#### (Review)

# **Pyrolysis & Adsorption Characterization of Activated Carbon synthesis – A Review**

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#### Abstract:

Actuated carbon (AC) is utilized in various conditions of uses after its disclosure as a solid and dependable adsorbent. A review on AC is introduced along with returning to the wellsprings of AC age; strategies used to produce AC including pyrolysis enactment; actual actuation; synthetic initiation and steam pyrolysis. The significant variables influencing the AC creation, the potential uses of AC and their future possibilities are likewise examined. AC is applied in water, wastewater and leachate medicines in numerous nations, particularly to clean the shading, eliminate the smell and some substantial metals. Taking into account this, an exhaustive rundown of research on compound, physical and organic change strategies of initiated carbon relating to prevent of foreign substance expulsion from watery arrangements was aggregated and investigated. Additionally, the examination of the actual blending strategy and the impregnation technique in enactment with antacid metals shows that the actuated carbon got through actual blending had a higher porosity than the initiated carbon created by the impregnation technique. The uses of initiated carbon items were quickly surveyed.

Keywords: Activated carbon; Adsorbance; Pyrolysis; Applications

#### 1. Introduction

Enacted charcoal is fundamentally charcoal that has been regulated with environmental oxygen to open up huge number of small pores which is accessible between the carbon particles. In this examination, coconut shells were utilized as a crude material in amalgamation of initiated carbon adsorbent utilizing two-venture actual change measure. To begin with, carbonation and afterward initiation utilizing steam. The investigation was done in a heater with a pinnacle heat limit of 1100°C. Initially the shells had been dried in a stove at 108oC for 24 hours to takeoutdampness. Bernal et.al(2) (assessed the impact physicochemical properties of the adsorbent and adsorbates on the adsorption limit. Aninvestigation of the adsorbate-adsorbent connections through inundation calorimetry in the analytes arrangements at various fixations was incorporated, notwithstanding the harmony information examination. The outcomes show that the drug mixes (2.28–0.71 mmol g-1) have lower adsorption limits in the initiated carbon and amphoteric qualities increment the limits of adsorption (2.60–1.38 mmol g–1). A. Ekpete et.al.(3)Carbonization of carbon got from plantain (Musa paradisiaca) stem was accomplished at a temperature of 400°C for 60 minutes. The carbonized carbon was isolated into two sections to be actuated independently. The enacted carbon CPPAC (carbonized plantain phosphoric corrosive initiated carbon) and CPZAC (carbonized plantain zinc chloride actuated carbon) were delivered by means of the substance initiation measure utilizing H3PO4 and ZnCl2. Portrayal of pH, mass thickness, dampness content, debris content, unpredictable issue, iodine number and oxygen practical gathering was led. When contrasting the surface properties of both CPPAC and CPZAC with the untreated plantain carbon (UPC), it was seen

that there existed huge contrasts in all properties with the exclusion of carboxylic gathering for CPPAC and phenolic bunch for both CPPAC and CPZAC, hence connoting that a substance change happened. Md Sumon Reza et.al (4) water is being contaminated by industrial and agricultural activities, pharmaceuticals, technocratic civilization, pesticides, garments, global changes etc. In addition to this, environmental pollution and global warming are swelling due to the greenhouse and harmful gases generated from the dumping and burning of fossil fuel. Addressing these problems, it is necessary to find out the cost-effective and environmental friendly processes to purify the contaminated water and air. Activated carbons (ACs) are one of the best solutions for removing the pollutants from aqueous and atmosphere as it is the carbonaceous materials with a high degree of porosity, well-developed surface area, and distinguished functional groups which are required for elimination of contaminants. P Ramirez et.al(5) done the investigation in the leftover squanders (sawdust) of Cedar (C) and Teak (T) are changed into an initiated material. The substance structure of both biomass (C and T) was determinate by TGA (Thermogravimetric Analysis). Initiated materials were portrayed in surface region following the BET (Brunauer, Emmett and Teller) strategy, morphology utilizing SEM (Scanning Electron Microscopy) initiation technique is reasonable for the change of cedar and teak squanders into an enacted carbon with a likely use for colors expulsion from water. Initiated materials introduced surface regions of 1375.67m2g-1 and 996.65m2g-1 for AC and AT, separately. Ana López Fernández et.al.(6)studied the actuated carbons by means of the aqueous treatment at 523 K/30 bar of two basic winemaking squanders: bagasse and bunch stalks. The aqueous carbons created by the above treatmentwere transformed into actuated carbons by means of their presentation to KOH and carbonization at 1073 K. These were then exposed to Raman spectroscopy, Fourier change infrared spectroscopy, filtering electron microscopy assessment, and the assurance. The capacity of the actuated carbons to adsorb methylene blue in fluid arrangement was then analyzed, deciding the impact of time, methylene blue fixation, and temperature. Y. K. Siong et.al (7) done at examination, two sorts of granular enacted carbon are utilized; one granular initiated carbon-A (GAC-A) and the other granular actuated carbon-B (GAC-B) to consider their presentation in the channels.Bright radiation framework is utilized to filter water without leaving any unsafe synthetic compounds. A model was made utilizing actuated carbon and bright radiation framework for water therapy. Surface region and porosity examination were performed on two initiated carbons. Vadivel Sivakumar et.al(8)done the examination analyzed the utilization of altered enacted carbon got from the seeds of broadly accessible plant wellspring of progression of actuated carbon tests were set up by exposing the materials to different substance measures. The physico-substance properties and adsorption capacities were thought about. Adsorption of financially utilized color materials of different focuses were concentrated with arranged enacted carbon tests from bunch tests. Srinivasakannan et.al (9) gather prevalent properties and great adsorption practices. initiated carbon was set up from green coconut shells by compound actuation strategy. It was then described by XRD, SEM, FT-IR and TGA. Distinctive actual properties, for example, mass thickness, dampness content, unpredictable issue content, debris substance, and surface zone and porosity were likewise decided. .DipaDas et.al (10)initiated carbon was utilized as adsorbent for the expulsion of carbon dioxide from vent gas just as different inorganic pollutants from squander water. Evacuation productivity of Methylene blue was concentrated by changing different boundaries, for example, adsorbent measurements and contact time. Pratibha R.Gawan (11) investigation the expulsion of different poisons from vent gas and waste water treatment initiated carbon can be utilized as a decent adsorbent coconut shell carbon changed over into enacted carbon by compound initiation utilizing distinctive actuating specialists like Cacl2, H2So4,H3Po4, KoH, and Zncl2 and thermally enacted. Bunch adsorption desulphurization activity was done at room temperature for adsorption for choice of definite initiation specialist for ceaseless process. of coconut shell actuated carbon was concentrated, for example, P.H, Moisture Content, Ashcontent, Volatile issue content, Ash content, Volatile issue content, Fixed carbon, Iodine Number, BET, surfacearea, Scanning Electronic Microscope (SEM).

