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Water Treatment by Using Thermally Activated Carbon Prepared from the Shells of *Arachis Hypogaea*

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Abstract Large quantity of polluted water is utilized worldwide without any pretreatment. The application of thermally prepared activated carbon minimize imports of commercial activated carbons thus, results in poverty elimination of developing countries. Arachis Hypogaea was obtained from agro-waste, dried at 110°C for 8 hours and Sieved under 2mm mesh for further use. The sieved material was slowly pyrolyzed for 60 minutes at 300°C in a muffle furnace. In a subsequent stage Arachis Hypogaea was thermally carbonized in a muffle furnace for 120 minutes at 500°C temperature to obtain Activated Carbon. Systematic experimentation was carried out in terms of dosage and timings were observed. Scientific analysis was carried out by using Scanning Electron Microscope (SEM) and Energy-dispersive X-ray spectroscopy (EDS) for the identification of micro and macro structures. Activated carbon prepared from biomass of Arachis Hypogaea was used to minimize substantial pollution load. There was dramatic reduction found in the crucial parameters like Temperature, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Turbidity at low dosage whereas significant variations are also observed with respect to various dosage. Activated Carbon prepared is a cost-effective, ecofriendly and environmentally sound adsorbent which may be used for the treatment of water.

Keywords: *Arachis Hypogaea, Activated Carbon, Water Purification, peanut shell, carbonization, SEM, EDS*

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1. Introduction

Water is crucial liquid required for maintenance and regulation of ecological systems. According to the reports of UN Habitat and WHO, (2021), approximately 56 percent of wastewater produced by household sources globally in 2020 [1]. About 1 billion people get affected due to untreated water every year [2]. In developing countries nearly 2.1 billion people lack access to safe water and 844 million people lack even basic water supply [3]. Access to clean water is the key to sustainable development and is essential for food production, quality health and poverty reduction. Drinking water is essential for all kind of lifeforms which must be safeguarded and supplied [4].

Activated carbon is a great adsorbent in water Purification, and itself is a green, pollution-free Substance. Its loose and porous nature and large specific surface area make it to have excellent purification potential. Activated carbon not only has good adsorption performance and low price, but also has exceptional properties such as recyclability and is widely used in water purification. In order to maximize the adsorption volume of activated carbon in water treatment, better serve water treatment, save cost, reduce energy consumption and improve productivity has become a basic research standard [5, 6]. The foundation of activated carbon (AC) is connected to early Egypt (1500 BC), and the Egyptians utilized its adsorption properties for water treatment and for medical goal. In recent years, the Swedish chemist reported on the adsorption of gas on coal [7,8]. Activated carbons deals with enormous spectrum of pore configurations. It is a more effective adsorbent that can be used to remove many contaminants (biological, organic and inorganic) of concern in water and wastewater treatment [9]. Activated carbon is used in drinking water filtration, catalyst carriers, industrial processes, gas purification, liquid chemicals, wastewater treatment, syrup purification, cosmetics, drugs, and health products [10,11,12]. In recent years, it has been utilized to control water pollution, air pollution, peculiar odors, etc., and its demand is also increasing [13]. It involuntarily acts as a tool in cost effective and significant wastewater treatment [14]. It is used for sequestration of carbon [15,16]. Black carbon is likely the most common term for PCM scatter in the environment through the atmosphere, water bodies, sediment and soil. It can be of anthropogenic origin (burning of fossil fuels - soot) or of natural origin like burning of plants [15,16,17]. Various types of Agro wastes, like Peanut shell [18], Coconut shell [19], Palm shell [20], Coffee residue [21], and Castor shell

[22], can be used as cost effective precursors for the Production of activated carbon [23]. Activated carbon Made-up from *Arachis Hypogaea* (Peanuts Shell) is proven to be efficient of discarding lead from raw water effectively [24,25]. The AC formed by waste and raw biomass such as Peanut shell, Coconut shell, Moringa oleifera seed, Pomegranate Peel, Rice Husk Ash, Lemon-Banana peel and Orange peels are the tremendously useful component for treating the contaminated water [26].

Arachis Hypogaea (Peanuts Shell) resources, which are ample but have a short consumption rate which is frequently used as animal fodder. The carboxyl groups and phenolic hydroxyl groups carried in the *Arachis Hypogaea* exhibits robust adsorption reaction after chemical moderation, making the act of the absolute activated carbon. Thus, *Arachis Hypogaea* (Peanuts Shell) can be used to produce activated carbon for treatment of Polluted water [23].

1.1. Significance of the Study

Present work provides a solution towards treatment of contaminated water which is potable by using low-cost adsorbent i.e. *Arachis Hypogaea (Peanuts Shell)* based activated carbon. It will expand attempts to supply society with water free of Contaminants. Present study acts as an important tool to fulfil the productive demand of Activated Carbon for the wastewater treatment. Additionally, the utilization of locally made agro-wastes based activated carbon would reduce imports of commercial activated carbon thus, contributing towards poverty elimination in developing countries Like India. In the present research work powdered and granular (PAC & GAC) form of activated carbon was used. GAC & PAC are widely used for purification of drinking water. It studies various water parameters like Temperature, pH, Electrical Conductivity, TDS and Turbidity. With the characterization of Activated Carbons Like Scanning Electron Microscope (SEM) study and analysis of Energy-Dispersive X-ray Spectroscopy (EDS).

2. Material and Methods

2.1. Experimental

The present study was carried out in Department of Environmental Science and laboratory analysis was made in SBES college Laboratory. SEM coupled with EDS analysis carried out at Central Facility for Advanced Research & Training Center (CFART), Dr. Babasaheb Ambedkar Marathwada University, Aurangabad (MS), India.

2.2. Sampling and Sample Preparations

Agro-Waste includes *Arachis Hypogaea* (Peanuts Shell) was Obtained from local market in Aurangabad City (MS), India, washed by distilled water to remove impurities and dried at 110°C for 8 hours, cooled before crushing and Sieving under 2mm mesh for further use [25].

