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# PRODUCTION OF ACTIVATED CARBON FROM DRY COCONUT SHELL AND ITS EFFICACY IN TREATING WASTE WATER

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**Abstract:** Activated carbon is a non-graphite form of carbon which could be produced from any carbonaceous material.Activated carbons are increasingly used as the economic and stable mass separation agent for the removal of surfactants to raise the final product quality many industrial processes. Activated carbons also play an important role in many areas of modern science and technology such as purification of liquids and gases, separation of mixtures and catalysis. The main objective of the study is to produce activated carbon from dry coconut shell and to treat the domestic waste water and to recycle the treated water for home gardens. The higher purity, negative cost, high rate of production and strong carbonaceous structure of coconut shell proves to be a precursor for carbon production. This research will pave way for the recycle and reuse of waste water that could further reduce the level of water pollution.

**Key words**: activated carbon, coconut shell, waste water, muffle furnace.

## INTRODUCTION

Water covers 70% of the earth's surface and makes up over 60% of the human body. In ancient India, water was considered as an inexhaustible gift of God and water was pure because the effluents at that time were limited (Mehta*et al*;2004). But as modern technology demand more and more water, ways must be constantly devised to tap new resources and to make reuse of water. Safe water is the doorway to health and health is the prerequisite for progress, social equity and human divinity (Sudha et al; 2009). Provision of safe and convenient water supply is the single most activity that could be undertaken to improve the health of the people.

Most of the environmental problems of the present day including pollution are essentially man made. Water pollution is the contamination of natural water bodies by chemical, physical, radioactive or pathogenic microbial substances making way for unsustainable life. Water pollution affects marine ecosystems, wildlife health, and human well-being(Brick*et al*;2004). Adverse alteration of water quality presently produces large scale illness and deaths, accounting for approximately 50 million deaths per year worldwide, most of these deaths occurring in Africa and Asia.

Nowadays, water quality has become the popular issue in this worldwide. People are increasingly concerned about contaminants in their drinking water that cannot be removed by water softeners or physical filtration(Thompson *et al*;2003). Therefore, it needs treatment to make it safe for human and all living things in this world. There are many types of treatment that can improve water quality. One of the treatments is using activated carbon as a wastewater pollutant removal.

Activated carbon is a form of carbon species that is processed and prepared to have high porosity and very large surface area available for adsorption(Ahmedna,*et al;*2000) Coconut shell is suitable for preparing microporous activated carbon due to its excellent natural structure and low ash content. Activated carbon can be produced by chemical activation or physical activation. Coconut shell carbons have several advantages like high density, high purity. They are virtually dust-free, since they are harder and more resistant to attrition (Elsheikh*et al*;2003). There is a uniform pore structure distribution, with the majority of pores having size in the microporous range.

Activated carbon is used in gas purification, gold purification, metal extraction, waterpurification, medicine, sewage treatment, air filters in gas masks and respirators, filters incompressed air and many other applications (Hammer, 2001).Recently activated carbon filters have gained popularity among recreational users of Cannabis,and other smoking herbs for their use in effectively filtering out "Tar" from the smoke.

They are becoming quick competition for Vapourizers as they are only a fraction of the cost and achieve nearly the same thing. One major industrial application involves use of activated carbon in the metal finishing field. It is very widely employed for purification of electroplating solutions.

In environment field activated carbon adsorption has numerous applications in removingpollutants from air or water streams both in the field and in industrial processes such as spillcleanup, Groundwater remediation , Drinking water filtration , Air purification , Volatile organic compounds capture from painting, dry cleaning, gasoline dispensing operations, and other processes(Khalili*et al* ; 2000).In medical applications activated carbon is used to treat poisonings and overdoses following oral ingestion. It is thought to bind to poison and prevent its absorption by the gastrointestinal tract. In cases of suspected poisoning, medical personnel administer activated charcoal on the scene or at a hospital's emergency department.

