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PREPARATION OF RECYCLE MUSSEL SHELL AS PHYSICAL ADSORBENT FOR RESTAURANT WASTEWATER TREATMENT

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ABSTRACT

The aim of this study is to investigate the ability of mussel shell as an adsorbent to treat wastewater. There are several parameters that have been studied which are chemical oxygen demand (COD), turbidity, total suspended solid (TSS), pH and colour concentration. The other parameters such as contact time (5 days) is constant and adsorbent dosage used are 0.5 grams, 1.0 grams and 1.5 grams. Based on the attempts, it is reported that for the 1.5 grams mussel shell used, the COD decreased from 12 to 2 mg/l, while the turbidity reduced from 200 to 4 NTU. Apart from that, the TSS also decreased from 59.2 to 4 mg/l. It is claimed that mussel shell has the ability to treat wastewater and can be further used for treatment of wastewater in industrial.

KEYWORDS: Adsorbent, adsorption, chemisorption, mussel shell, physisorption.

INTRODUCTION

Malaysia is developing industrial country in the world, therefore many of rivers become polluted due to the wastes released or poured into the river. For example, paper industry, requires chemicals such as polyethylene that very dangerous and poisonous to biotic in the river. In order to ensure the water safe release to the river, it needs to treat water according to Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979; Standard A and B.

Wastewater presents major environmental and health impact. For example, colour is dangerous contaminant that will give health impact if not treated it properly before discharge it into river (Vanderan D., 2002). Since 98 percent of our fresh water supply comes from surface water, proper treatment of sewage must be ensured. In February 2006, Malaysia's Ministry of Energy, Water and Communication awarded a US$133 million contract to Japanese companies to build four treatment plants in Kuala Lumpur, Negeri Sembilan, Johor and Malacca. Its shows that the government is concern about important wastewater treatment in order to ensure our environment still clean (Buyusa, 2008). Wastewater generated by the dye production industry and many other industries which use dyes and pigments is characteristically high in colour and organic content. About 10,000 different commercial dyes and pigment exist and over 7 x 105 % of these dyes are released in effluent during dyeing process (Vaidya AA, 1982).

Moreover, substances that exist in water can be divided into three. Those are suspended, colloid and dissolved. In order to remove colloids, we should understand why the colloids cannot be removed by sedimentation and filtration. Colloids are stable due to their surface charge. We need to neutralize this charge. Almost colloids founds in water are negatively charged, the addition of Sodium ions should reduce charge.

Adsorption and ion exchange processes are the most useful methods to remove those constituents in wastewater. Adsorption is one of the separation processes which the desired compound in the mixture of liquid or gas will be separated from each compound by the usage of adsorbent which is in the form of solid. Adsorption is integral to a broad spectrum of physical, biological, and chemical processes and operations in the environmental field. Adsorption of dissolved impurities from solution has been widely employed for water purification. Adsorption is now viewed as a superior method for wastewater treatment and water reclamation. Applications of adsorption are well known for

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chemical processing air pollution control and water treatment. Applications in wastewater treatment and water pollution control are generally not as well recognized, nor as well understood. In industry, adsorption will use commercial activated carbon (CAC) to remove heavy metals from wastewater, such as Cd (Ramos et al., 1997), Ni (Shim et al. 2001), Cr (Ouki et al., 1997) and Cu (Monser and Adhoum, 2002).

However, activated carbon remains an expensive material for heavy metal removal. Thus, in order to replace the conventional adsorbents, special attention has been given to focus on the natural adsorbents as an alternative to replace the conventional adsorbents. Natural materials may have potential as inexpensive sorbents. Based on the investigation, there are several agricultural by-product that have been used as adsorbent such as rice husks, sugarcane bagasse, and wheat straw (Khan et al., 2004). Other than that, coagulation is one of another process to treat wastewater. Coagulation is a method to alter the colloids so that they will be able to approach and adhere to each other to form larger particle. The main purpose of coagulation is to treat surface water and remove turbidity, colour and bacteria. During coagulation, a positive ion is added to water to reduce surface charge to the point where the colloids are not repelled from each other. Also, a coagulant is substances that added to water to accomplish coagulation (David A. Cornwell, 2009). In order to carry out the coagulation, the main factor that will influence the quality of treatment is the type of coagulant. The coagulant use in coagulation process will reflect the final quality of wastewater.

