Introduction

Charcoal 1.1

l What is charcoal .1.1

Charcoal is a light black residue consisting of carbon, and any remaining ash, obtained by removing water and other volatile constituents from animal and vegetation substances. Charcoal is usually produced by slow pyrolysis, the heating of wood or other substances in the absence of oxygen.[l] It is usually an impure form of carbon as it contains ash; however, sugar charcoal is among the purest forms of carbon readily available, particularly if it is not made by heating but by a dehydration reaction with sulfuric acid to minimize introducing new impurities, as impurities can be removed from the sugar in advance. The resulting soft, .brittle, lightweight, black, porous material resembles coal

.(Fig 1.1 Wood pile before covering it with turf or soil and firing it (around 1890

Production methods 1.1.2

Charcoal has been made by various methods. The traditional method in Britain used a clamp. This is essentially a pile of wooden logs (e.g. seasoned oak) leaning against a chimney (logs are placed in a circle. [2]The chimney consists of 4 wooden stakes held up by some rope. The logs are completely covered with soil and straw allowing no air to enter. It must be lit by introducing some burning fuel into the chimney; the logs burn very slowly and transform into charcoal in a period of 5 days' burning. If the soil covering gets torn (cracked) by the fire, additional soil is placed on the cracks. Once the burn is complete, the chimney is plugged to prevent air from entering. The true art of this production method is in managing the sufficient generation of heat (by combusting part of the wood material), and its transfer to wood parts in the process of being carbonized. A strong disadvantage of this production method is the huge amount of emissions that are harmful to human health and the environment (emissions of unburnt methane). As a result of the partial combustion of wood material, the efficiency of the traditional method is .low

Fig 1.2 Charcoal Burner, Bouth Woods

Improved methods use a sealed metal container, as this does not require watching lest fire break through the covering[3] low ever, on-site attendance is required, and also this method sacrifices part of the material for generating process heat - with the associated low yield. At Bullworthy Project in the U.K., charcoal production supports an experiment in low impact living and nature conservation. Modern methods employ retorting technology, in which process heat is recovered from, and solely provided by, the combustion of gas released during carbonization. (Illustration). Yields of retorting are considerably higher than those of kilning, and may .reach 35%-40%

Examples of large industrial, but clean, industrial technologies are the Lambiotte shaft furnace, and the Reichert retort.’1 A recently developed technology is the Condensing Retort developed by Clean Fuels. This .latter technology is suitable for medium to large industries

The last section of the film Le Quattro Volte (2010) gives a good and long, if poetic, documentation of the traditional method of making charcoal. The Arthur Ransom children’s series Swallows and Amazons features carefully drawn vignettes of the lives and the techniques of charcoal burners at the start of the 20th century, in the Lake District of the .UK

The properties of the charcoal produced depend on the material charred. The charring temperature is also important. Charcoal contains varying amounts of hydrogen and oxygen as well as ash and other impurities that, together with the structure, determine the properties. The approximate composition of charcoal for gun-powders is sometimes empirically described as C7H40. To obtain a coal with high purity, source material should be free of non-volatile compounds (sugar and a high charring temperature can be used). After charring, partial oxidation with oxygen or chlorine can reduce hydrogen levels. For activation of charcoal see .activated carbon

Common charcoal is made from peat, coal, wood, coconut shell, or petroleum. “Activated charcoal” is similar to common charcoal, but is made especially for use as a medicine. To make activated charcoal, manufacturers heat common charcoal in the presence of a gas that causes the charcoal to develop lots of internal spaces or “pores.” These pores .help activated charcoal “trap” chemicals