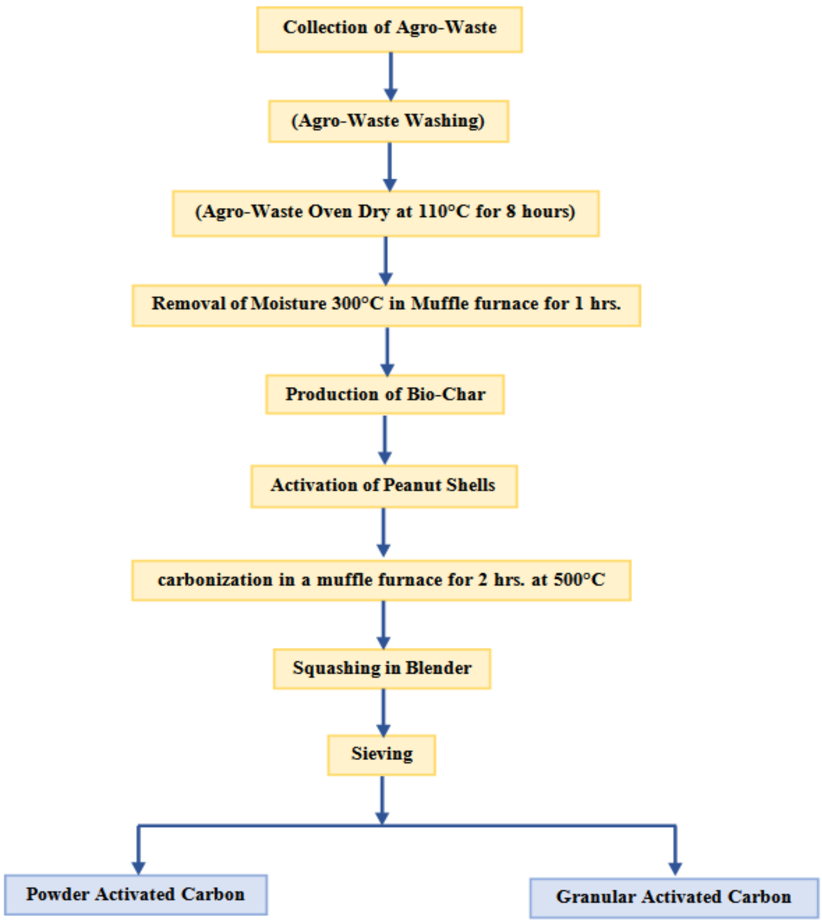


Figure 1. flow diagram for the Preparation of Activated Carbon made up from Arachis Hypogaea

2.3. Carbonization and Thermal Activation

Activated carbon is Pyrogenous Carbonaceous Material (PCM) which was manufactured by thermochemical conversion of carbonaceous feedstock (activation/ pyrolysis) [15,16,17]. The adsorption limit of activated carbon depends on the porosity and chemistry of the surface [14]. Collected washed *Arachis Hypogaea* stem was air dried and kept airtight in the aluminum foil after making small pores. The airtight biomass of *Arachis Hypogaea* was placed in the Muffle Furnace. Material was slowly pyrolyzed for 60 minutes at 300°C in a muffle furnace in order to obtain charcoal shown in Figure 1 [27].

The Sample of *Arachis Hypogaea* was thermally carbonized in a muffle furnace for 2 hrs. at 500°C temperature shown in Figure 1. The sample was squashed with Mixer and sieved to a size smaller than 2mm to obtain PAC (Powered Activated Carbon) and remaining material was GAC (Granular Activated Carbon) [27,28].

2.4. Dosage Experiment for GAC and PAC

The removal trials for the GAC and PAC were evaluated as batch method in the 100 mL flask with 50 ml of sample for each in Conical flask. Batch study was analyzed through PAC 1, PAC 2, PAC 3, PAC 4, PAC 5 and GAC 1, GAC 2, GAC 3, GAC 4, GAC 5. Volume of AC taken is respectively 0.25, 0.50, 0.75, 1.00, 1.25 gm for all GAC's 1-5 and PAC's 1-5. Moreover, these samples of GAC1-GAC5 and PAC1-PAC5 mixtures were shaked thoroughly by using an orbital shaker at rpm 150 ± 1.5 hr. The mixture of all GAC1-GAC5 and PAC1-PAC5 was filtered through a Whatman filter papers (size 42μ) in beaker, it was poured in airtight bottles (100 ml) for further analysis. Free space kept in airtight bottle after pouring the sample in it. The analysis of GAC1-GAC5 and PAC1-PAC5 was carried out in laboratory by using Systronics μ-pH System 361, Systronics Conductivity meter 306 and μP multi parameter analyser to analyze the physical parameters eg. Temperature, pH, Electrical Conductivity, TDS and Turbidity. Sample was analyzed under Scanning Electron Microscope (JEOL, Model: JSM-6510) and Energy−dispersive X−ray spectroscopy (EDS) (INCAx-act, Model: 51- ADD0076).

3. Statistical and Graphical Analysis of PAC and GAC Results

3.1. Statistical Methodology

A sample t-test was used to test significant difference in the mean of sample data and specified value. Generally, when p value is less than 0.05 (level of significance) then null hypothesis rejected at 5% level of significance otherwise it is accepted. When null hypothesis rejected there is significant difference in the mean of the sample data and the specified value. Statistical formula for t test is given below,

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} \quad (1)$$

Where,
$\bar{x}$ -Sample mean
μ- Population mean (claimed value)
s- Sample standard deviation
n- Sample size
t- Test statistic

3.2. T Test Analysis

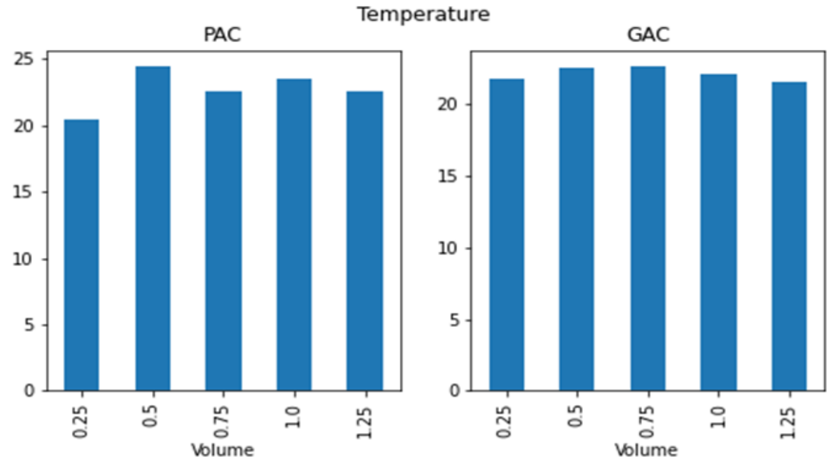
To test the significance of PAC and GAC treatment the initial value of water parameter and parameter value after the PAC treatment and GAC treatment compared. For this comparative statistical analysis one sample t test was formulated using above formula 1. T test results from the R-Studio have been shown in following Table 1. and Table 2.