It is a well known fact India is a largest producer and exporter of coconut and coconut products in the world. India is also the 3rd largest producer of coal. In India these are 12 major ports and 135 minor ports which are well connected by a road system that it makes it very easy for transportation around 25000 tons of activated carbon and importing 1000 tons of activated carbon every year(Srinivasakannan *et al;*2006). In the global scenario, the demand for activated carbon is around 0.50 million tons per annum with a global growth rate of 22 – 30% per annum.

Activated carbon produced from coconut shells typically have a tighter, more micro porous pore structure than their coal based counter parts (Kim*et al*; 2001). This is due to the inherent pore structure of the raw material coconut shell as compared to raw material coals. This micro porosity lends itself towards certain applications where activated carbon is used (Tam*et al*; 1999). Also, coconut shell – based carbons tend to be harder, more resistant to abrasion and lower in ash than similar grades of coal based carbonwhich renders it more effective for the adsorption of gas/vapor and for the removal of color and odor of compounds.

Activated carbons are increasingly used as the economic and stable mass separation agent for the removal of surfactants to raise the final product quality many industrial processes. Activated carbons also play an important role in many areas of modern science and technology such as purification of liquids and gases, separation of mixtures and catalysis. Adsorption of activated Carbon is governed by the chemical nature of the aqueous phase, the solid phase and the chemical nature of the absorbing organic.

Due to its high degree of micro-porosity, just one gram of activated carbon has a surface area in excess of 500m$^2$, as determined by adsorption isotherms of carbon dioxide gas at room or 0.0°C temperature. The activated carbon is extensively used in the refining and bleaching of vegetable oils and chemicals solutions, water purification, recovery of solvents and other vapours, recovery of gold, in gas masks for protection against toxic gases, in filters for providing adequate protections against war gases/nuclear fall outs, etc.

Activated carbons are carbonaceous materials that can be distinguished from elemental carbon by the oxidation of the carbon atoms found on the outer and the inner surfaces. These materials are characterized by their extraordinary large specific surface areas, well-developed porosity and tunable surface-containing functional groups. For these reasons, activated carbons are widely used as adsorbents for the removal of organic chemicals and metal ions of environmental or economic concern from air, gases, potable water and wastewater. The surface oxygen functional groups can be easily introduced by different activation methods. Activated carbon usually increases the cost of the treatment process. Its economical drawback has stimulated the interest to utilize cheaper raw materials for the production of activated carbon.

All activated carbon s contain micropores, mesopores and macropores within their structure but the relative proportions vary considerably according to the raw material. Most of the developed nations have facilities to activate coconut shell, wood and coal. Third world countries have recently entered the industry and concentrate on readily available local raw materials such as wood and coconut shell. The significant feature of activated carbon is that it makes a unique and a particularly economic adsorbent is that it can be produced from waste materials such as coconut shell. Hence, the objective of the investigation is to prepare the activated carbon using coconut shell and to treat the polluted water and domestic waste water using activated carbon.

## MATERIALS AND METHODS

### Collection of raw materials

The coconut shells which are raw materials used for the production of activated carbon were collected and then pre-treated before activated carbon was produced.

### Pre-treatment of raw materials

The coconut shells were dried in the sun for 6 to 8 hours. Later the dried shells were crushed using a hand crusher to very fine powder. The crushed powder was then sieved and only the powder was selected as precursor for the production of activated carbon. It is then exposed to various environment conditions to produce activated carbon by carbonization method.

### Carbonization method

Samples were collected after crushing to obtain particles of smaller size. The samples were exposed to light and humanity for to enhance the development of the pore structure during pyrolysis. The above mentioned steps promote uniform carbonization reactions during the pyrolysis. The dried, light and humidity treated coconut pieces were placed into a muffle furnace. The pyrolysis was carried out under at 500-800°C (depending on the set activation temperature) for 1 to 2 h (depending on the decided activation time).The temperature was reached at a rate of approximately 20°C per minute. Upon completion of the pyrolysis, the sample was removed from the reactor and crushed. Then the chemical activated product was dried and stored for characterization. Then the product was taken for sieving and collection. After being cooled to less than 100°C, the carbon was sieved to retain the 0.425-2.00mm particles. The fines can be separated and bagged separately as powdered carbon. The 0.425-2.00-mm activated carbon can then be taken for bagging and storage and the final yield for steam-activated coconut shell was produced.