Types of charcoal 1.1.3

:Charcoal is found in either lump, briquette, or extruded forms

- Lump charcoal is made directly from hardwood material and .usually produces far less ash than briquettes
- Pillow shaped briquettes are made by compressing charcoal, typically made from sawdust and other wood by-products, with a binder and other additives. The binder is usually starch. Some briquettes may also include brown coal (heat source), mineral carbon (heat source), borax, sodium nitrate (ignition aid), limestone (ash-whitening agent), raw sawdust (ignition aid), and other .additives
- Hexagonal sawdust briquette charcoal is made by compressing sawdust without binders or additives. Hexagonal Sawdust Briquette Charcoal is the preferred charcoal in countries like Taiwan, Korea, Middle East and Greece. It has a round hole through the center, with a hexagonal intersection. Mainly for BBQ uses as it does not emit odor, no smoke, little ash, high heat, and .(long burning hours (exceeding 4 hours

- Extruded charcoal is made by extruding either raw ground wood or carbonized wood into logs without the use of a binder. The heat and pressure of the extruding process hold the charcoal together. If the extrusion is made from raw wood material, the extruded logs [are then subsequently carbonized. [4
- Japanese charcoal removes pyroligneous acid during the charcoal making. Therefore when burning, there are almost no stimulating smells or smoke. The charcoal of Japan is classified into three .kinds

Uses of charcoal 1.1.4

Fig 1 .3 charcoal

Charcoal has been used since earliest times for a large range of :purposes as following

.Industrial fuel•

.Cooking fuel•

.Black Powder•

.Carbon source•

.Purification and filtration•

.Art•

.Medicine•

[Environmental implications. [5•

1.1.5Activated Carbon Regeneration and Reactivation

Regeneration involves removal of the contaminants from the carbon without destroying the contaminants. Reactivation means destroying the contaminants and reactivating the carbon, which usually occurs at very high temperatures. if regeneration of the spent carbon is not feasible, or thecarbon is irreversibly contaminated by the adsorbed substance, the spent carbon should be disposed of. The increased use of activated carbons has been accompanied by the development and broader application of a number of new regeneration processes.[6]The most commonly used conventional techniques are thermal ,chemical, and .electrochemical regeneration

Adsorption 2.1

?l What is adsorption.1.2

Adsorption is considered to be an important phenomenon in most natural physical, biological, and chemical processes, and activated carbon is the most widely used adsorbent material in water and wastewater treatment. [7] Adsorption is the accumulation or concentration of substances at a surface or interface. The adsorbing phase is termed the adsorbent, and the material being adsorbed the adsorbate. Adsorption can occur between two phases, namely liquid—liquid, gas—liquid, gas—solid, or liquid—solid .interfaces

When activated carbon is used, the adsorbing phase is a solid. In activated carbon adsorption, a hypothetical interfacial layer exists between the solid [and fluid phases. [8

:Types of Adsorption 1.2.2

There are two types of adsorption, physical adsorption also known as physisorption and chemical adsorption or chemisorptions. The two types differ in the strength of the interaction between the adsorbant and the adsorbate and the mechanisms of adsorption as well as their sensitivity to .temperature. The types of adsorption are compared in table 1.1

.Table 1.l Comparison of physical and chemical adsorption

Chemisorption	Physisorption	
Monolayer	Coverage	Mono or multilayer
,Nature of adsorption reversible	Non-dissociative and may be irreversible	Often dissociative
Very specific	Nonspecific	Specificity to adsorption sites
Unlimited	Temperature range The condensation Point of the gas	Near or below the
		Temperature
increase	decrease	Dependence
Adsorption enthalpy	4—50 $kJmol^{-1}$	40 - 800$kJ\ mol^{-1}$
slow	Uptake	Fast
		Very variable, often
Easy by reduced pressure	Difficult	Kinetics of adsorption

Factors Influencing Adsorption 1.2.3

Charcoal adsorption is not a uniquely homogeneous process, but is rather .dependent on the various factors outlined below

l Surface Area of Adsorbent.1.2.3

The more finely’ divided and more porous adsorbents would be expected to yield more adsorption per unit weight of adsorbent. The surface can be characterized either as external when it involves bulges or cavities with width greater than depth or internal when it involves pores and cavities [that have depth greater than width. [9, 10

Physical and Chemical Characteristics of the Adsorbate 1.2.3.2

Physical and chemical characteristics of the adsorbate in general, the absorbability of a compound increases with increasing molecular weight and increasing number of functional groups such as double bonds or halogens, larger molecules are adsorbed onto charcoal better than smaller .molecules

The degree of solubility of the solute is also of primary concern for adsorption. There is an inverse relationship between the extent of adsorption of a particular solute and its solubility in the solvent from which the adsorption occurs. High solubility means that the solute—solvent bonds are stronger than the attractive forces between the solute .and the adsorbent

2.3.3pH.