Table 1. t-test results for PAC

Water Parameter	Initial Value	Mean value	CPCB/BIS Standard	t test statistic	p-value
Temperature (°C)	20.8	22.66	20-25	2.79	0.0493
pH	7.9	8.32	6.5-8.5	1.45	0.2195
Electrical Conductivity	813.1	1.2074	2000	-12510.00	0.0000
Total Dissolve Solids	323	78	500	-98.48	0.0000
Turbidity	0.8	0.024	1	-129.33	0.0000

Table 2. t-test results for GAC

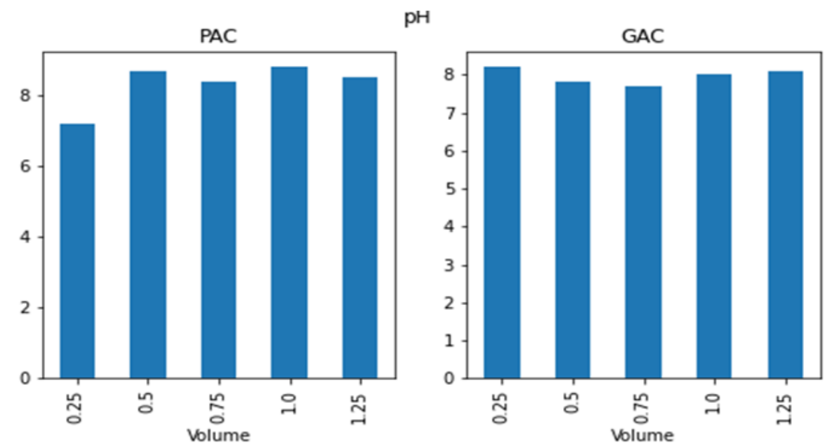
Water Parameter	Initial Value	Mean value	CPCB/BIS Standard	t test statistic	p-value
Temperature (°C)	20.8	22.12	20-25	6.83	0.0024
pH	7.9	7.96	6.5-8.5	0.65	0.5529
Electrical Conductivity	813.1	932.3	2000	10.56	0.9998
Total Dissolve Solids	323	274.2	500	-2.54	0.0319
Turbidity	0.8	0.28	1	-8.92	0.0004



*$H_{01:}$ There is no significant difference in the initial temperature reading and mean temp after the PAC treatment.
Vs $H_{a1:}$ There is significant difference in the initial temperature reading and mean temp after the PAC treatment.

*$H_{01:}$ There is no significant difference in the initial temperature reading and mean temp after the GAC treatment.
Vs $H_{a1:}$ There is significant difference in the initial temperature reading and mean temp after the GAC treatment.

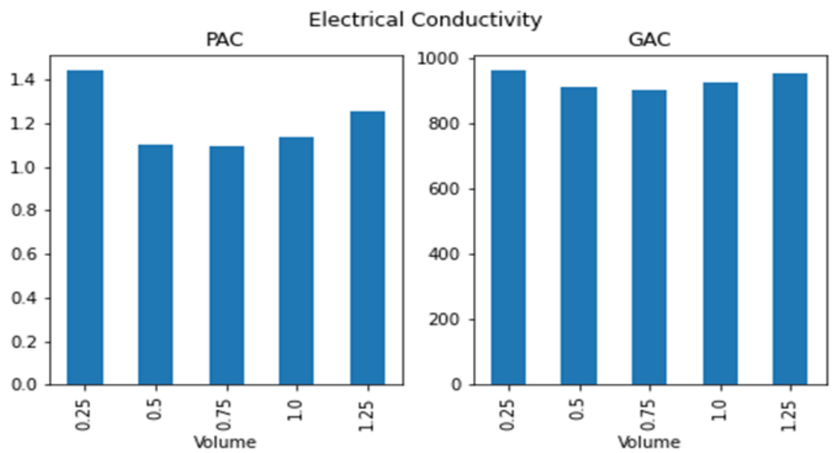
Figure 2. Graphical Representation of Temperature during analysis of PAC and GAC



*$H_{02:}$ There is no significant difference in the initial pH reading and mean pH after the PAC treatment.
Vs $H_{a2:}$ There is significant difference in the initial pH reading and mean pH after the PAC treatment.

*$H_{02:}$ There is no significant difference in the initial pH reading and mean pH after the GAC treatment.
Vs $H_{a2:}$ There is significant difference in the initial pH reading and mean pH after the GAC treatment.

Figure 3. Graphical Representation of pH during analysis of PAC and GAC



*$H_{03:}$ There is no significant difference in the initial Electrical Conductivity reading and mean Electrical Conductivity after the PAC treatment.
Vs $H_{a3:}$ There is significant decrease in the initial Electrical Conductivity reading after the PAC treatment.
*$H_{03:}$ There is no significant difference in the initial Electrical Conductivity reading and mean Electrical Conductivity after the GAC treatment.
Vs $H_{a3:}$ There is significant decrease in the initial Electrical Conductivity reading after the GAC treatment.

Figure 4. Graphical Representation of Electrical Conductivity during analysis of PAC and GAC

3.2.1. Temperature

From the test results in Table 1 & Figure 2, p value for PAC is 0.0493 which is less than 0.05 (level of significance). Since, here null hypothesis rejected at 5 % level of significance. So it is concluded that after PAC treatment there is significant difference in the mean value of temperature than initial reading. From the test results in Table 2 & Figure 2, p value for GAC is 0.0024 which is less than 0.05(level of significance). Since, here null hypothesis rejected at 5 % level of significance. So it is concluded that after GAC treatment there is significant difference was observed in the mean values of temperature than initial reading. Mean temperature values after the PAC and GAC were within the BIS/CPCB standards.