Ahed J Alkhatib et.al (12) initiated charcoal can adsorb harmful materials, substances, harms acquainted with stomach related framework including stomach and digestive tract. The ongoing of writing underpins utilizing single utilization of initiated charcoal (SDAC) following overdose of a poison, compound substance, medication, or toxic substance. When initiated charcoal is controlled promptly following the admission of the compound substance, anyway following 6 hours, SDAC still works effectively. Robert W. Derlet (13) et.al. reviewed the current use of activated charcoal and recent studies that suggest that activated charcoal may be the single most effective treatment in many types of poisoning. New explanations for the mechanisms of action include "back diffusion" and disruption of enterohepatic loops. Clinical data endorse a new and aggressive role for activated charcoal in the management of poisoned and overdosed patients. Zaumi Febriyantri (14) et.al conducted to deliver enacted carbon from banana void organic product pack. Preparation of enacted carbon was led utilizing zinc chloride initiation under aqueous carbonization at 200°C. Its application was utilized for expulsion of phenol with various adsorption factors, for example, pH, contact time, fixation and adsorbent measurement. Nitrogen adsorption desorption isotherm bend obviously demonstrated Type IV with hysteresis circle relating with the presence of mesopores. The BET and Langmuir surface region were 46.304 and 69.166 m2 g-1, separately. Surface science displayed more oxygen useful gatherings. Morphology uncovered sporadic pores and the majority of them were shut by the presence of zinc, silicon and different components. Abdullah A. Basaleh (15) investigated themesoporous- enacted carbon (AC) was created from metropolitan natural strong waste, where synthetic initiation with H3PO4 as the actuating specialist was utilized. Impacts of different boundaries, for example, enactment temperature, centralizations of H3PO4, and initiation time, on the qualities of the created AC were explored. YuanGao(16) inspect the plausibility of utilizing crab shell squander as a novel forerunner and KOH, NaOH, H3PO4 and H4P2O7 as substance enacting specialists to deliver initiated carbons (ACs). ACs was portrayed for their pore structure, surface science properties and surface morphology by N2 adsorption–desorption isotherm, filtering electron microscopy, Boehm titration and FT-IR spectra. The outcomes indicated that AC-KOH displayed high BET surface territory of 2197 m2/g, enormous pore volume of 1.192 cm3/g with micropore volume division of 69.80%. Suely Patrícia (17) et.al investigated the Actuated carbon from pyrolysed sugarcane bagasse (ACPB) introduced pore size goes from 1.0 to 3.5nm, and surface territory somewhere in the range of 1200 and 1400m(2)g(-1) that is higher than generally seen to business initiated carbon. The ACPB material was effectively stacked with of silver nanoparticles with width around 35nm (0.81wt.%). X-beam photoelectron spectroscopy (XPS) examinations indicated that the material surface contains metallic/Ag(0) (93.60wt.%) and ionic/Ag(+) states (6.40wt.%). The adsorption limit of natural model atoms (for example methylene blue and phenol) was effective to ACPB and ACPB stacked with silver nanoparticles (ACPB-AgNP), demonstrating that the material adjustment with silver nanoparticles has not changed its adsorption limit. ACPB-AgNP restrained microorganisms development (Escherichia coli), it is a promising bit of leeway for the utilization of these materials inwastewater treatment and water purging cycles. P. Nowicki (18) et. Al. studied New carbonaceous adsorbents were set up by methods for immediate, physical and synthetic actuation of corn cobs and cherry stones just as espresso and tobacco industry squander materials. The impact of enactment technique on the textural boundaries, corrosive base character of the surface and sorption properties toward poisonous gases of the materials acquired was tried. Contingent upon the antecedent just as technique for planning, the end results were miniature/mesoporous actuated carbons of surface region coming to 1426 m2/g, demonstrating to a great extent unique corrosive base properties of the surface. The outcomes acquired in our examination have demonstrated that a reasonable decision of the enactment technique for modern and rural biodegradable waste materials grants creation of modest carbonaceous adsorbents with high sorption limit towards nitrogen dioxide and hydrogen sulfide coming to 83 mg NO2/strays and 215 mg H2S/strays, separately. B.H.Hameed (19) Bamboo, a plen-