Organic molecules form negative ions at high pH values, positive ions at low pH values, and neutral molecules at intermediate pH values. Adsorption of most organic materials is higher at neutral conditions. In general, liquid phase adsorption of organic pollutants by activated carbon .is increased with decreasing pH

This results from the neutralization of negative charges at the surface of the carbon at low pH values. Neutralization of negative charges reduces .the hindrance to diffusion and leads to more active adsorption sites

Temperature 1.2.3.4

Adsorption involves specific relations between the properties of charcoal and the solute. Therefore, the quantitative effects of temperature are not the same with all carbons and solutes. The extent of adsorption should increase with decreasing temperature because the adsorption reactions are exothermic. However, increased temperature also increases the rate of diffusion of the solute through the liquid to the adsorption sites, which eventually leads to an increased adsorption. An important difference in the adsorption of solutes versus gases is found in the role of temperature. [l] An increase in temperature increases the tendency of a gas to escape from the interface and thus diminishes adsorption. However, in adsorption from the liquid, the influence of temperature on solvent .affinities is more dominant

Porosity of the Adsorbent 1.2.3.5

The adsorption performance is dependent on the condition of internal surface accessibility. A very important and decisive property of adsorbent materials is the pore structure. The total number of pores and their shape and size determine the adsorption capacity and even the rate of adsorption. [12] The significance of pores in adsorption processes largely depends on their sizes. Most of the solid adsorbents possess a complex .structure that consists of pores of different sizes and shapes

Balanitis aegyptiaca 1.3

?What is *Balanitis aegyptiaca* 1.3.1

Balanitis aegyptiaca is a species of tree, classified either as a member of the *Zygophyllaceae* or the *Balanitaceae*. This tree is native to much of [Africa and parts of the Middle East.[13

Fig 1.4 *Balanitis aegyptiaca* ftuits

There are many common names for this plant. In English the fruit has been called desert date, soap berry tree or bush, Thron tree, Egyptian myrobalan,[14] Egyptian balsam or Zachum oil tree, in Arabic particularly in Sudan it is known as lalob, heglig and less frequently as hidjihi, inteishit, and (huly). In Hausa it is called aduwa, in Swahili .mchunju and in Amharic bedena

1.3.2Distribution.

Balanitis aegyptiaca is found in the Sahel-Savannah region across Africa. It is one of the most common trees in Senegal and Mauritania, one of its local names is teishit. It can be found in many kinds of habitat, tolerating a wide variety of soil types, from sand to heavy clay, and climatic moisture levels, from arid to sub-humid. It is relatively tolerant of [flooding, livestock activity, and wildfire.[15

Fig 1.5 *Balanitis aegyptiaca* seeds

1.3.3Description

The *Balanitis aegyptiaca* tree reaches 10 m (33 ft) in height with a generally narrow form. The branches have long, straight green spines arranged in spirals. The dark green compound leaves grow out of the base of the spines and are made up of two leaflets which are variable in size and shape.[16]The fluted trunk has grayish-brown, ragged bark with .yellow-green patches where it is shed

The tree produces several forms of inflorescence bearing yellow-green bisexual flowers with five long greenish petals. In Senegal, they are pollinated by halictid bees, including Halictus gibber, and flies, including

Rhiniaapicalis and *Chrysomiachioropiza*. The carpenter ant *Camponotussericeus* feeds on the nectar exuded by the flowers. The larva of the cabbage tree emperor moth *Bunaeaalcinoe* causes defoliation of .the tree