3.2.2. pH

From the test results in Table 1 & Figure 3, p value for PAC is 0.2195 which is greater than 0.05 (level of significance). Since, null hypothesis can't be rejected at 5 % level of significance. So it is concluded that after PAC treatment there is no significant difference in the mean value of pH and initial reading. From the test results in Table 2 & Figure 3, p value for GAC is 0.5529 which is greater than 0.05(level of significance). Since, null hypothesis can't be rejected at 5 % level of significance. So it can be concluded that after GAC treatment there is no significant difference was observed in the mean value of pH and initial reading. Mean pH values after the PAC and GAC were within the BIS/CPCB standards.

3.2.3. Electrical Conductivity

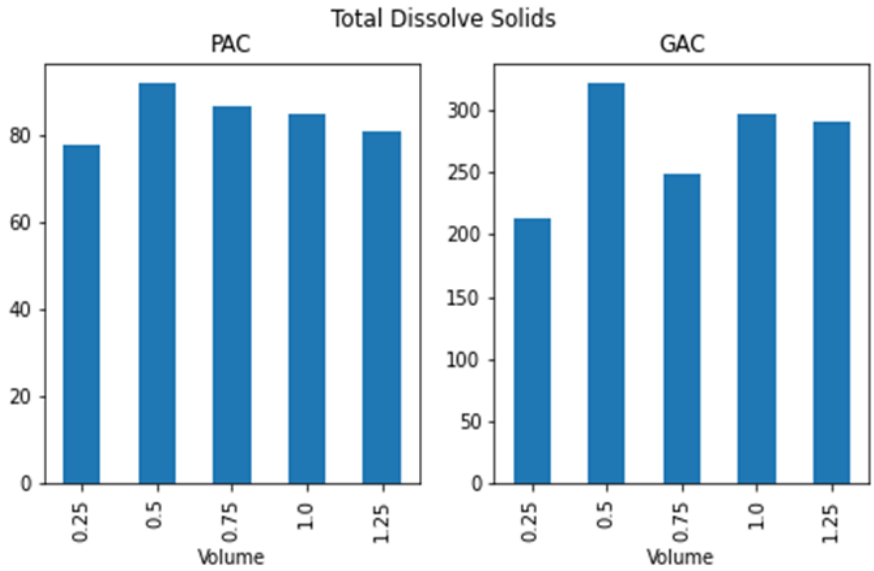
From the test results in Table 1 & Figure 4, p value for PAC is 0 which is less than 0.05(level of significance). Since, null hypothesis rejected at 5 % level of significance. So it is concluded that after PAC treatment mean value of Electrical conductivity decreased significantly than initial reading. From the test results in Table 2 & Figure 4, p value for GAC is 0.9998 which is greater than 0.05 (level of significance). Since, null hypothesis can't be rejected at 5 % level of significance. So it can be concluded that after GAC treatment there is no significant difference was observed in the mean values of Electrical conductivity than initial reading. Mean Electrical conductivity values after the PAC and GAC were within the BIS/CPCB standards.

3.2.4. Total Dissolved Solids

From the test results in Table 1 & Figure 5, p value for PAC is 0 which is less than 0.05(level of significance). Since, null hypothesis rejected at 5 % level of significance. So it is concluded that after PAC treatment mean value of Total Dissolve Solids decreased significantly than initial reading. From the test results in Table 2 & Figure 5, p value for GAC is 0.0319 which is less than 0.05(level of significance). Since, null hypothesis rejected at 5 % level of significance. So it can be concluded that after GAC treatment mean value of Total Dissolve Solids decreased significantly than initial reading. Mean Total Dissolve Solids values after the PAC and GAC were within the BIS/CPCB standards.

3.2.5. Turbidity

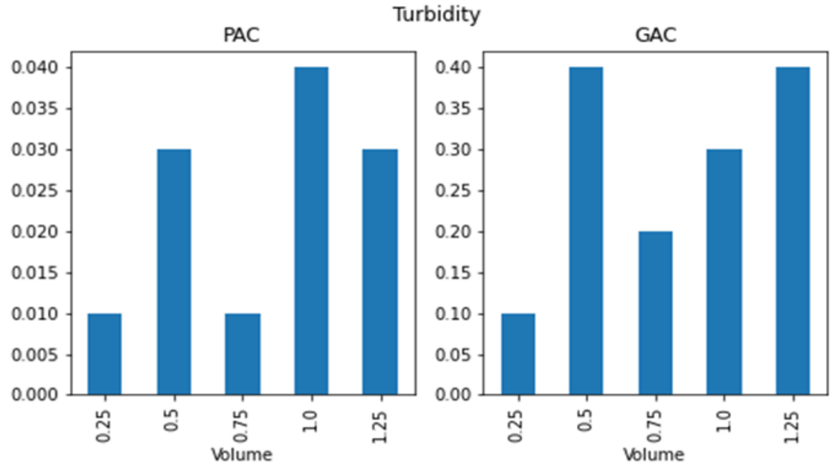
From the test results in Table 1 & Figure 6, p value for PAC is 0 which is less than 0.05(level of significance). Since, null hypothesis rejected at 5 % level of significance. So it is concluded that after PAC treatment mean value of Turbidity decreased significantly than initial reading. From the test results in Table 2 & Figure 6, p value for GAC is 0.0004 which is less than 0.05(level of significance). Since, null hypothesis rejected at 5 % level of significance. So it can be concluded that after GAC treatment mean values of Turbidity decreased significantly than initial reading. Mean turbidity after the PAC and GAC are within the BIS/CPCB standards.



*H_{04}: There is no significant difference in the initial Total Dissolve Solids reading and mean Total Dissolve Solids after the PAC treatment.
Vs H_{a4}: There is significant decrease in the initial Total Dissolve Solids reading after the PAC treatment.