Therefore, this study is aim to investigate the ability of mussels shell as an adsorbent to treat wastewater because they are natural and abundant source. The performance will be determined based on COD, turbidity and TSS.

METHODOLOGY

Preparation of mussel shell adsorbent

The mussel shells were collected from Restaurant Seri Kelemak which is located in Alor Gajah, Melaka. The mussel shells washed with pure water several times to remove dust and fines. Then, the shell were dried in the oven about 100oC for 24 hour duration time. The cleaned and dried shells were then burned in the furnace at 500oC for 1 hour. Then, the burned shells were grinded into fined particles using a heavy duty grinder and the size will be analyzed by using particle analyzer. Finally, the grinded shells were stored in tightly capped glass jars and placed at room temperature.

Preparation of wastewater samples

In this study, about 10 litres wastewater sample was taken from Kentucky Fried Chicken (KFC) Restaurant which is located in Ipoh, Perak.

Analysis

In this experiment, there are five analyses will be carried out which are chemical oxygen demand (COD), turbidity, total suspended solid (TSS), pH and colour concentration. The apparatus and instrumentations used are oven, furnace, grinder, turbidity meter, pH meter, vacuum pump and UV-VIS Spectrophotometer.

RESULTS AND DISCUSSIONS

Particle size analysis of mussel shell adsorbent

Figure 1 represents the particle size analysis of mussel shell adsorbent. The average particle size of mussel shell is 563.677 µm at volume 10.56 % mixture of distilled water and mussel shell. Particle size is important in order to increase the surface area of the adsorbent (Terence Allen, 1997). The more surface area of the adsorbent, the adsorption process becomes more effective.

The adsorption performance of Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) is a measure of water and waste water quality. Figure 2 exhibits the effect of mussel shell in the removal of COD. Based on the graph, it shows that three different dosage of mussel shell was used with contact time of five days. For 0.5 grams mussel shell used, the initial reading of chemical oxygen demand is 12 mg/l and decreased to 11 mg/l after one day and continuously to day two which is 7 mg/l, remains constant on day three, 6 mg/l on day four and 4 mg/l on the day five. Then for the 1.0 grams dosage of mussel shell, result obtains also decreasing from 13 mg/l for the initial, decreasing to 10 mg/l in the day one and day two, 8 mg/l in day three, 7 mg/l in the day four and 5 mg/l in the day five. By using 1.5 grams mussel shell the chemical oxygen demand was reduced which is from 12 mg/l to 2 mg/l.

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It shows that by increasing the adsorbent dosage, the concentration of the chemical oxygen demand will reduced. This is because mussel shell is a calcium rich resource that can be used to produce calcium oxide (lime). The reaction that occurs will reduce the chemical oxygen demand (COD) (Patterson et al., 2013). The quality of any water is high when there is decrease in chemical oxygen demand (COD) after treatment (Aboua et al., 1995). This improved quality of the water sample after treatment indicates the effectiveness of mussel shell for waste water treatment.

The adsorption performance of turbidity

Turbidity is caused by suspended materials which absorb and scatter light. These colloidal and finely dispersed turbidity causing materials do not settle under quiescent conditions and are difficult to remove by sedimentation. Turbidity measurements performed using proprietary nephelometric instruments are expressed as Nephelometric Turbidity Units (NTU). In this study, the turbidity was measured and reported as in Figure 3. By using three dosage of mussel shell, the turbidity was measured in five day contact time. As the result, for 0.5 grams mussel shell used, the turbidity reduced from initial 200 NTU to 12 NTU while for 1.0 grams mussel shell the turbidity from 208 NTU reduced to 8 NTU and 1.5 grams of mussel shell used, turbidity measured is 200 NTU and reduced to 4 NTU.

From the result, the optimum dosage to treat turbidity is 1.5 grams of mussel shell. Turbidity can be reduce when the colloid particles tends to agglomerate and settle at the bottom. Supernatant were collected at the top which it can be seen the turbidity is removed. This is the reason turbidity is reduce.

The adsorption performance of total suspended solid (TSS)

Total suspended solid (TSS) are solid materials, including organic and inorganic, that are suspended in the water. High concentrations of total suspended solids can lower the water quality. Figure 4 shows the results for the total suspended solid removal from the wastewater.