tiful and modest regular asset in Malaysia was utilized to plan enacted carbon by physiochemical actuation with potassium hydroxide (KOH) and carbon dioxide (CO2) as the initiating specialists at 850 °C for 2 h. The adsorption harmony and energy of methylene blue color on such carbon were then inspected at 30 °C. Adsorption isotherm of the methylene blue (MB) on the enacted carbon was resolved and connected with regular isotherm conditions. Suhas (20)et.al. reviewed the work done in the course of the most recent couple of a very long time on the utilization of lignin and lignin-based scorches and actuated carbons as adsorbents for the expulsion of substances from water and spotlights on the usage of lignin as adsorbent, its transformation to roasts and enacted carbons and the utilization of these materials as adsorbents. In addition, the audit likewise looks at the textural and surface compound properties of lignin-based initiated carbons. The work so far completed demonstrates that lignin is moderately non-receptive and likely the segment of lignocellulosic forerunners fundamentally liable for the microporosity of initiated carbons. Khezami (21)work was to describe the enacted carbon created from wood and its essential segments: cellulose, lignin and xylan (hemicelluloses). Two different ways of initiation were tried: straightforward pyrolysis under N2 and warm treatment of the material impregnated with (KOH-actuation). Concerning the pyrolysis, synchronous estimations of DTA-TGA permitted to analyze the warmth of response and the decay pace of the 3 wood parts. Additionally it was demonstrated that lone the roast from cellulose has a critical BET-surface territory of pores. The KOH-actuated carbons from wood and wood segments were portrayed by their BET surface territory, their spectra in temperature modified desorption (TPD) up to 1173 K and by their ability to adsorb toxin mixes in watery stage, for example, phenol and methylene blue. Yasumitsu Uraki (22)et.al. studied the Softwood acidic corrosive lignin (SAL) liberated from a high-sub-atomic mass part could be spun at 220°C by a turning machine outfitted with an extruder. In spite of the fact that the subsequent filaments required thermostabilization, this progression could be led with a quicker warming rate than that for strands got from hardwood acidic corrosive lignin (HAL). The thermostabilized SAL strands were changed over to initiated carbon filaments (ACF) via carbonization in a flood of nitrogen at 1000°C, trailed by steam enactment at 900°C. At an enactment season of 40 min, the SAL-ACF had a bigger explicit surface region than the relating HAL-ACF. Sixiao Hu (23) et.al. reviewd an effortless and reasonable methodology has been effectively conceived to manufacture ultrafine (100-500 nm) exceptionally permeable actuated carbon filaments (ACFs) by electrospinning of watery arrangements of prevalently salt lignin (low sulfonate content) trailed by concurrent carbonization and enactment at 850 °C under N2. Fusing a polyethylene oxide (PEO) transporter with simply up to one ninth of lignin empowered effective electrospinning into strands as well as held sinewy structures during warming, mitigating the requirement for a different warm adjustment step. In situ impregnation of soluble base hydroxide actuating synthetic compounds with simply up to half of the lignin carbon forerunner, i.e., only one 10th to one fourth of the amounts utilized in assembling initiated carbon particulates, permitted synchronous carbonization and enactment in a solitary warming advance. J.Rodríguez-Mirasol the (24) et.al studied initiated carbons from eucalyptus kraft lignin has been researched. A pretreatment technique has been set up to stay away from fractional combination and growing in the carbonization stage. Carbonization has been learned at various temperatures and the structure of the microporous burns has b een described. Actuated carbons have been set up from CO2 incomplete gasification of scorches acquired at 823 and 1073 K. Qinksen (25) et.al.Studied few lignin-based initiated carbon filaments (ACFs) were set up by introductory amalgamation of lignin-phenolformaldehyde (LPF) pitches with changed lignin substance, 8-20%, individually, and afterward the dissolve turning and warm medicines. Since the guaiacyl gatherings of lignin responded with the formaldehyde, the function of lignin played turns into a dominator for controlling the warm properties of LPF gum and the pore size and related properties of ACFs. This was demonstrated by the correlation of the checking electron magnifying lens photos of all readied ACFs. FTIR spectra demonstrated that the ACFs were organized by lignin-contributed carbons. The porosity and adsorption conduct of these ACFs were