### Collection of water samples and its treatment with activated carbon

The polluted water samples were collected from Singanallur Lake from Coimbatore city for the study purpose. The domestic waste waterwas collected from a hotel near the PSGR Krishnammal College campus, Coimbatore.For each experimental run, 1 kg of activated carbon and 250 gm of sand was mixed well in a tray. Then it was filled in gunny bags which were later stitched on the four sides. The domestic waste water and polluted water is taken in two clean buckets respectively. The gunny bags with activated carbon are then introduced into both the buckets. The water quality parameters were checked for physicochemicalparameters as per standard methods before and after the treatment and the efficiency dose of activated carbon was determined.

## RESULTS AND DISCUSSION

The carbonization of the precursor, coconut shells led to a char (solid yield of 25.1%) with the textural characteristics is inferred from the $N_2$ and $CO_2$ adsorption isotherms. It could be concluded that the char was essentially microporous in nature. Also, the char contained a significant volume of macropores.

Since the overall reaction is exothermic i.e. converting carbon to carbon dioxide, it is possible to utilize this energy and have a self-sustaining process.

$$C + H_2O \text{ (Steam)} \rightarrow CO + H_2 \text{ (-31 K cal)}$$

$$CO + \tfrac{1}{2} O_2 \rightarrow CO_2 \text{ (+67 Kcal)}$$

$$H_2 + \tfrac{1}{2} O_2 \rightarrow H_2O \text{ (steam) (+58 Kcal)}$$

$$C + O_2 \rightarrow CO_2 \text{ (+94 K cal)}$$

The results of this study show that it is feasible to prepare activated carbons with relatively high surface areas and pore volumes from paper sludge by direct chemical activation. A longer activation time could induce negative effect on the carbon structure, and, thus, decrease the iodine value. In order to have a high surface area carbon and to minimize the energetic cost of the process, the following optimal conditions, impregnation time of 2 hours, activation temperature of $70^0$ C for 1 hr were achieved. Under these conditions, activated carbon with relatively high specific surface area was produced from dry coconut shell using steam activation. The porosity of the product was comparable with that of commercially achieved carbon, indicating its micro porous and mesoporous character.

Table 1 showed the physicochemical parameters in both polluted and domestic water as per standard methods before the treatment. The pH of the polluted water was 9.2, TDS was 1873 mg/l, TSS level was 7.5 mg/l, alkalinity was 733 mg/l and hardness was 476.5. mg/l. The physic-chemical parameters of domestic waste water were as followed: pH was 8.5, TDS, 10200 mg/l.TSS ranged about 19.50 mg/l, alkalinity was 2125 mg/l and hardness 476.5mg/l. The comparative pH values of polluted and domestic waste water after treatment with activated carbon was shown in Figure 1.The pH of the polluted water and domestic waste water decreased after three weeks of treatment with activated carbon.

Figure 2 showed the total dissolved solids of polluted and domestic waste water after treatment with activated carbon.TDS was 1726 mg/l after first week of treatment and decreased to 1225 mg/l after three weeks in polluted water.TDS value was 9470 mg/l in the first week of treatment and gradually decreased to 7320 mg/l after three weeks in domestic waste water. The TSS values of polluted and domestic waste water was depicted in Figure 3.TSS value of polluted water was 2.50 mg/l compared to the control value 7.50.TSS of domestic waste water was 18.3 in the first week and decreased to 14.2 after three weeks of treatment.