Total suspended solid test was carried out by using three dosage of adsorbent which are 0.5 grams, 1.0 grams and 1.5 grams. The lowest suspended solid value is 1.5 grams dosage adsorbent used. It reduces from 59.2 mg/l to 4 mg/l. For 0.5 grams, also decreasing which is from 55.2 mg/l to 28 mg/l while by using 1.0 grams, from 63.2 mg/l decreasing to 14 mg/l.

Based on the result, it shows the total suspended solid are reduce. This is because the total suspended solid is clotted together with the mussel shell.

The adsorption performance of pH

Figure 5 represents the results obtain for the effect of mussel shell in pH. The pH of waste water was adjusted to 2 by using acid and 10 by using alkali.

Based on the graph plotted, the initial value of pH was adjusted to pH 2 and pH 10. Three dosage of mussel shell was been test with contact time five days. As the result, the pH increases from 2 which is an acid to 5.2 when using 0.5 grams mussel shell and increase to 6.3 with 1.0 grams mussel shell. While using 1.5 grams mussel shell the pH increase from 2 to 6.8 which is near to neutral (Decelles, 2002). For the pH 10, the pH decrease from 10 to 9.2 with 0.5 grams mussel shell, 10 to 8.6 with 1.0 grams mussel shell used and 10 to 7.9 with 1.5 grams of mussel shell.

From the three dosage used, 1.5 grams is more suitable because the finding show that by using 1.5 grams mussel shell the pH is nearer to 7 which is neutral.

The adsorption performance of color concentration

Figure 6 display the result of color concentration in the wastewater after the adsorption process. This test was carried out by using UV-VIS Spectrophotometer. For the raw wastewater, which is no adsorbent is added; the concentration is about 1.812 mg/l. When the sample was treated with 0.5 grams of adsorbent, the concentration still remains constant 1.812 mg/l. For 1.0 grams adsorbent used, the concentration decreased to 1.742 mg/l while decreased more in 1.5 grams which is 1.738 mg/l. Conclusion that can be make is the colour concentration of the wastewater become more diluted when mussel shell is added. This is because the colour particle is adsorbed by the mussel shell (Ademoroti et al, 1996).

CONCLUSIONS

Based on the result obtained for the parameters used, the adsorption process was strongly affected by the dosage of adsorbent. According to the findings, it is clearly shows that 1.5 grams of adsorbent used is more effectively compared

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to 0.5 grams and 1.0 grams. This is happened because when more adsorbent is used in the process the adsorption is more effective in term of the surface area increase. As the absorbance increased, the adsorption process will increase. As a conclusion, mussel shell waste was capable to remove constituent from waste water and all the theories are accepted. Mussel shell has the ability in order to treat waste water. This method can be applied in industrial because it is an effective method and lower in cost.

Based on this study, mussel shell was used as adsorbent to remove constituents in waste water with the studied of various parameters which are chemical oxygen demand, turbidity, total suspended solid, pH and color concentration. There are several recommendations needed to improve for future study. Mussel shell waste can be applied with various adsorbent such as oil, dye, other metal ions because it has a good capability of lowering the transition metal-ion concentration, widely available because unused resource and low cost adsorbent. In addition, the adsorption mechanism investigation, that the shells can be applied with the industrial effluents. The mussel shell also can be converted into synthetic activated carbon. Meanwhile, there are lots of waste can be used as an absorbent to study its capability to remove pollution in wastewater such as pineapple peel and sea shell. At the same time, it can help to reduce the cost of disposal and environmental friendly. The adsorbent used in the study must be compared with the commercial activated carbon to know the efficiency. Apart from that, other parameter such as the effect of surface area, contact time and adsorbent dosage can be used in studies to know the capability and efficiency of adsorbent in various conditions.