additionally considered. Xiao-Juan Jin(26) et.al initiated the activating carbon was set up through compound actuation of lignin from a straw pulping forerunner, utilizing K 2CO3 and KOH as synthetic specialists. To improve the readiness technique, the impact of the fundamental cycle boundaries, (for example, impregnation proportion, actuation temperature and enactment time) on the exhibition of the acquired initiated carbon (communicated regarding iodine number and yield of enacted carbon) was researched, and the activities of the initiating specialists were analyzed. The actuated carbon arranged by K 2CO3under ideal conditions, allowed to get a BET surface territory of 1104 m2/g, including an outer or non-microporous surface of 417 m 2/g, a normal adsorption pore width of 2.0 nm, the measure of methylene blue, iodine number and the yield of initiated carbon being of 10.6 mL/0.1 g, 1310 mg/g and 19.8%, individually. Wan Mohd(27)et.al.started the investigations were led to think about the pore improvement in palm-shell and coconutshell-based enacted carbons created under indistinguishable exploratory conditions.Carbonization and actuation measures were completed at 850 degrees C utilizing a fluidized bed reactor. Inside the scope of consume off contemplated, at any consume off, the micropore and mesopore volumes made in palm-shell-based actuated carbon were consistently higher than those of coconut-shell-based initiated carbon. On macropore volume, for palm-shell-based initiated carbon, the volume expanded with increment in consume off to 30% and afterward diminished. Hong Sun (28) et.al. reviewed the activated carbons were created from corn straw lignin utilizing H3PO4 as initiating specialist. The ideal initiation temperature for delivering the biggest BET explicit surface region and pore volume of carbon was 500 °C. The most extreme BET explicit surface region and pore volume of the subsequent carbon were 820 m2g-1 and 0.8 cm3g-1, individually. The adsorption isotherm model dependent on the Toth condition along with the Peng-Robinson condition of state for the assurance of gas stage fugacity give an acceptable portrayal of high weight CO2, CH4 and N2 adsorption. The dynamic adsorption results show that the advancement distinction somewhere in the range of CO2 and CH4 isn't self-evident, demonstrating that its active detachment execution is restricted. Steve Rogan (29) et.al.reports starting investigations on the carbonization and initiation conduct of "Lignoboost" lignin exposed to research center scale physico-substance enactment measures. It depicts the yields and actual properties of lignin-based roasts and gives an underlying assessment of the nanoporous structure of the resultant "LignActiv"- enacted carbons. Quanstang(30) et.al. done the examination is to investigate reactant microwave pyrolysis of lignin for sustainable phenols and energizes utilizing actuated carbon (AC) as an impetus. A focal composite exploratory plan (CCD) was utilized to upgrade the response condition. The impacts of response temperature and weight hourly space speed (WHSV, h(- 1)) on item yields were researched. GC/MS investigation indicated that the primary substance mixes of biooils were phenols, guaiacols, hydrocarbons and esters, the majority of which were gone from 71% to 87% of the bio-oils relying upon various response conditions. Bio-oils with high convergences of phenol (45% in the bio-oil) were acquired. Fiero V(31) et.al actuated carbons were set up by initiation of Kraft lignin with ortho-phosphoric corrosive at different temperatures (400–650 °C), weight proportions of ortho-phosphoric corrosive to lignin (P/L = 0.7-1.75) and impregnation times (1-48 h). The subsequent carbons were described by natural investigation, N2 adsorption at 77 K and SEM. The outcomes demonstrate that the pyrolysis of lignin impregnated with ortho-phosphoric corrosive delivers basically microporous carbons, with a level of the complete micropore volume around steady (80%), whatever the carbonisation temperature. The portion of ultramicropores diminishes with expanding temperature though that of supermicropores arrives at a greatest at 600 °C. The greatest surface region (1305 m2/g) and pore volume (0.67 cm3/g) are reached at 600 °C, while pyrolysis of corrosive impregnated lignin at temperatures higher than 600 °C produces a critical decrease of both pore volume and BET surface region because of: (I) the shrinkage of the material brought about by the corruption of the phosphate and polyphosphate scaffolds and (ii) the oxidation of the carbon brought about by the deficiency of the ensuring P2O5.

## Nomenclature

- aL Affinity constant (L/mol)
- C BET constant
- h Initial adsorption rate (mg/g min)
- K DR constant
- Kc Equilibrium constant (L/g)
- K<sub>F</sub> Freundlich constant ((mol/g)(mol/L)n)
- KL Langmuir constant (L/g)
- 1/n Heterogeneity factor
- $q^{D}$  Adsorption capacity (mg/g)
- qt Adsorption capacity at time t (mg/g)
- ST Total surface area (m2/g)
- t Time (min)
- T Temperature (K)
- V<sub>mi</sub> Micropore volume (cm3/g)
- VT Total pore volume (cm3/g)
- W Volume of adsorbate (cm3/g)
- Q Density of liquid adsorbate (g/L)

# 2. Materials synthesis

For the most part enacted carbon can be set up from different crude materials including farming and ranger service deposits. By and large the vast majority of the antecedents utilized for the planning of actuated carbon are wealthy in carbon. Production of AC was accomplished normally through two courses, actual initiation and substance enactment. Actual enactment includes carbonization of crude material followed by the initiation at high temperatures (somewhere in the range of 800 and 1100°C) within the sight of oxidizing gases like carbon dioxide or steamRice husk, corn cob, olive residues, sunflower shells, pinecone, rapeseed, cotton residues, olive-waste cakes, coal, rubberwood sawdust, fly ash, coffee endocarp



Figure 1. Activated Carbon classification

N2



Figure 2. Preparation method of Granular Activated carbon

# 3. Characterization Techniques

# 3.1. Physical Characterization

adsorption at 77 K was used to choose express surface regions, pore volume and pore size assignment of carbon tests. The surface district (SBET) of the sorbents was controlled by applying the BET (Brunauer–Emmet in addition, Teller) model of isotherms. Hard and fast pore volume (VT) was settled from the proportion of N2 adsorbed at p/p0 = 0.95. Micropore surface zone (Smic) and micropore volume (Vmic) was constrained by Dubinin-Radushkevich condition (DR) applied to N2 adsorption data. The mesopore surface district (Smes) and mesopore volume (Vmes) were dictated by deducting the micropore surface region from full scale surface zone and the micropore volume from hard and fast pore volume, respectively. The FTIR spectra and analyzing electronic microscopy SEM are of remarkable help to get information about utilitarian social events and morphology of sanctioned carbon tests, independently.