Figure 4 showed the alkalinity values of polluted and domestic waste water after three weeks of treatment. It was shown that alkalinity values were 673.5 mg/l in the first week when compared to control value 733 mg/l in polluted water. In domestic waste water, alkalinity was 1925 mg/l in the first week and gradually decreased to 570.3 mg/l after three weeks.The comparative hardness values of polluted and domestic waste water were shown in Figure 5. The hardness level in polluted water was 412 mg/l in untreated water and the level decreased quite considerably after three weeks. The hardness was 476.5 mg/l in domestic waste water and the values decreased from 361.97 mg/l to 123.25mg/l after three weeks of treatment.

**CONCLUSION**

The results of this study show that it is feasible to prepare activated carbon with relatively high surface areas and pore volumes from paper sludge by direct chemical activation. The coconut shell activated carbon gives more scope for application in wider areas like treatment of drinking water, industrial process water and waste water. The activated carbon thus obtained has the ability to absorb the colour, odour and suspended particles that is present in water and reduces pollution.

**REFERENCES**


1. Ahmedna, M. Marshall, W. E. &Rao, R.M.2000. Production of granular activated carbons from select agricultural by-products and evaluation of their physical, chemical and adsorption properties. BiosourceTechnology, 71), 113-123.
2. Brick, T., B. Primrose, R. Chandrasekhar, S. Roy, J. Muliyil, and G.Kang. 2004. Water contamination in urban south India:household storage practices and their implications for water safety and enteric infections. *International Journal of Hygiene and Environmental Health* **207**: 473–480.
3. Elsheikh A., Newman A., Al-Daffaee H., Phull S. andCrosswell N.2003. Characterization of activated carbon prepared from a single cultivar of Jordanian olive stones by chemical and physicochemical techniques. J.Anal. Appl. Pyrolysis, 30, 1-16 .
4. Hammer MJ (2001). *Water and wastewater technology*. 4th ed. Prentice-Hall Inc.
5. Khalili N. R., Campbell M., Sandi G. and Gola J.2000. Production of micro and mesoporous activated carbon from paper mill sludge, I: Effect of zinc chloride activation. Carbon, 38, 1905-1915 (2000).
6. Kim, J.W. Sohn, M. H.Kim , D. S.Sohn, S. M.& Kwon, Y. S.2001.Production of granular activated carbon from waste walnut shell and its adsorption characteristics for Cu2þ ion. Journal of Hazardaous Materials,85(3), 301–315.

**7.** Mehta, M., A. Dass and K. J. Singh.2004. Keeping quality of drinking water. *Human Ecology* **16**: 125-128.

**8.** Srinivasakannan C. and Abu Baker M.Z.2006. Production of activated carbon from rubber wood sawdust. Biomass Bioenergy in press.9, 234-235.

**9.** Sudha, V. B. P., K. O. Singh, S. R. Prasad and P. Venkatasubramanian.2009. Killing of enteric bacteria in drinking water by a copper device for use in the home: laboratory evidence. Transactions of the Royal Society of Tropical Medicine and Hygiene **103**:819–822.

**10.** Tam, M. and Antal, M., 1999. Preparation of Activated Carbons from Macadamia Nut Shell and Coconut Shell by Air Activation. Ind. Eng. Chem. Res. 38, 4268-4276.

**11.** Thompson T, Sobsey M, Bartram J.2003. Providingclean water, keeping water clean: an integrated approach. Int J Env Health Res 2003,13:S89-S94.