Scientific classification of *Balanitis aegyptiaca* 1.3.4

Kingdom:	Plantae
unranked):	Angiosperms)
unranked):	Eudicots)
unranked):	Rosids)
Order:	*Zygophyllales*
Family:	*Zygophyllaceae*
Genus:	Banalitis
Species:	*B. aegyptiaca*

Binomial name

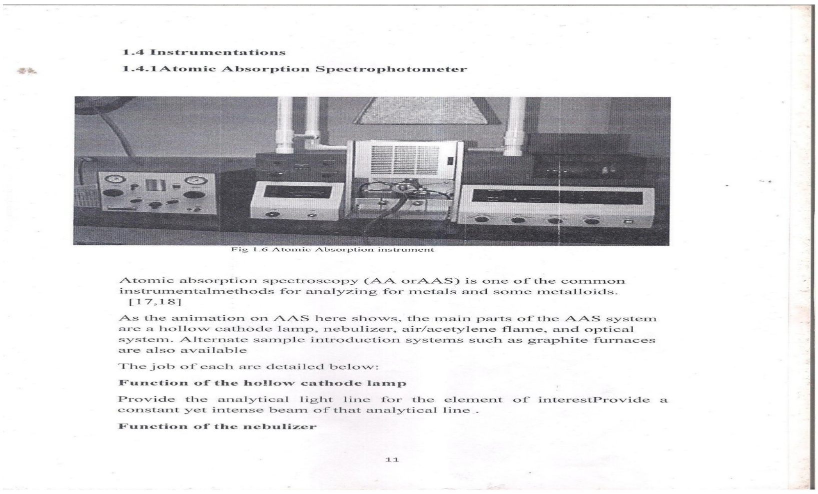
Banalitis aegyptiaca (L.) Delile, 1812

Synonyms

.*Ximenia aegyptiaca* L

Instrumentations 1.4

l Atomic Absorption Spectrophotometer.1.4



1.4 Instrumentations

1.4.1Atomic Absorption Spectrophotometer

Fig 1.6 Atomic Absorption instrument

Atomic absorption spectroscopy (AA orAAS) is one of the common instrumentalmethods for analyzing for metals and some metalloids. [17,18]

As the animation on AAS here shows, the main parts of the AAS system are a hollow cathode lamp, nebulizer, air/acetylene flame, and optical system. Alternate sample introduction systems such as graphite furnaces are also available

The job of each are detailed below:

Function of the hollow cathode lamp

Provide the analytical light line for the element of interestProvide a constant yet intense beam of that analytical line .

Function of the nebulizer

11

Fig 1.6 Atomic Absorption instrument

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:The function of each are detailed below

Function of the hollow cathode lamp

Provide the analytical light line for the element of interest provide a

Constant, yet intense, beam of that analytical line

Function of the nebulizer

Suck up liquid sample at a controlled rate Create a fine aerosol for introduction into the flame Mix the aerosol and fuel and oxidant .thoroughly for4 introduction into the flame

Function of the flame

Destroy any analyte ions and breakdown complexes create atoms (the .elemental form) of the element of interest Fe0, CuO, ZnO, etc

Function of the monochromator

Isolate analytical lines' photons passing through the flame. Remove scattered light of other wavelengths from the flame. In doing this, only

.(narrow spectral line impinges on the photomultiplier tube(PMT

(Function of the photomultiplier tube (PMT

As the detector the PMT determines the intensity of photons of the [analytical line exiting the monochromator. [18,19,20

Conductivity of electrolytes 1.4.2

The conductivity of a solution is an expression of the capacity of that solution to conduct electric current. Distilled or deionized water will conduct virtually no electricity at all and will therefore have

.conductivity reading of zero

All salts are dissolved in the water - in making up a nutrient solution for example - so the conductivity of the solution increases. The conductivity of a nutrient solution can therefore be used as a guide to its ‘strength as [indicates the amount of salts dissolved. [21,22

Fig 1.7 Conductivity meter

The aim of the study 1.5

:The aim of this study is

- To prepare charcoal from the wooden part of the fruits of *Balanitis .aegyptiaca*
- .To measure the extent of cationic adsorption of thus prepared charcoal