#### Abbreviations

AC	Activated Carbon
ACF	Activated Carbon Fibers
AC-PA	Activated Carbon prepared by Phosphoric Acid activation
AC-PH	Activated Carbon prepared by Potassium Hydroxide activation
AC-ZC	Activated Carbon prepared by Zinc Chloride activation
BET	Brunauer Emmett Teller
df	degrees of freedom
EDX	Energy Dispersive X-ray spectroscopy
ETID Four	or Transform Infrand another some

FTIR Fourier Transform Infrared spectroscopy

GAC Granular Activated Carbon	
PAC Powdered Activated Carbon	
PSD Pore Size Distribution	
SEM Scanning Electron Microscop	e
TEM Transmission Electron Microscope	
TGA Thermo-Gravimetric Analysis	s
XRD X-Ray Diffraction spectroscop	зy

# 3.2. Chemical Characterization

It has been set up that the iodine number (in mg/g) gives a check of the surface zone (in m2/g) [19], and it evaluates the porosity for pores with estimations between 1.0-1.5 nm. The ejection of iodine by the activated carbons gained from phosphoric destructive impregnation is related to their porosity characteristics which choose the degree of receptiveness of these iotas. A lower adsorption of iodine can be credited to the presence of pores less than 1.0 nm, which generally makes up an enormous segment of the development of these carbons [23]. For forerunners impregnated by 2 M phosphoric destructive, the mass of iodine burned-through was generally low (346.9 mg/g), however carbons made from 12 M phosphoric destructive showcase much higher breaking point (506.6 mg/g) demonstrating huge ultra-microporosity. These carbons contain by and large micropores with a little responsibility of mesoporosity. An typical lead was seen for the truly instituted carbon which gave up minimal take of 264.4 mg/g. This value may propose a low adsorptive cycle, and is apparently associated with a low proportion of porosity.

S.No.	Materials	Physical Characterization	Chemical Characterization	Adsorption Results	Ref.
1.	Granular activated carbon (CAG) Oxidized activated carbon (CAO) Reduced activate (CAR)	Surface area (SBET) (m2 g -1 ) CAO - 456 CAG - 854 CAR1073- 1146 Micropore volume (cm3 g -1 ) CAO -0.20 CAG -0.42 CAR1073-0.51 Total volume 1 (cm3 g -1 ) CAO -0.32 CAG -0.41 CAR1073-0.52	Total acidity ( $\mu$ mol g-1) CAO - 636 CAG - 90.5 CAR1073-93.4 Total basicity ( $\mu$ mol g-1) CAO - 740 CAG - 748 CAR1073-1150 Carboxylic acid ( $\mu$ mol g-1) CAO - 137 CAG - 27.1 CAR1073 - 7.39 Lactones( $\mu$ mol g-1) CAO - 510 CAG - 38.4 CAR1073-6.37 Phenols( $\mu$ mol g-1) CAO - 456 CAG - 854 CAR1073-1146	PhenolMolecular size(*A) - $4.96 \times 4.27$ Solubility H2O - $0.822 298 \text{ K}$ (mol L-1)PKa - $9.99$ Salicyclic acidMolecular size(*A) $3.96 \times 4.87$ Solubility H2O- $0.016 298 \text{ K}$ (mol L-1) PKa- $3.57$ Acetaminophen Molecularsize(*A) $6.50 \times 4.70$ Solubility H2O 298 K (molL-1) PKa- $8.57$ MethylparabenMolecular size(*A)- $7.69 \times 6.02$ Solubility H2O 298 K (molL-1) PKa- $9.16$	[1,2,4]
2.	CPPAC (carbonized plantain phosphoric acid activated carbon)	pH - 9.30 ± 0.06 Bulk(g/ml) - 0.34 ± 0.00 Moisture (%)-7.33 ± 1.15 Ash (%)-31.00 ±6.08 Moisture (%) - 32.33 ± 1.15	Dose -0.3 g Iodine adsorption – 64.00 ± 1.41 Dose -0.5 g Iodine adsorption 81.50 ± 2.12 Dose -0.7 g	Carboxylic (meq/g)- 0.09 Lactones (meq/g) – 0.08 Phenols (meq/g)- 0.03 Total basic sites (meq/g)- 1.65	[6,7,8]