**Muffle furnace used for experimentation**

**Coal pieces obtained after pyrolysis**

**Powdered activated carbon obtained by carbonization method**

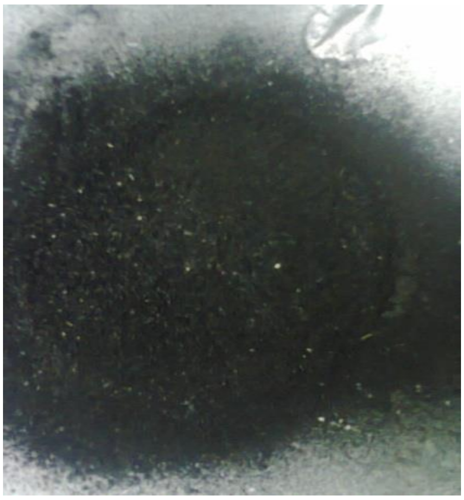

**Table 1 Physiochemical parameters of the polluted and domestic waste water before treatment with activated carbon**

| Parameters | Polluted water | Domestic waste water |
|---|---|---|
| pH | 9.2 | 8.5 |
| TDS(mg/l) | 1873 | 10200 |
| TSS(mg/l) | 7.50 | 19.50 |
| Alkalinity | 733 | 2125 |
| Hardness | 412 | 476.5 |