*H_{04}: There is no significant difference in the initial Total Dissolve Solids reading and mean Total Dissolve Solids after the GAC treatment.
Vs H_{a4}: There is significant decrease in the initial Total Dissolve Solids reading after the GAC treatment.

Figure 5. Graphical Representation of Total Dissolve Solids during analysis of PAC and GAC



*H_{05}: There is no significant difference in the initial Turbidity reading and mean Turbidity after the PAC treatment.
Vs H_{a5}: There is significant decrease in the initial Turbidity reading after the PAC treatment.

*H_{05}: There is no significant difference in the initial Turbidity reading and mean Turbidity after the GAC treatment.
Vs H_{a5}: There is significant decrease in the initial Turbidity reading after the GAC treatment.

Figure 6. Graphical Representation of Turbidity during analysis of PAC and GAC

4. Scanning Electron Microscope (SEM) Study

SEM is considered as most reliable method to study the changes in the surface morphology characteristics of solid substances [29]. The Structure of AC before and after adsorption was analyzed using Scanning Electron Microscope (JEOL, Model: JSM-6510) coupled with Energy‐dispersive X‐ray spectroscopy (EDS) (INCAx-act, Model: 51- ADD0076). SEM Image of thermally activated PAC's and GAC's are given in Figure 7 a, b, Figure 8 a1, b1, Figure 9 a3, b3.

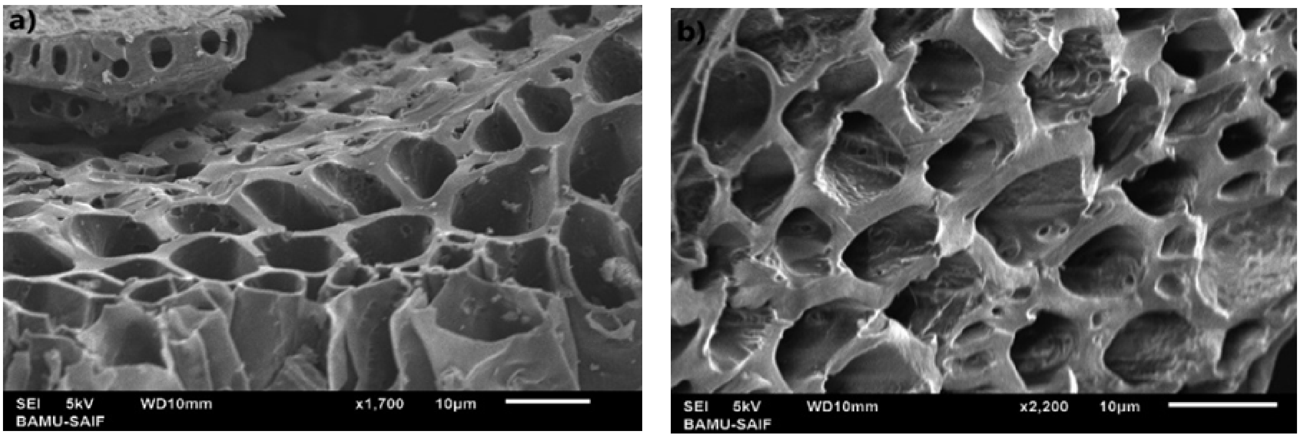


Figure 7. a) SEM image of PAC before Purification and b) SEM image of GAC before Purification

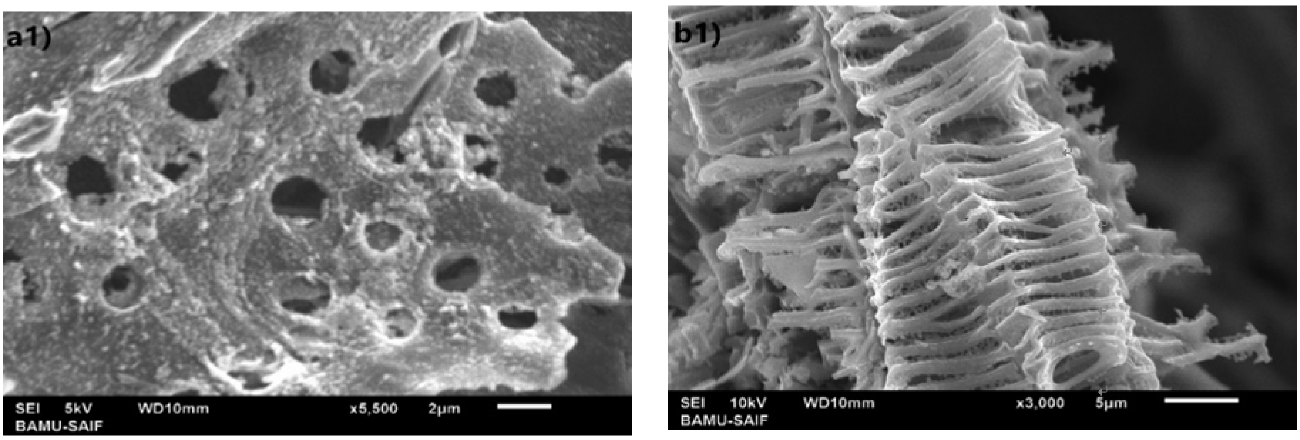


Figure 8. a1) SEM image of PAC 1 after Purification and b1) SEM image of GAC 1 after Purification

