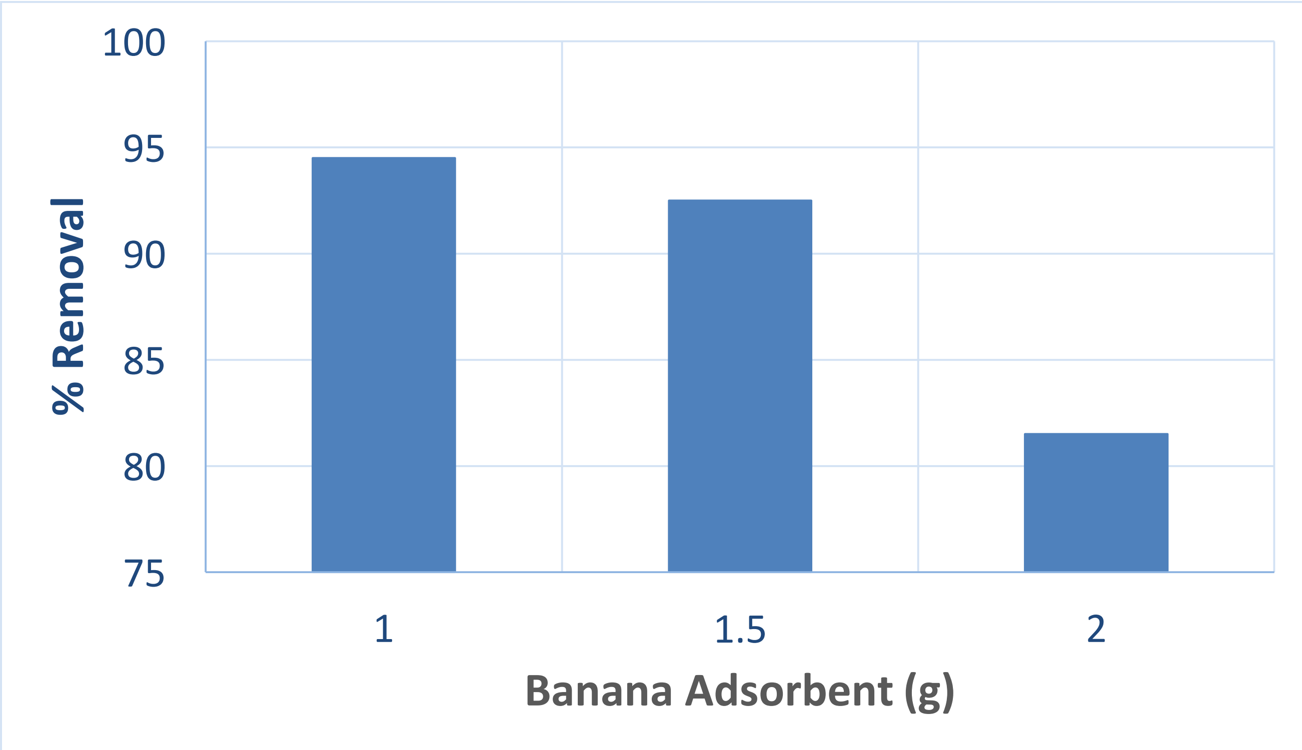

Figure 18: Lead removal using various dosage of banana adsorbent

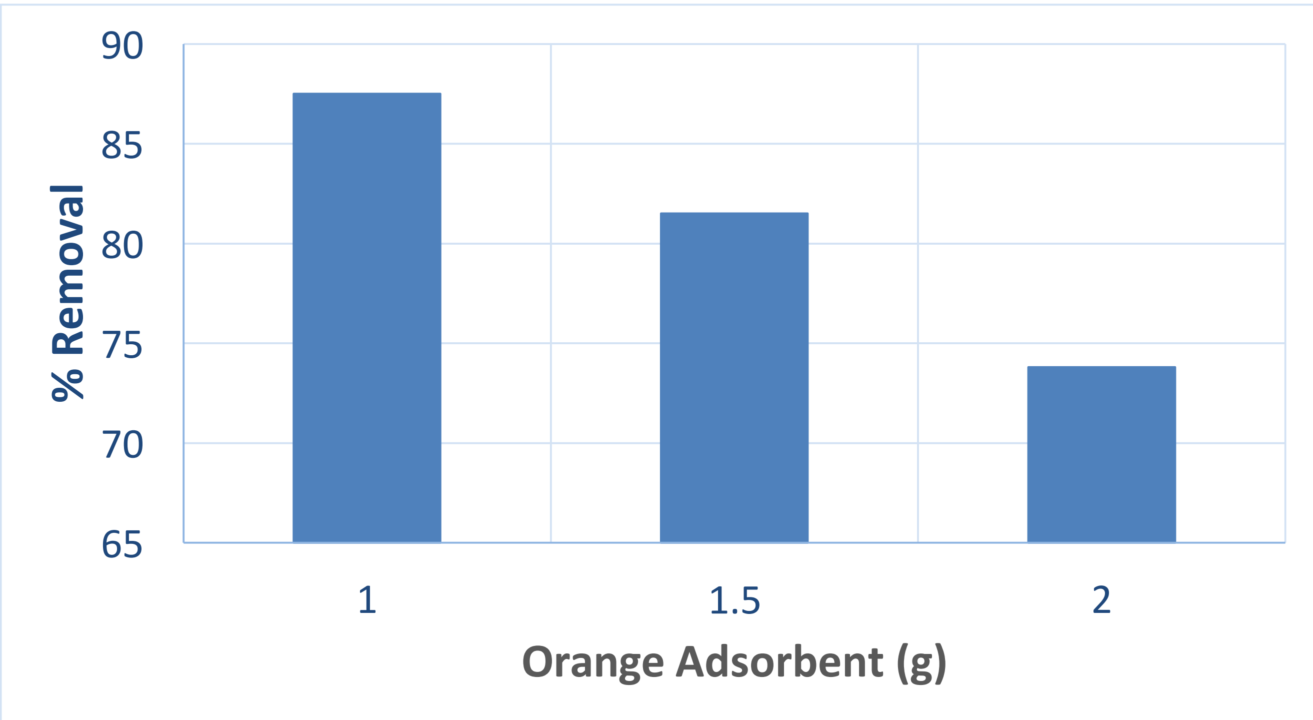

Figure 19: Lead removal using various dosage of orange adsorbent

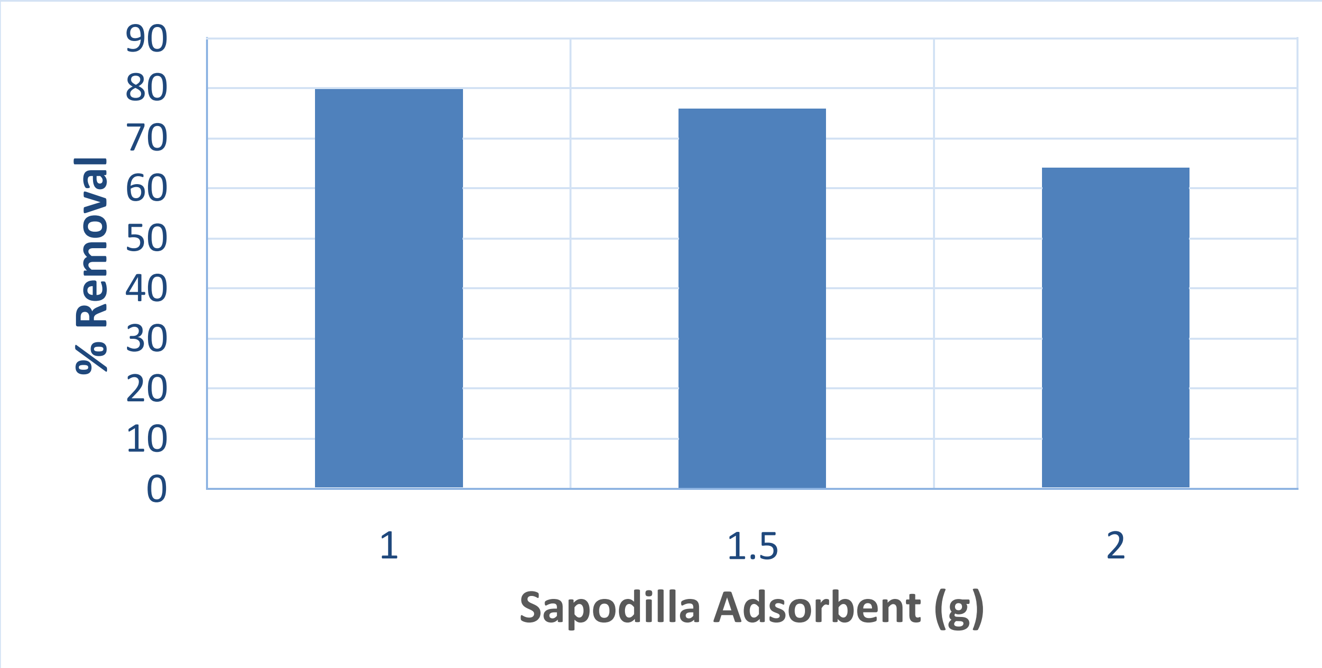

Figure 20: Lead removal using various dosage of sapodilla adsorbent

3.4 Effect of Contact Time

The effect of contact time was observed for the analysis of heavy metals to check the maximum removal at a particular duration of time. The eighteen samples were run with different time duration range 0 to 6 hours. The maximum removal of chromium and lead were observed at 1 hour using banana, orange and sapodilla as an adsorbent with a constant amount 1 g. After six hours, the phenomenon of desorption took place. Desorption is a process in which the equilibrium condition during adsorption takes place where further removal of any contaminant stops. Figures 21 and 22 shows the relationship between the concentration removal of heavy metals and contact time [21].