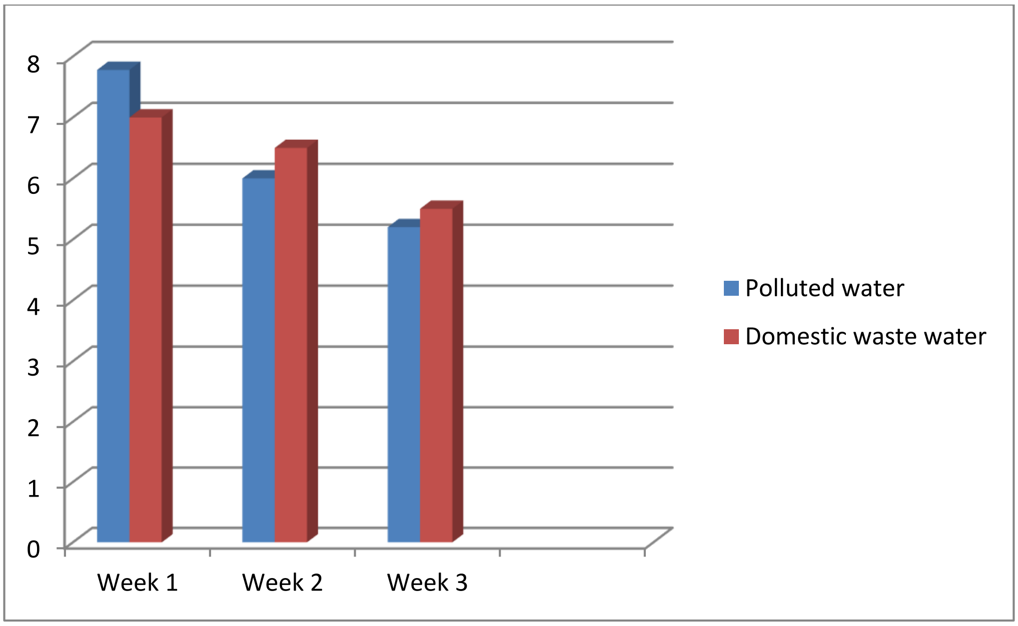


**Figure 1: Comparative pH values of polluted and domestic waste water after treatment with activated carbon**

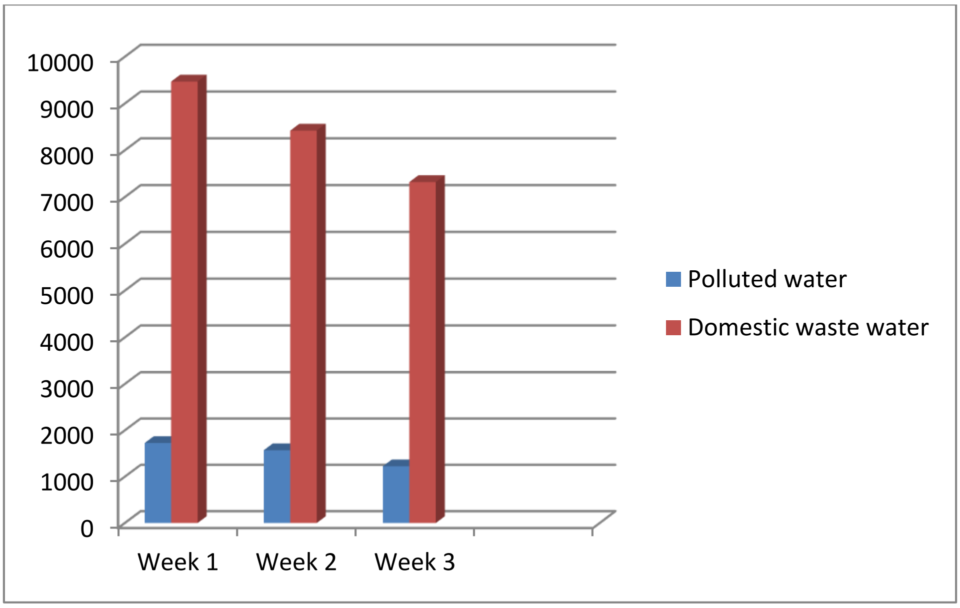


**Figure 2: Comparative Total dissolved solids of polluted and domestic waste water after treatment with activated carbon**