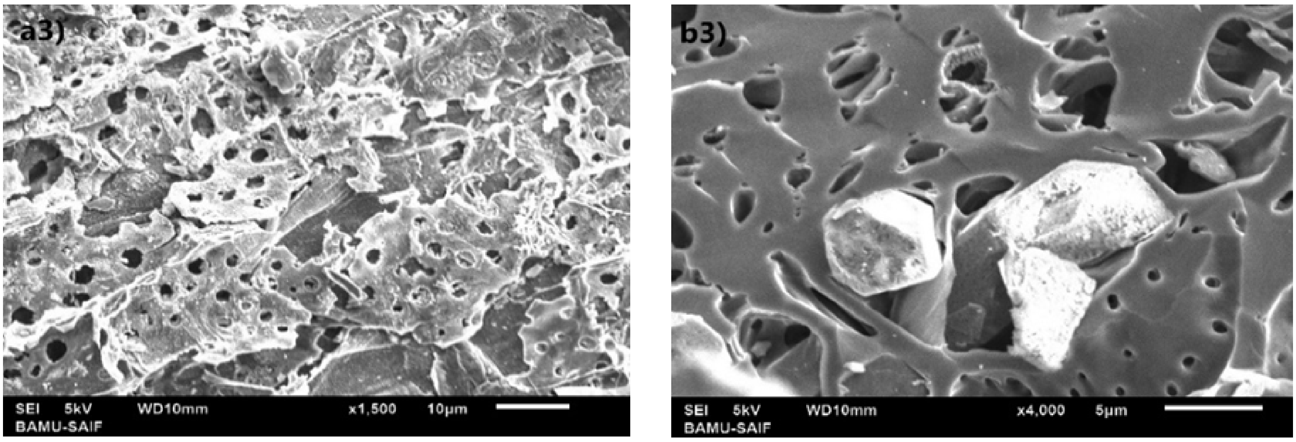


Figure 9. a3) SEM image of PAC 3 after Purification and b3) SEM image of GAC 3 after Purification

The images of PAC's and GAC's show the presence of honeycomb structure and macro-pores on the surface of AC, which provides satisfactory conditions for PAC and GAC adsorption. existence of macro-pores on the AC surface, provided favorable conditions for adsorption [30]. The surface of PAC and GAC found to be macro and micro pores structure (Figure 7 a, b). The average wall size of PAC and GAC is respectively 1.377 µm and 2.506 µm. average pore size is about respectively 1.489 by 1.909 µm and 2.148 by 2.722 µm. it shows proper activation of material made-up from biomass of *Arachis Hypogaea*. The AC surface is found to be smooth with some mineral particles evenly dispersed and some are stuck around pores (Figure 8 a1, b1, Figure 9 a3, b3). SEM analysis indicates the strong affinity of the carbon made-up from biomass of *Arachis Hypogaea* removed contaminants from given water samples.

5. Energy-dispersive X-ray Spectroscopy (EDS) Analysis

EDS study of biomass before and after Purification of *Arachis Hypogaea* AC was carried out to confirm the combination of Various elements on to the adsorbent. Energy-Dispersive X-ray spectra of the *Arachis Hypogaea* AC before and after Purification of water sample are given in Figure 10 & Figure 11. Their percentage composition is given in the Table 3. EDS of AC before purification indicates the presence of C, O, and Mg elements in the sample. The EDS of the AC after adsorption shows appearance of an additional peak of Sulphur. This appearance of a new peak, characterized as Sulphur, confirms the adsorption of Sulphur onto the AC. The EDS indicate the main compositions of C and O on the surface of Both AC's. Thus, the EDS study verifies the results obtained by SEM study results presented in the previous paragraphs.

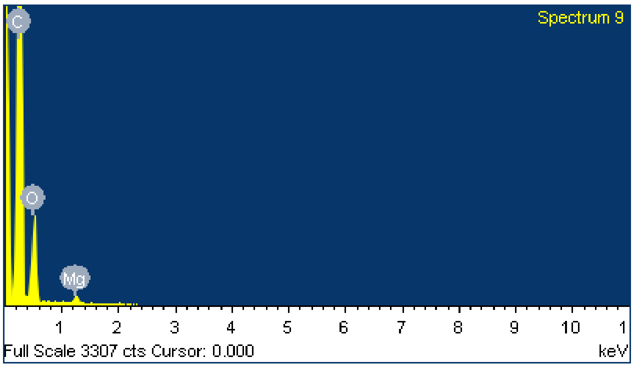


Figure 10. EDS of AC before Purification

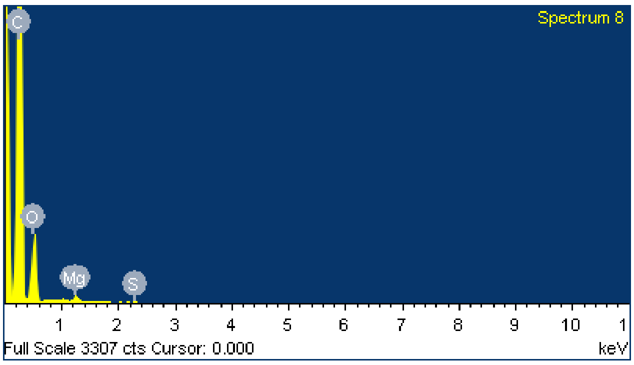


Figure 11. EDS of AC before Purification

Table 3. Elemental composition of AC before and after Purification (obtained from EDS)

Elements	AC before Purification of sample		AC after Purification of sample	
	Weight%	Atomic%	Weight%	Atomic%
C	162.15	81.77	146.76	82.97
O	46.15	17.47	37.44	15.89
Mg	3.06	0.76	2.42	0.67
S	-	-	2.21	0.47
Total	211.35	100	188.83	100

6. Results and Discussion

6.1. Dose effect on GAC and PAC

The dosage study plays significant role in the adsorption phenomenon for the batch experiment study. In the present study, amount of AC dosage used were in the range of 0.25-1.25 g/L and sample volume taken is 50 ml. In the analysis of Physical parameters like Temperature, pH, Electrical Conductivity, TDS and Turbidity, the prepared concentration of 50 ml was used.

6.1.1. Temperature

Method for analysis used was Digital thermometer. The temperature of the water for drinking in India usually ranges from 20°C to 25°C (room temperature), therefore temperature tests obtained in Table 4 are, Initial Reading of sample was 20.8, PAC 1, 20.4, PAC 2, 24.4, PAC 3, 22.5, PAC 4, 23.5 and PAC 5, 22.5, Maximum temperature of PAC was 24.4, Minimum temperature was 20.4 and Average was 22.66. GAC 1, 21.8, GAC 2, 22.5, GAC 3, 22.6, GAC 4, 22.1 and GAC 5, 21.6, Maximum temperature of GAC was 22.6, Minimum temperature was 21.6 and Average was 22.12, Analysis of temperature shows that all obtained results were within the permissible limit and very close to initial reading.