Experimental 2

Material 2.1

Sample 2.1.1

(Sample origin (collection 2.1.1.1

The “*Balanitis aegyptiaca*” sample was obtained from the Khartoum. This item of commerce is usually brought from the largest auction of .lalobe produced in Sudan

Sample purification and preparation 2.1.1.2

The sample was purified by removing outer shell and boiled until cortex is completely dissolved, the internal seed became clean. After drying in air the seed was broken, the inner core was discarded and the outer wooden layer was collected and preserved in a clean poly ethylene bags .till further use

Sample treatment 2.1.1.3

A weighed amount of lalobe seeds wood was previously dried was immersed in a solutions of Sodium hydroxide of different concentration .(5%, 10% and 20%) for specified time and then filtered and dried

Chemicals 2.1.2

.(Chromium(III) Chloride (AnalR grad-

.(Zinc(II)Nitrate (AnalR grade -

.(Lead (II) Nitrate. (AnalR grade-

.(Sodium hydroxide. (AnalR grade-

Instrument 2.1.3

Atomic absorption spectroscopy (AA6800, SHIMADZU, KYOTO,- (Japan

(Conductivity meter (4320 JENWAY, U.K-

.(Sensitive balance(Sarotuos 1000 U.K-

.(Hot air Oven(Galenkamp, U.K-

:Methods 2.2

Preparation of charcoal 2.2.1

All sample (NaOH treated and Un-treated) were taken in separate closed in metallic containers and heated in absence of oxygen for 36 hours, till full carbonization of the samples was achieved. The charcoal thus formed .was collected and kept in a desiccators till further use

Preparation of stocks of standard solutions 2.2.2

and 0.0145 grams of, Pb(NO3)2, CrCl3 and Zn (NO3)2, 0.008 ,0.025 respectively, were weighted accurately in beakers and dissolved in small amount of distilled water, then transferred to(25ml) volumetric flask and the volumes were completed up to the marks with distilled water. Then $CrCl_3$ solution(20 ppm), $Pb(NO_3)_2$ solution (20 ppm) and $Zn(NO_3)_2$ solution (20ppm) were obtained. From these stock solutions .concentration of 10 ppm and 5 ppm were obtained by further dilutions

Measurement of concentration of adsorbed cations by AAS 2.2.3 .technique

g from activated carbon [untreated] were added to each solution of 2 * cations under study [concentration of 10 ppm, 20 ppm and 5 ppm for .[each

g of activated carbon [treated with varying concentrations of NaOH 2 * 5%, 10% and 20%] were added to each solution of at the concentration 5 .ppm, 10 ppm and 20 ppm

Then the Activated carbon (charcoal) was left to stand in to these * solutions for 45 minutes and then filtered off. The concentrations of cation in the solutions were measured by atomic adsorption .spectrophotometer

Measurement of water Conductivity subjected to treatment with .2.2 charcoal

2g from charcoal were weighted accurately and added to 920 ml of tap .water and left in a beaker (50 ml) for period of 45 minutes

Then (20 ml) of tap water taken were taken in another beaker (50ml) and used as reference. The beakers were put in to a thermostated water bath where the temperature was kept constant throughout measurements. The conductivity the water in each beaker was measured by a conductivity .(meters (Jenway 650, U.K

Results and discussion 3

:Atomic absorption results 3.1

:Cation of lead concentration 3.1.1

Table 3.1 The concentration of Pb ion test solution before and after .charcoal treatment

Concentration of NaOH% for Treatment	Concentration of pb before charcoal treatment/ppm	Concentration of pb after charcoal treatment /ppm
1.28	20	0%
Nd	20	5%
Nd	20	10%
Nd	20	20%
0.63	10	0%
Nd	10	5%
Nd	10	10%
Nd	10	20%
Nd	5%	0%
Nd	5%	5%
Nd	5%	10%
Nd	5%	20%

Table 3.1 show the concentration of Pb cation in ppm, determined by AAS techniques, before and after treating solution with the prepared