		Volatile (%)-32 33+ 1 15	Indine adsorption 92.50 + 2.12		
		volutile (70) 52.55± 1.15			
	CDZAC	-11 - 9.50 + 1.70		Carbourdia (mag/a) = 0.08	
	CFZAC	$p_{\rm H} = 8.30 \pm 1.70$	Dose -0.5 g	Carboxylic (meq/g) $= 0.08$	
	(carbonized	Bulk(g/ml) - $0.32 \pm 0.05$	Indine adsorption $57.00 \pm 0.00$	Lactones (meq/g) – 0.10	
	plantain zinc	Moisture (%)- $10.33 \pm 2.08$	Dose -0.5 g	Phenols (meq/g)- 0.02	
	chloride	Ash (%)-20.00 ±1.53	Iodine adsorption $72.50 \pm 2.12$	Total basic sites (meq/g)- 2.52	
	activated	Moisture (%) $-10.33 \pm 2.08$	ii) Dose -0.7 g		
	carbon)	Volatile (%)-23.33± 1.53	Iodine adsorption 84.50 ± 2.12		
	(LIPC)	$pH - 6.80 \pm 0.06$	Dose -0.3 g	Carboxylic (meg/g)- 0.09	
	(Ur c)	$\frac{1}{2} \frac{1}{2} \frac{1}$	Lodino adsorption	Lactonos(mog/g) 0.13	
		$M_{1}(g/111) = 0.38 \pm 0.01$		Lactories(meq/g)=0.13	
	plantain carbon	Moistire (%)-15.30 $\pm$ 1.15	$24.50 \pm 6.36$	Phenois (meq/g)-0.05 Total	
		Ash (%)-25.50 ±3.29	Dose -0.5 g	basic sites (meq/g)- 0.68	
		Moisture (%) $-72.33 \pm 1$	Iodine adsorption		
			$51.00 \pm 0.00$		
			Dose -0.7 g		
			Iodine adsorption		
			64.00 + 2.12		
		Activation method	Activation method	Physico-chemical	
		i)Conventional heating	Chemical (H3PO4) Adsorp-	(ZnCl2 + CO2)	
		Olive stone – 17.83	tion capacity:	Olive stone-120	
	Olive stone	Olive wood-7.92	Olive stone - 9.01	Olive wood- 9.08	
		Olive pulp -13.7	Olive mill waste-1.75	Olive pulp- 0.38	
		Olive seed-19.10	Olive pulp -0.31	Olive seed -121	
		Olive cake - 559	Olive seed-190	Olive cake-0.46	
		ii)Thermal	Olive cake - 49	Thermal and chemical	
		Olive stone – 13.96	Chemical (KOH) Time (h) -4	(KOH)	
		Olive mill waste- 15	Olive stone-120	Olive stone-394	
	Olive mill	Olive pulp -0.31	Olive wood- 9.08	Olive wood- 930	
	waste	Olive seed-190	Olive pulp- 0.38	Olive pulp- 246	
		Olive cake $-49$	Olive seed -121	Olive seed -1540	
		$\frac{111}{2} Pnysical (H2O/N2)$	Chamical (HCl) Tamp (°C)	Olive cake-46	
3		Olive stone $= 57.46$	Olive stope-20	Olive stope $120$	[10-12,
5.		Olive pulp -0.31	Olive wood-15	Olive wood- 38	15]
		Olive seed-11.50	Olive pulp-20	Olive pulp- 148	
	Olive pulp	Olive cake – 49	Olive seed -15	Olive seed -35	
		iv) Pyrolysis	Olive cake -20	Olive cake-456	
		(100°C, 200°C)	Chemical (HNO3) pH	Physical (H2O/N2) (50	
		Olive stone – 2.17	Olive stone-2.6	min/800 °C)	
		Olive waste- 4.82	Olive wood -3.1	Olive stone-373	
		Olive pulp -3.36	Olive pulp- 0.18	Olive wood- 988	
		Olive seed-4.43	Olive seed -0.20	Olive pulp- 968	
	Olive seed	Olive cake – 2.19	Olive cake -1.5	Olive seed -1495	
				Olive cake-741	
		v) Untreated	Chemical (H2SO4) Area		
	Olive cake	Olive stone $-4.90$	(m2/g)	Microwave (KOH impreg-	
		Olive wood $-6.27$	Olive stone-1169	nated)	
		Olive pulp – 6.06	Ulive wood - 879	Olive stone-22.73	