6.1.2. pH

Freshwater acidity and alkalinity determined by pH. Groundwater is primarily monitored for the quantity and chemical composition among both organic and inorganic substances [31]. There is no recommended pH level for safety. Despite the fact that pH has no direct impact on users, it is one of the most major constraint with regards to water quality work [31,32].

Method for analysis used was Electrometric method. pH of the drinking water usually ranges from 6.5 to 8.5 as per BIS & CPCB standards [33,34]. Table 5 shows that the initial reading of sample was 7.9, PAC 1, 7.2, PAC 2, 8.7, PAC 3, 8.4, PAC 4, 8.8 and PAC 5, 8.5, Maximum pH of PAC, 8.8, Minimum pH was 7.2 and average, 8.32. GAC 1, 8.2, GAC 2, 7.8, GAC 3, 7.7, GAC 4, 8 and GAC 5, 8.1, Maximum pH of GAC, 8.2, Minimum pH was 7.7 and Average was 7.96, Analysis of pH in Table 5 shows that maximum range of PAC 2 & 4 was beyond the permissible limit, respectively 8.7 and 8.8 and range of PAC 1 was maintained 7.2 from initial 7.9, so it considered as agreeable pH for PAC though all other remained samples of PAC were within the permissible limit. With respect to GAC, range of GAC 3 was maintained 7.7 from initial 7.9, so it considered as perfect pH range for PAC, however all other remained samples of GAC were within the permissible limit.

6.1.3. Electrical Conductivity

The electric flow potential of water is calculated using conductance, which is directly proportional to the ion concentration in the water [31,35]. The lower the salinity, the less oxygen is extracted [31,36].

Method for analysis used was Electrometric. Electrical Conductivity of the drinking water usually ranges between 2000 μS/cm as per BIS & CPCB standards [33,34] obtained Electrical Conductivity tests tabulated in Table 6. Initial Reading of sample was 813.1 μS/cm, PAC 1, 1.441 μS/cm, PAC 2, 1.103 μS/cm, PAC 3, 1.098 μS/cm, PAC 4, 1.140 μS/cm and PAC 5, 1.255 μS/cm, Maximum Electrical Conductivity of PAC was 1.441 μS/cm, Minimum Electrical Conductivity was 1.098 μS/cm and Average was 1.2074 μS/cm. GAC 1, 962.7 μS/cm, GAC 2, 911.9 μS/cm, GAC 3, 904.8 μS/cm, GAC 4, 928.8 μS/cm and GAC 5, 953.3, Maximum Electrical Conductivity of GAC was 962.7 μS/cm, Minimum Electrical Conductivity was 904.8 μS/cm and Average was 932.3 μS/cm, Analysis of Electrical Conductivity in Table 6 shows that ranges of all PAC were within the permissible limit. range of PAC 3 was minimum and maintained 1.098 μS/cm from initial 813.1 μS/cm, which shows significant difference between them, so it was considered as perfect Electrical Conductivity range for PAC though all other remained samples of PAC were within the permissible limit and also shows huge difference between initial reading. With respect to GAC, range of GAC 3 was maintained 904.8 μS/cm from initial 813.1 μS/cm which makes little difference, so it was considered as perfect Electrical Conductivity range for GAC however all other remained samples of GAC are within the permissible limit. Another noticed observation with respect to Electrical Conductivity was, PAC plays an ambitious role to dropped down EC from water rather than GAC.

6.1.4. Total Dissolve Solids

Inorganic salts, primarily chlorides, bicarbonates, magnesium, calcium, sodium, potassium, and sulphate, as well as dissolved organic matter in water, are all included in total dissolved solids. The main producers of TDS in drinking water come from natural sources such as soil, rock, and water interaction, as well as man - made sources such as discharge of unprocessed sewage, industrial wastewater and urban runoff [31,37]. When higher TDS water is used for drinking, consumers frequently report a bad taste [31,38].

Method for analysis used was Electrometric. TDS of the drinking water usually ranges between 500 ppm as per BIS & CPCB standards [33,34] obtained TDS tests in Table 7. Initial Reading of sample was 323 ppm, PAC 1, 78 ppm, PAC 2, 92 ppm, PAC 3, 87 ppm, PAC 4, 85 ppm and PAC 5 was 81 ppm, Maximum TDS of PAC was 92 ppm, Minimum TDS was 78 ppm and Average was 84.6. GAC 1, 213 ppm, GAC 2, 321 ppm, GAC 3, 249 ppm, GAC 4, 297 ppm and GAC 5 was 291 ppm, Maximum TDS of GAC was 321 ppm, Minimum TDS was 213 ppm and Average was 274 ppm. Analysis of TDS in Table 7 shows that ranges of all PAC's are within the permissible limit. range of PAC 1 was minimum and maintained to 78 ppm from initial 323 ppm, which shows enormous difference between them, so it considered as perfect TDS range for PAC though all other remained samples of PAC were within the permissible limit and also shows huge difference between initial reading. With respect to GAC, range of GAC 1 was maintained 213 ppm from initial 323 ppm which shows large difference, so it was considered as perfect TDS range for GAC however all other remaining samples of GAC were within the permissible limit. Values of PAC with respect to TDS plays crucial role to decrease TDS from water compared to GAC. Table 7 shows that above all samples of GAC's and PAC's decreased the initial range i.e 323 ppm respectively.

Table 4. Temperature readings during analysis of PAC and GAC

Sr. No.	Vol. (gm)	Variable	Initial Reading (°C)	PAC(°C)	GAC(°C)	Volume of Sample	Analytical Method
1	0.25	Temperature (^{0}C)	20.8	20.4	21.8	50 (ml)	Digital thermometer
2	0.50			24.4	22.5		
3	0.75			22.5	22.6		
4	1.00			23.5	22.1		
5	1.25			22.5	21.6		
Maximum				**24.4**	**22.6**		
Minimum				**20.4**	**21.6**		
Average				**22.66**	**22.12**		

Table 5. pH readings during analysis of PAC and GAC

Sr. No.	Vol. (gm)	Variable	Initial Reading	PAC	GAC	Volume of Sample	Standards as per BIS & CPCB	Analytical Method
1	0.25	pH	7.9	7.2	8.2	50 (ml)	6.5 to 8.5	Electrometric
2	0.50			8.7	7.8			
3	0.75			8.4	7.7			
4	1.00			8.8	8			
5	1.25			8.5	8.1			
Maximum				**8.8**	**8.2**			
Minimum				**7.2**	**7.7**			
Average				**8.32**	**7.96**			