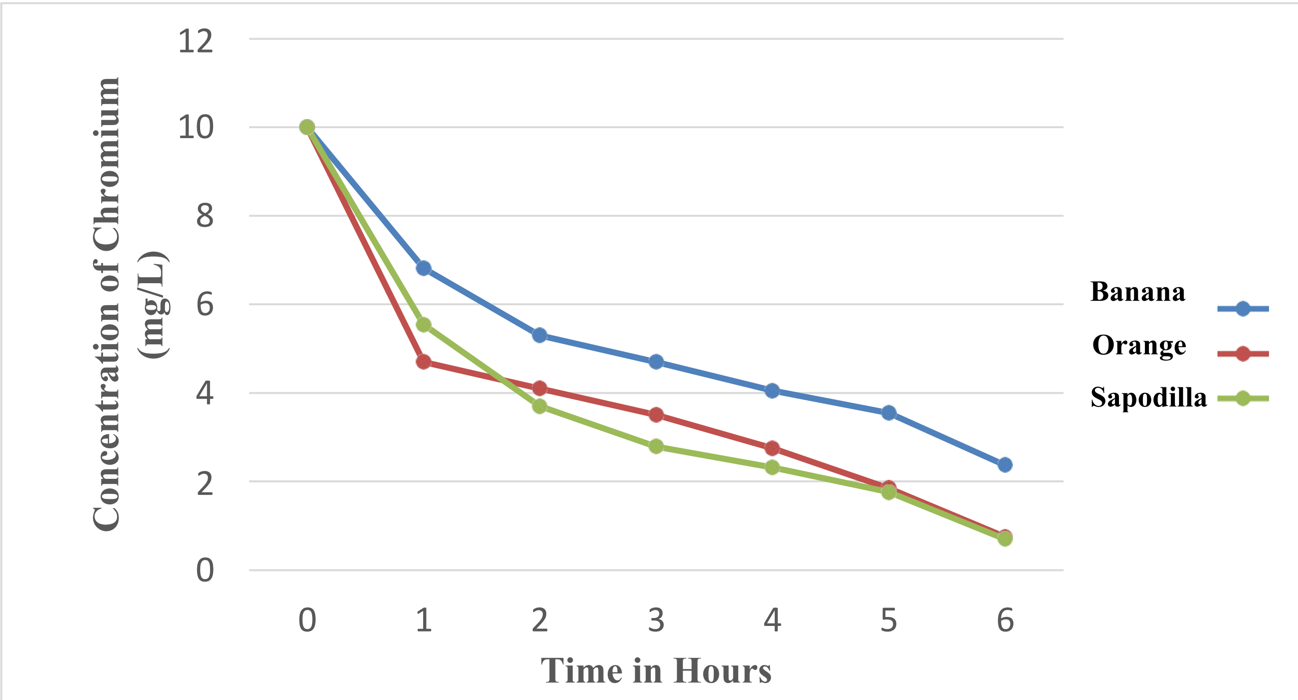

Figure 21: Removal of Chromium concentration with time

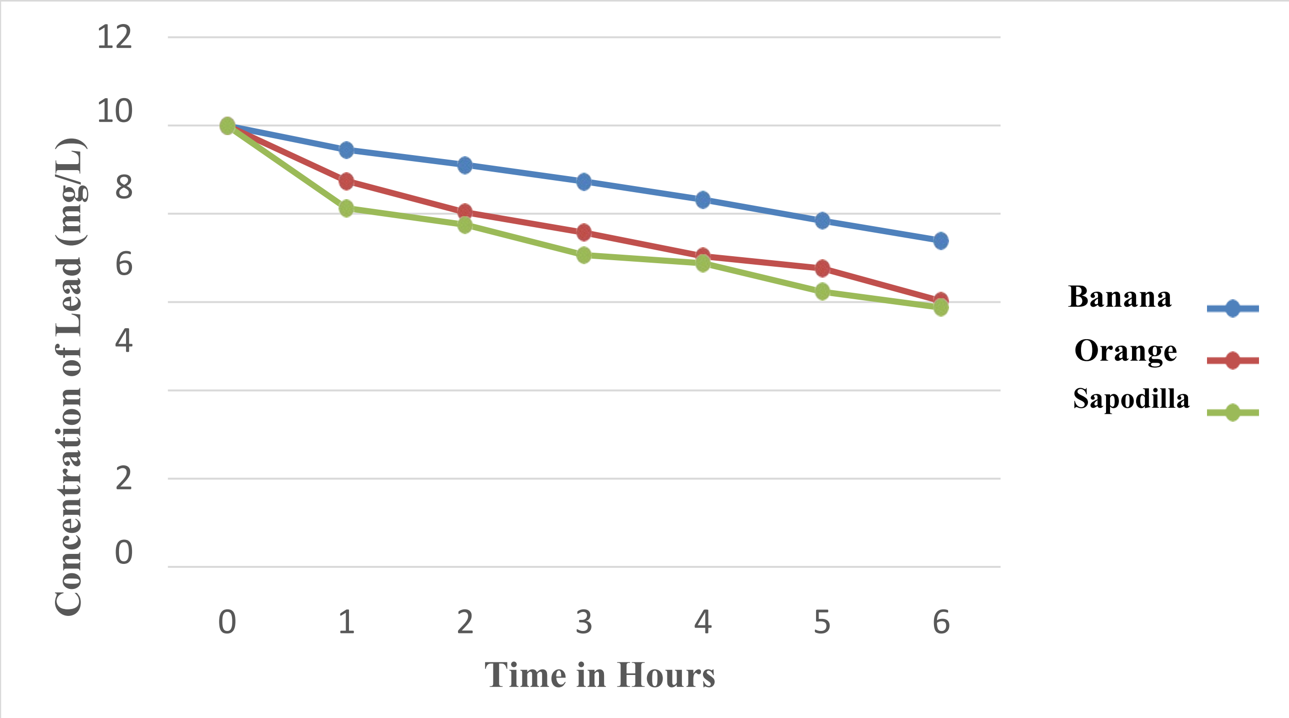

Figure 22: Removal of Lead concentration with time

3.4 Overall comparison of removal efficiency of physicochemical parameters of domestic greywater

From the observation of the results of physicochemical parameters, the maximum efficiency of removal of these parameters was observed at a dosage of 1g and the time 1 hour. Although some variations were observed like in some chemical parameters, the maximum removal efficiency was observed at 1.5g. Figure 23 shows the overall removal efficiency comparison of banana, orange and Sapodilla adsorbent for the dosage of 1g for 1 hour.