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FIGURES

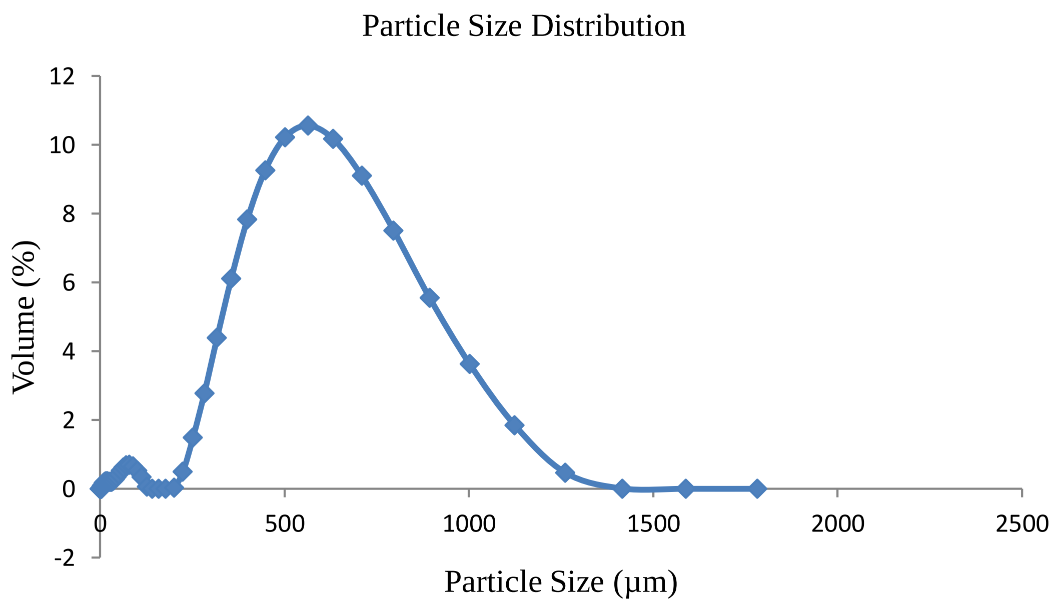

Figure 1. Particle size analysis of mussel shell adsorbent

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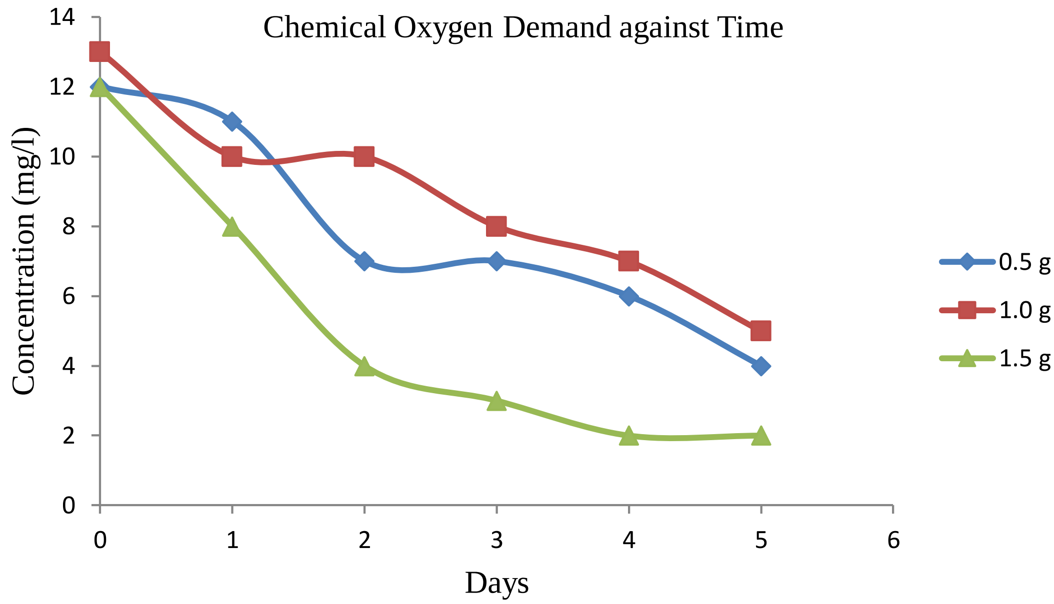