Table 6. Electrical Conductivity readings during analysis of PAC and GAC

Sr. No.	Vol. (gm)	Variable	Initial Reading (µS/cm)	PAC (µS/cm)	GAC (µS/cm)	Volume of Sample	Standards as per BIS & CPCB (µS/cm)	Analytical Method
1	0.25	Electrical Conductivity (µS/cm)	813.1	1.441	962.7	50 (ml)	2000	Electrometric
2	0.50			1.103	911.9			
3	0.75			1.098	904.8			
4	1.00			1.140	928.8			
5	1.25			1.255	953.3			
Maximum				**1.441**	**962.7**			
Minimum				**1.098**	**904.8**			
Average				**1.2074**	**932.3**			

Table 7. Total Dissolve Solids readings during analysis of PAC and GAC

Sr. No.	Vol. (gm)	Variable	Initial Reading (ppm)	PAC(ppm)	GAC(ppm)	Volume of Sample	Standard as per BIS & CPCB (ppm)	Analytical Method
1	0.25	Total Dissolve Solids (ppm)	323	78	213	50 (ml)	500	Electrometric
2	0.50			92	321			
3	0.75			87	249			
4	1.00			85	297			
5	1.25			81	291			
Maximum				**92**	**321**			
Minimum				**78**	**213**			
Average				**84.6**	**274.2**			

Table 8. Turbidity readings during analysis of PAC and GAC

Sr. No.	Vol. (gm)	Variable	Initial Reading (NTU)	PAC (NTU)	GAC (NTU)	Volume of Sample	Standard as per BIS & CPCB (NTU)	Analytical Method
1	0.25	Turbidity (NTU)	0.8	0.01	0.1	50 (ml)	1	Nepheloturbidity method
2	0.50			0.03	0.4			
3	0.75			0.01	0.2			
4	1.00			0.04	0.3			
5	1.25			0.03	0.4			
Maximum				**0.04**	**0.4**			
Minimum				**0.01**	**0.1**			
Average				**0.024**	**0.28**			

6.1.5. Turbidity

Turbidity in water is caused by suspended particulate matter (SPM) such as plankton, inorganic and organic materials, silt, clay, and other colloidal matter, all of which hinder light transmission [31,39].

Method for analysis used was Nepheloturbidity method. Turbidity of the drinking water usually ranges between 1 NTU as per BIS & CPCB standards [33,34] obtained Turbidity tests in Table 8 are, Initial Reading of sample was 0.8 NTU, PAC 1, 0.01 NTU, PAC 2, 0.03 NTU, PAC 3, 0.01 NTU, PAC 4, 0.04 NTU and PAC 5, 0.03 NTU, Maximum Turbidity of PAC was 0.04 NTU, Minimum Turbidity was 0.01 NTU and Average was 0.024 NTU. GAC 1, 0.1 NTU, GAC 2, 0.4 NTU, GAC 3, 0.2 NTU, GAC 4, 0.3 NTU and GAC 5 was 0.4 NTU, Maximum Turbidity of GAC was 0.4 NTU, Minimum Turbidity was 0.1 NTU and Average was 0.28 NTU. Analysis of Turbidity in Table 8 shows that ranges of all PAC were within the permissible limit. range of PAC 1 was minimum and maintained to 0.01 NTU from initial 0.8 NTU, which shows large difference between them, so it considered as perfect Turbidity range for PAC though all other remained samples of PAC were within the permissible limit and also shows enormous difference between initial reading. With respect to GAC, range of GAC 1 was maintained 0.1 NTU from initial 0.8 NTU which shows enormous difference, so it considered as perfect Turbidity range for GAC however all other remained samples of GAC were within the permissible limit. Another noticed observation of PAC with respect to Turbidity plays significant role to drop down Turbidity from water compared to GAC. Table 8 shows that all samples of GAC's and PAC's dropped down the initial range i.e 0.8 NTU numerously.

7. Conclusion

Water is precious liquid on earth. The present study reveals a systematic analysis of adsorption properties of the *Arachis Hypogaea*. Various experiments and analysis like Dose effect study, Scanning Electron Microscope, Energy-dispersive X-ray spectroscopy (EDS) and statistical analysis were carried out. Temperature analysis shows that all obtained results are within the permissible limit and very close to initial reading (Room temperature). With respect to Electrical Conductivity PAC plays significant role to lower the range of EC from water compared to GAC. PAC plays a significant role to decrease TDS from water compared to GAC. While through the filtration of water, it was noticed that the water was not so turbid but relatively it was very clear, turbidity was removed significantly. So PAC plays crucial role to reduce Turbidity from water compared to GAC. It was found that PAC 1 and GAC 3 removed contaminants significantly at 0.25 gm and 0.75 gm respectively from given water sample.

With respect to SEM the surface of PAC and GAC found to be macro and micro pores structure (Figure 2 a,b). It shows proper activation of material made-up from biomass of *Arachis Hypogaea*. The AC surface is established to be plane with some mineral particles evenly isolated and some are stuck around pores (Figure 3 a1, b1, Figure 4 a3, b3). SEM analysis shows the strong affinity of these AC to remove contaminants from given water samples. EDS of AC before purification indicates the presence of C, O and Mg elements in the sample. The EDS of the AC after adsorption shows appearance of an additional peak of Sulphur, confirms that the adsorption of Sulphur onto the AC.

It is concluded that the AC made up from *Arachis Hypogaea* carbonized at 500°C for 1.5 hours with recorded contact time using an orbital shaker at 150 rpm for 1.5 hours is capable of Activated Carbon to remove impurities from drinking water. A low cost, low maintenance, ecologically sustainable and chemical free Activated Carbon for drinking water treatment system has been made. On the basis of present research work it is concluded that activated carbon is one of the most significant, scientific and ecofriendly method which may be used at large scale to overcome the water contamination and pollution related issues.

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Statement of Competing Interests

The authors have no competing interests.

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