		Olive seed – 5.40	Olive pulp- 920	Olive wood- 63.50	
		Olive cake – 5.96	Olive seed- 950	Olive pulp- 28.41	
			Olive cake – 451	Olive seed -29.45	
				Olive cake-19.57	
		AC-ST	ST-HTC	Temp (303°C) GS	
		Total pore volume (Vp)	Proximate analysis	Freundlich	
		(cm3 g -1 ) 1.38	Moisture (wt%) 9.4	KF (g-1) – 470.12 1/n – 0.143	
		Micropore volume (W0)	Volatile (wt% db) 48.4	R2 - 0.989	
		(cm3 g -1) 0.87	Ash (wt% db) 1.7	Langmuir qm (mg g-1 ) –	
	bagasse (GS) &	Average micropore size	Fixed carbon (wt% db) 49.9	789.75 b (mg-1) – 2.678	
	cluster stalks	(L0) (nm) 1.65 Mi-	GCV (MJ kg-1 ) 27.5		
	(ST) & Hydro	croporous surface (Smi)	<b>Ultimate analysis</b> C	ST	
	thermal	(m2 g -1 ) 1011	(wt% daf) 57.6 H (wt% daf)	Freundlich	
	carbons (HTC)	Non-microporous surface	4.9 (wt% daf) 3.9	KF (g-1) - 520	
		(Se) (m2 g-1 ) 18	(wt% daf) 4.7	1/n – 0.145	
		Total surface area (Stotal)	(wt% daf) 42.5	R2 – 0.798	
		(m2 g-1 ) 1190 SBET (m2	GS-HTC	Langmuir	
		g-	Proximate analysis Moisture	qm (mg g-1 ) – 920.1	
		1) 2658	(wt%) 2.8 Volatile (wt% db)	b (mg-1 )- 1.397	
		AC-GS Total pore volume	43.6 Ash (wt% db) 5.9 Fixed		
4		(Vp) (cm3 g -1 ) 0.87	carbon (wt% db)	Temp (353°C)	[15,16,19
1.		Micropore volume	49.9	GS	,21-23]
		(W0) (cm3 g -1 ) 0.79	GCV (MJ kg-1 ) 26.7	Freundlich	
		Average micropore		KF (g-1) – 465.25	
		size (L0) (nm) 1.15	Ultimate analysis	1/n - 0.151	
		Microporous	C (wt% dat) 55.2	R2 - 0.874	
		surface (Smi) (m2	H (wt% daf) 5.7 N		
		g -1 ) 1238	(Wt% daf) 2.45	qm(mgg-1) = 779.17	
		Non-microporous	(wt% daf) 0.2  Oa	b (mg-1) - 2.442	
		surface (Se) (m2 g	(wt% daf) 36.1 34.5		
	G5-ПІС •_	-1 )61 Total cumba ca anos		$Ereunalicn$ $E(\sim 1) = 510$	
		(Stata) (m2 - 1)		KF(g-1) = 519	
	51-111C	(3101a1) (1112 g-1 ) 1220		$P_{2} = 0.137$	
		SBFT $(m^2 - 1)$		$R_2 = 0.766$	
		1857		$am (mg g_{-1}) = 944.7$	
		1007		h (mg-1) - 1 465	
				0 (mg 1) 1.400	
	One granular	BET Surface Area (m2/g)	GAC – A	GAC –A	
	activated car-	(GAC-A) 789.600	pH – 7.13	Tap water – 26.15 Well water-	
	bon-A (GAC-A)	(GAC-B) 793.5958	r Turbidity – 0.23	6.87	
		External Surface	Suspended solid –	Sea water- 4.73	
	&	Area (m2/g)	2 mg/l		
		$(C_{A}C_{-}A)$ 196 892	$\frac{\partial \theta}{\partial \theta}$		
5.	. (1 1	(GAC-R) 190.092	$C_{\rm max}$		[17,18]
	other granular	(GAC-D) 187.830	p mg/i		
	activated car-				
	bon-B (GAC-B)	Micropore Area	GAC – B	GAC –B	
		(m2/g)	рН – 8.26	Tap water -20.74 Well wa-	
		(GAC-A) 611.189	Turbidity – 0.31	ter—13.51 Sea water-3.54	
		(GAC-B) 4 987	Suspended solid- 4.2 mg/l		
		CIIC D/ 1.707	pusperiaea sona- 4.2 mg/1	1	

		Pore Diameter	Chemical (O2 ) - 7mg/l		
		(GAC-A) 21.8379			
		(GAC-B) 21.473			
		АСРВ	АСРВ	АСРВ	
6.	Activated carbon from pyrolysed bagasse (ACPB) & Activated carbon from pyrolysed bagasse - silver nanoparticle (ACPB- AgNP)	Surface area, (m2 g-1) 1475 Micropores surface area, (m2 $g-1$ ) 708 Pore volume, (cm3 $g-1$ ) 0.79 Micropores volume, (cm3 $g-1$ ) 0.30 Pore size distribution, DFT (nm) 1–3.5 ACPB –AgNP Surface area, BET (m2 $g-1$ ) 1560 Micropores surface area, t-plota (m2 g-1) 727 820 Pore volume, (cm3 $g-1$ ) 0.58 Micropores volume, t- plota (cm3 $g-1$ ) 0.37 Pore size distribution, DFT (nm)1– 2.75	Surface chemical compositionc Carbon, C (wt.%) 81.5 Oxygen, O (wt.%) 10.9 Silver, Ag (wt.%) – 5.7 Other elementsd (wt.%) 6.2 surfacee Ag, metallic (wt.%) – 90.7 Ag+, ionic (wt.%) – 8.5 ACPB –AgNP Carbon, C (wt.%) 83.4 Oxygen, O (wt.%) 9.57 Silver, Ag (wt.%) – 12.4 Other elements (wt.%) 3.2 Silver Ag, metallic (wt.%) – 93.56 Ag+, ionic(wt.%) – 7.4	N100 mg L-1 A 1.76 mg L-1 (1.36–2.57) B 10.46 μg L-1 (9.11– 11.53) C 15.52 μg L-1 (21.00– 21.12) ACPB-AgNP N100 mg L-1 A 1.87 mg L-1 (1.50–2.64) B 12.47 μg L-1 (8.79– 12.83) C 16.33 μg L-1 (12.00– 21.12)	[24,25, 28-31]
7.	Activated carbon (AC)+ H3PO4	BET(m2/g) - 718.48 Sext.(m2/g) - 483.713 Smic(m2/g) - 246.615 Vt(cm3/g) - 0.13552 Vmic(cm3/g) - 0.55663 Dp(Å) - 730.711	Proximate analysis Property Content (%) Moisture 6.66 Ash 8.6 Volatile 90 Element Content (%) C44.6 H 6.8 N 3.11	The adsorption capacity of MB was calculated using the following equation: q(mg/g) = (Co - Ct) × V m Carboxylic (meq/g)- 0.52 Lactones (meq/g)-1.23 Phenols (meq/g)-0.99 Total basic sites (meq/g)- 1.82	[30,32,33 ]
8.	Coconut-shell- based activated carbon & palm-shell-	BET multipoint - 48.30 DR micropore – 0.05 BJH cumulative	CCl4 (68 ± 18.8) - Moisture CCl4 + CGX 50 (4391 ± 3237) - Volatility CCl4 + CGX 100	Langmuir Constant (Q) mgg- 1 AC = -0.0283 HLC+LIGNIN = -22.484 Palm + AC = 70mg/g	[27,29]

based activated	adsorption - 0.12	(1072 ± 1105) -	Solid coconut shell – 0.78	
carbon	BJH volume pore	hematoxylin and eosin	Sugar CaneBagasse -	
	adsorption – 18.06	(H & E)	803	