Figure 2. The effect of mussel shell adsorbent in the removal of COD

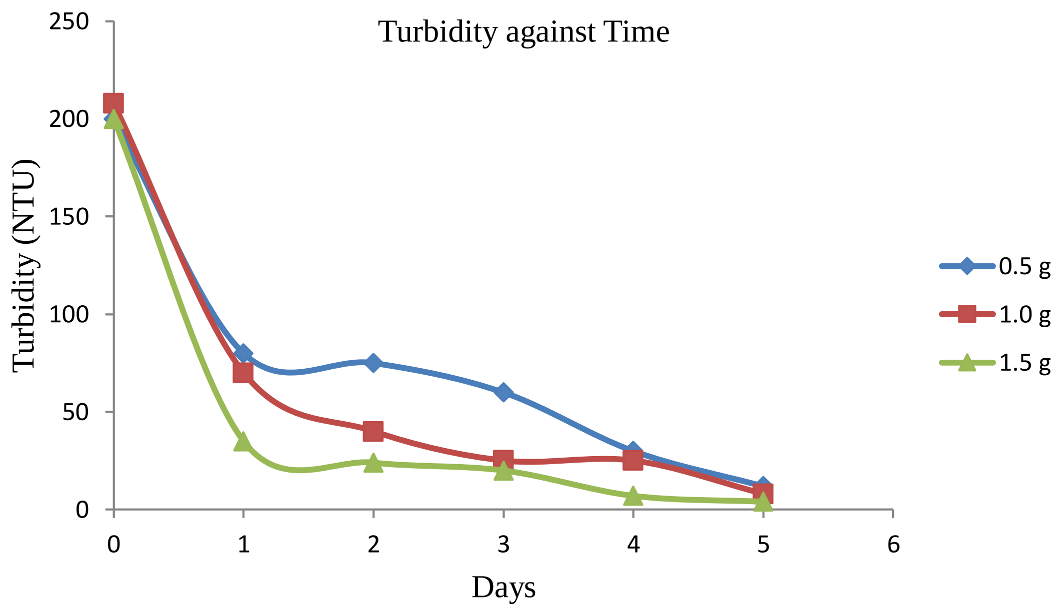

Figure 3. The effect of mussel shell adsorbent in the removal of turbidity

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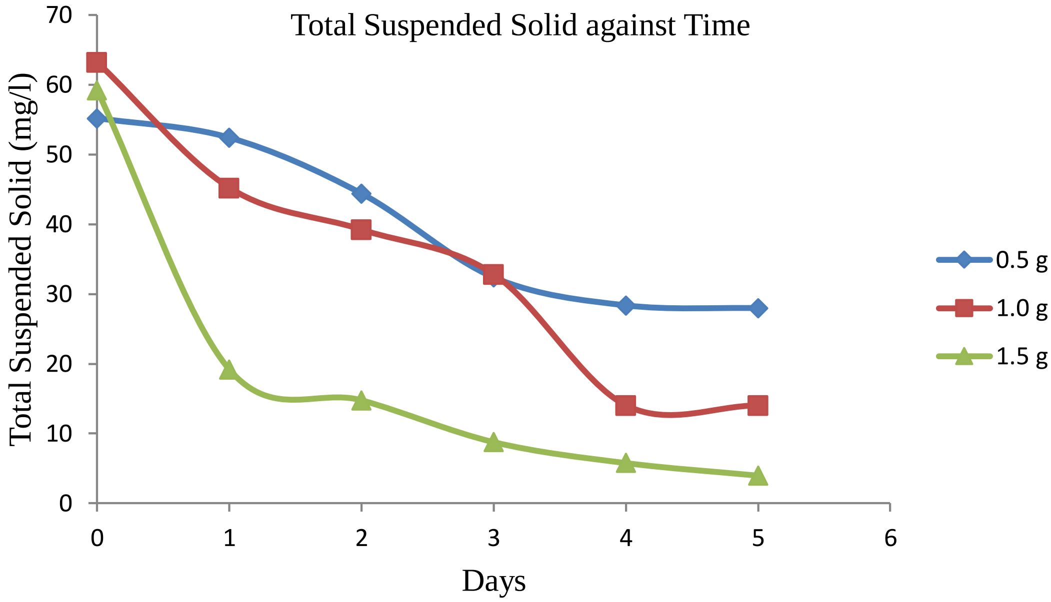