Balanites *aegyptiaca* activated carbon. The concentration of ph catious solutions in the decreased after charcoal treatment from (20, 10 and5 pm) to (1.28, 0.63 and almost undetectable) respectively. This confirm the ability of charcoal to adsorb ion of Pb, also the results in the same table indicate that the charcoal when treated with sodium hydroxide [5% 10% and 20%] shows more adsorption for Pb while indicates that sodium hydroxide had expand the active adsorbing cites of charcoal and allow . for more adsorption of ctaion

The adsorption of Pb ion is greater when the charcoal treated with concentration of NaOH of 20%, than when concentration was only 10% .and 5%

:Cation of Zinc 3.1.2

Table 3.2 The concentration of Zn cation before and after charcoal .treatment

Concentration of NaOH% for Treatment	Concentration of Zn before charcoal treatment/ppm	Concentrate of Zn after charcoal treatment\pprn
2.233	20	0%
1.680	20	%5
1.225	20	10%
0.625	20	20%
1.3044	10	0%
0.921	10	%5
0.402	10	10%
0.0127	10	20%
Nd	5	0%
Nd	5	%5
Nd	5	10%
Nd	5	20%

Table 3.2 show the concentration of Zn cation in ppm, determined by AAS techniques before and after treating solution with the prepared Balanites aegyptiaca charcoal. The concentration in the experiments decreased after charcoal treatment from 20, 10 and 5 ppm to 2.23pp 1.30 and almost undetectable) respectively. This confirm the ability of charcoal to adsorb cation of Zn, also the result in the same table indicate that the charcoal when treated with sodium hydroxide [5%, 10% and 20%] had greater adsorption for Zn cation, this might be due that sodium hydroxide can expand the pores of charcoal and more adsorption to ..ctaion

The adsorption of Zn cation is greater when the charcoal treated with .NaOH concentration was 20% than 10% and 5%

:Cation of Chromium 3.1.3

Table 3.3 The concentration of Cr cation before and after charcoal .treatment

Concentration of		Concentration of Zn2+ in solution /ppm
Before charcoal treatment	after charcoal treatment	(NaOH solution (% w/w
7.896	20	0%
5.854	20	%5
3.605	20	10%
0.970	20	20%
3.0717	10	0%
0.826	10	%5
0.002	10	10%
Nd	10	20%
1.833	5	0%
0.808	5	%5
0.031	5	10%
Nd	5	20%

Table 3.3 show the concentration of Cr cation in ppm ,determined by AAS techniques, before and after treating the solution with the prepared

Balanitis aegyptiaca charcoal. The concentration of cation in solution decreased after charcoal treatment from (20, 10 and 5 ppm) to (7.896, 3.07 17 and 1.833 ppm) respectively .This confirm the ability of charcoal to adsorb cation of Cr. Also the result in the same table indicate that the charcoal when treated with sodium hydroxide [5% ,10% and 20%] give more adsorption for Cr cation, this mean the sodium hydroxide can .expand the pours of charcoal and gives more adsorption to cation

The adsorption of Cr cation is greater when the charcoal treated with NaOH concentration 20% than 10% and 5%. from three tables it is noticed that, the adsorption of Pb cation is greater than Zn and Cr cations. The reason might be due to its higher atomic weight and consequently .size and the charge on the cation

3.2Conductivity measurements

Table 3.4 Conductivity of water before and after charcoal treatment micro Siemens/

Conductivity of water after charcoal treatment / micro semen	Conductivity of water before charcoal treatment/micro Siemens
139.0	184.3
139.4	184.7
139.9	185.2
139.4	184.7
C 28.7	C 28.7

Table 3.4 show the conductivity of water in micro semen determined by coductometric technique, before and after treating water with the prepared Balanitis aegyptiaca charcoal the conductivity of water decreased after charcoal treatment which indicates that the number of .ions in water was decreased due to adsorption to activated carbon

Conclusion

. *Balanitis aegyptiaca* is a good source for activated carbon •

Sodium hydroxide can enhance activated carbon adsorption of cation • .from there aqueous solution

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