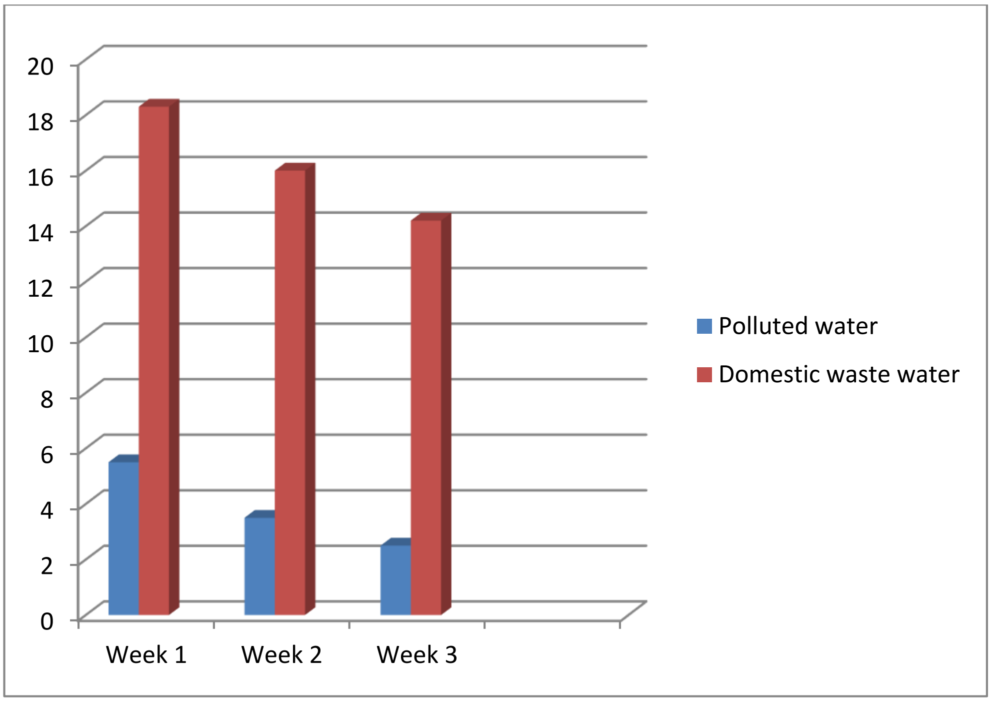


**Figure 3: Comparative TSS values of polluted and domestic waste water after treatment with activated carbon**

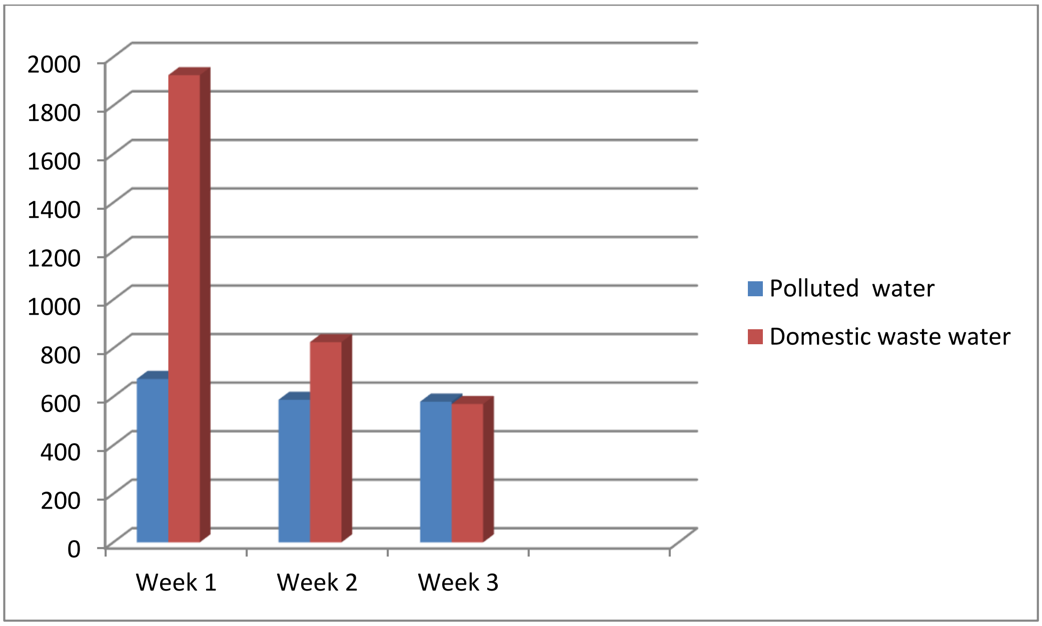


**Figure 4: Comparative alkalinity of polluted and domestic waste water after treatment with activated carbon**

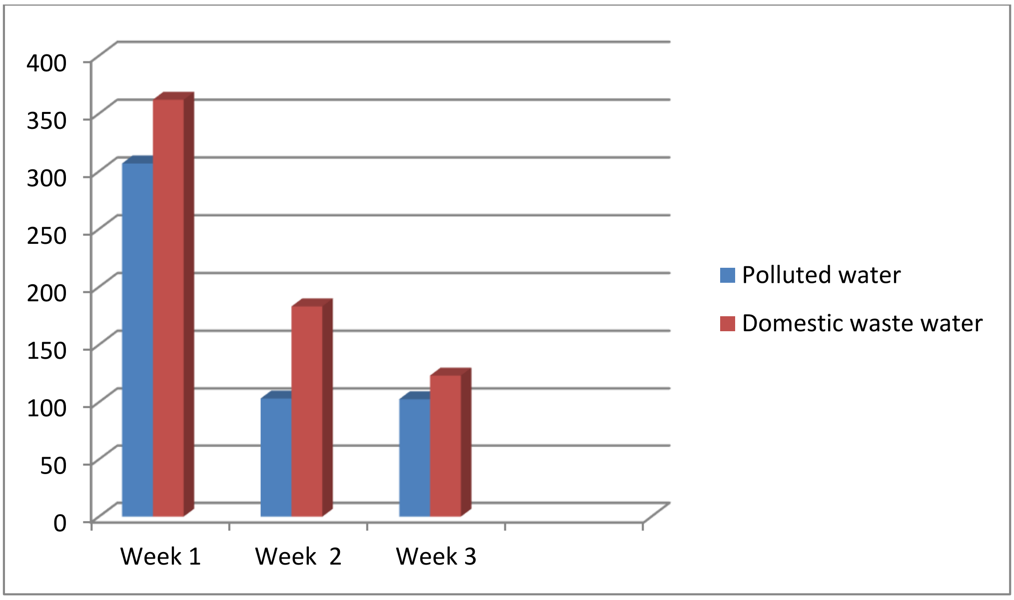


**Figure 5: Comparative hardness of polluted and domestic waste water after treatment with activated carbon**