Figure 4. The effect of mussel shell adsorbent in the removal of TSS

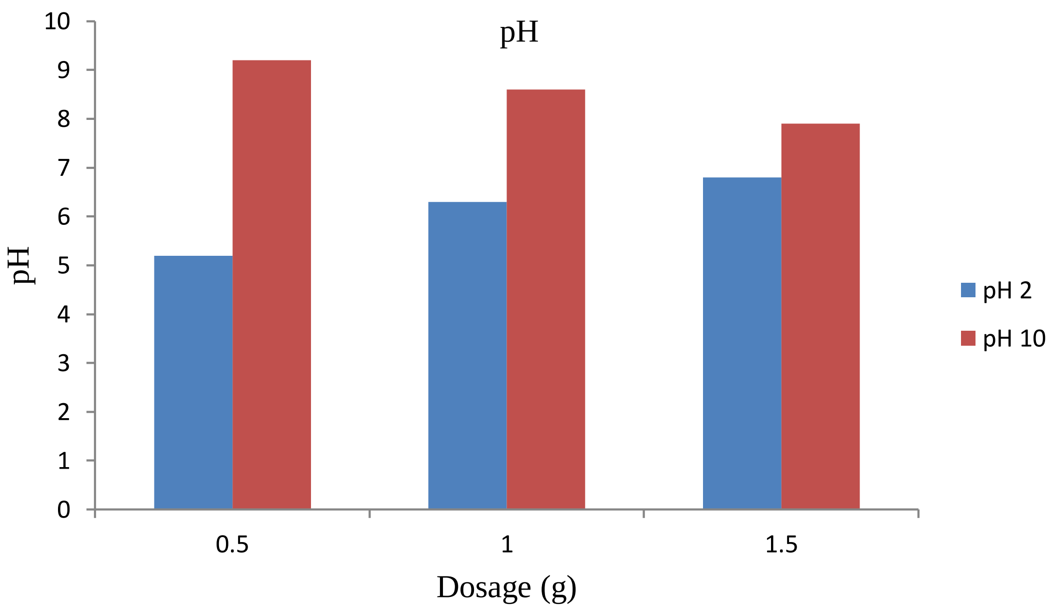

Figure 5. The effect of mussel shell adsorbent in pH

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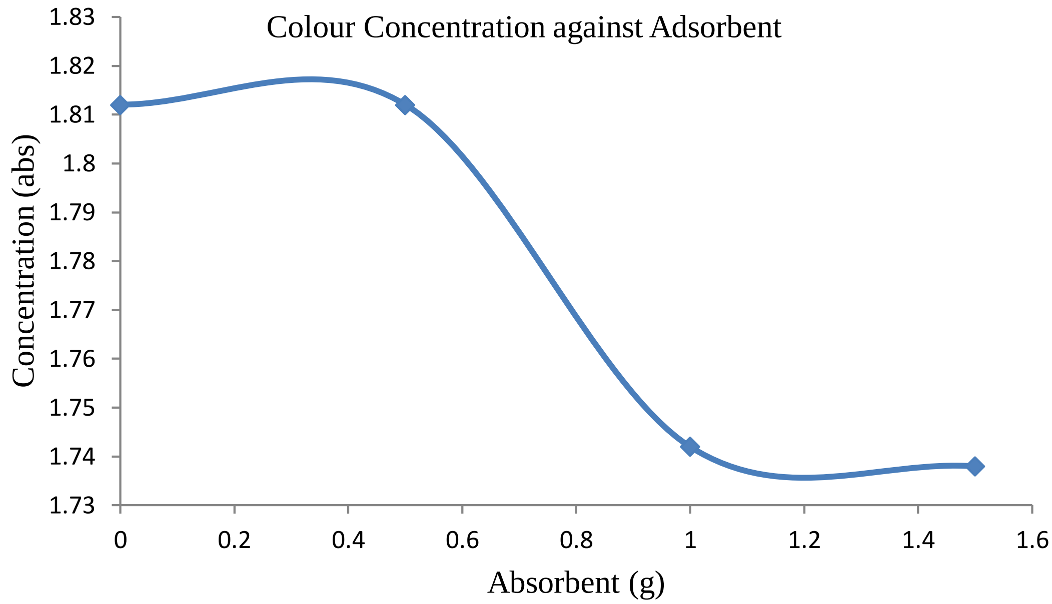

Figure 6. The effect of mussel shell adsorbent in colour concentration