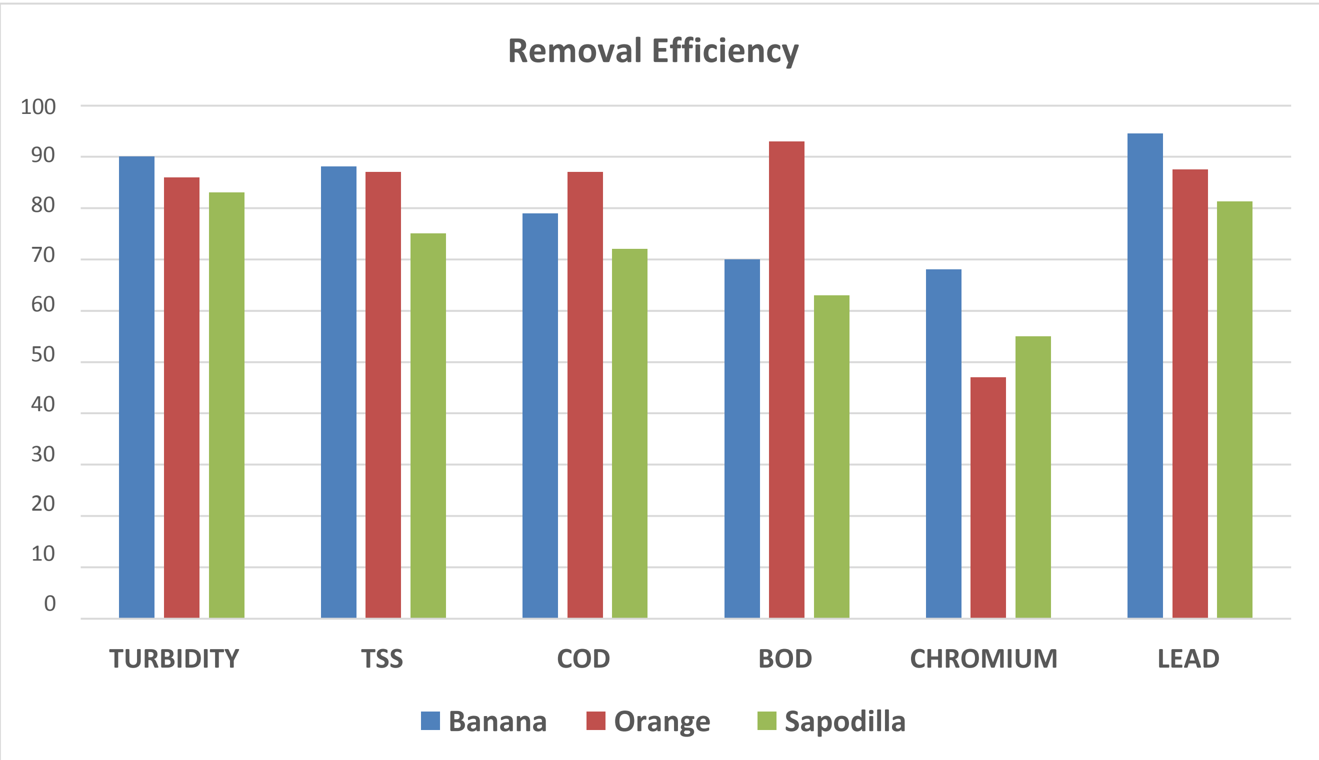

Figure 23: Comparison of removal efficiency of physicochemical parameters

Conclusion

There are many technologies to treat the water, bio-adsorption technique is also one of them. Fruit wastes (like Banana, Orange, etc.) are agricultural waste which is discarded as waste material in all over the world. Two objectives were set, the first objective was to determine the generation of fruit waste in Qasimabad Hyderabad city while the second objective was related with the treatment of domestic greywater using fruit waste as an adsorbent. Three fruit wastes were selected for adsorption which includes Banana, Orange and Sapodilla waste. Activated carbon was prepared from these fruit wastes and then were used for adsorbent to check the different physic-chemical parameters of domestic greywater. Six physicochemical parameters like Turbidity, TSS, COD, BOD, Chromium and Lead were analyzed and their removal efficiency by using three adsorbent at different dosages and different time period were observed. The optimum dosage of adsorbent was selected 1g. At 1g of adsorbent dosage the removal of these six parameters were greater than 65% which was suitable for effluent according to Sindh Environmental Protection Agency. The activated carbon technology is the branch of nanotechnology which is the advanced technology nowadays for future generation. The main advantage of this activated carbon is that this technology treats mostly the organic pollutants like VOCs etc. In industrial wastewater huge quantity of VOCs and other organic pollutants are present which may be easily removed by activated carbon, therefore for the treatment of industrial wastewater activated carbon is the best technology for the removal of organic matter. In future this technology can be used in filtration process of the influent which is coming from industries.

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