## 3.3. MORPHOLOGY CHARACTERISTICS:

The morphologies of the examples were described by utilizing field outflow checking electron microscopy (FEI QUANTA FEG250, USA). The stage structure was researched by X-beam diffraction with Cu Ka radiation source (Model D8-Advance, Germany) worked at 40 kV and 100 mA. The pore structure of the acquired example was examined by nitrogen adsorption [25,26] at 77 K on a surface territory analyzer (ASAP2020M þ C, Micrometrics, GA, USA). The surface region of test was assessed by the Langmuir model and Brunauer Emmett Teller (BET) model, while the pore size dissemination[27,29] was assessed by Barrett Joyner Halenda (BJH) hypothesis. The FTIR spectra were acquired by Nicolet 380 FT-IR (Nicolet, USA). The compound conditions of tests were concentrated by X-beam photoelectron spectroscopy (PHI1800, Physical Electronics, MN, USA). The Micro Raman spectrometer (RM-1000, Renishaw, GL, UK) was utilized to research the adaptation condition of graphite in the ACFs. Thermogravimetric tests were done with a warm analyzer (TGA6, Perkin Elmer, USA) to examine the pyrolysis cycle and actuation component.

### 3.4. ADSORPTION CHARACTERSTICS:

The Langmuir and Freundlich isotherms, determined concurring to Eqs. (5)-(7) were plotted. It was seen that the Langmuir model gave the most noteworthy R2 values which were more prominent than 0.99, demonstrating that the adsorption of CR onto ACFs should be monolayer. All the RL values acquired were somewhere in the range of 0 and 1, indicating that the adsorption of CR was ideal and fundamentally comprised of homogeneous adsorption patches. The most extreme monolayer adsorption limit of 1100 g kgg-1 was get when the actuation time was 3 h. What's more, we had thought about the CR adsorption limits of S10-1-3 with other enacted carbon- base adsorbents [30,31]. It can be seen that S10-1-3 had higher CR adsorption limit than those of biomass and bioenergy most other initiated carbon detailed aside from AC/surfactant, which was the actuated carbon adjusted with dioctadecyl dimethyl ammonium chloride [32]. Nonetheless, the carbon antecedent utilized in this investigation was inexhaustible biomass material (silkworm case), and the planning cycle was generally simple. Consequently, our ACFs could be an additionally encouraging adsorbent for water treatment. The impact of the pH on the adsorption of CR The pH of fluid arrangement is a significant factor that affected color evacuation.

The impact of pH on the adsorption of CR onto S10-1-3 was concentrated in the pH scope of 2.0-11.0. It was seen that the adsorption of CR onto S10-1-3 was unequivocally pH subordinate. The estimation of qe diminished with expanding pH esteem, and thehighest adsorption limit was acquire at pH 2, demonstrating that S10-1-3 would in general adsorb CR viably in the unbiased and acidic arrangement. This might be credited to the electrostatic communications between the emphatically charged adsorbent and the adversely charged (SO32) CR color anion [33]. The surface charge of adsorbent turned out to be commonly certain in acidic medium and the negative in basic medium. In this way, the adsorption limit of orchestrated example was higher atlower pH. Comparable perception was obtained.FTIR spectra upheld the particular adsorption of CR on ACFs.It related to the sulfonate gathering of CR, got self-evident, recommending the interest of single and twofold sulfur joins SeO and SO in the bond development with the useful gathering of ACFs surface. Also, the vibrations at 1053 cm-1 was exceptionally clear, which was an away from of the adsorption of CR onto S10-1-3. Subsequently, it tends to be reasoned that substance adsorption was likewise associated with the CR adsorption onto the ACFs.

## 4. CONCLUSION

Adsorption measure is an amazing strategy that can be utilized for productive evacuation or take-up of poisonous materials from gas and fluid stages. Initiated charcoal is one of the main adsorbent that can be utilized for these reasons. The utilization of AC is maybe the best broadspectrum control innovation accessible at present second. It is likewise very conceivable to expand the measure of adorption of inorganics by impregnating the initiated carbon with reasonable synthetic compounds. The determination of impregnating material should be with the goal that it empowers the adsorption by means of regular substance responses (for example balance, redox, hydrolysis, precipitation and synergist responses). Among the numerous elements influencing sorption or expulsion of poisonous materials from fluid arrangements, the pH impact is the most noticeable particularly on account of inorganics, frail natural corrosive and bases which their separation is profoundly pH subordinate.

**Funding:** Please add: "This research received no external funding" or "This research was funded by NAME OF FUNDER, grant number XXX" and "The APC was funded by XXX". Check carefully that the details given are accurate and use the standard spelling of funding agency names at https://search.crossref.org/funding. Any errors may affect your future funding.

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Acknowledgments: I would like to thank my management for supporting the collection of articles.

Conflicts of Interest: The authors declare no conflict of interest.

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