REMOVAL OF CHROMIUM (VI) IONS FROM AQUEOUS SOLUTION USING GOLD COAST BOMBAX (ACTIVATED CARBON).

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Certification

This is to certify that this project was carried out by AKWAEZE C. Queeneth (SE/12/64583), EWENIKE I. Florence (SE/12/59218) JOSEPH Racheal (SE/12/65088), JOHN Ejike Stanley (SE/12/59736) and ADAJI Dorcas Ojoniko (SE/12/65034)

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Dedication

We dedicate this project work to Almighty God, our parents, family members, friends and to all the lecturers in Chemistry Department.

Acknowledgment

We give God the glory for his endless mercies towards us, for His grace and assistance towards the completion of this project work. We give Him all the praise for it is not he that wills or runs, but to whom He sows mercy.

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Abstract

Bombax (buonopozense), commonly known as the Gold Coast Bombax has been successfully utilized for the removal of Cr(VI) from aqueous solution. The effect of different parameters such as contact time, sorbate concentration, pH of the medium and temperature were investigated and maximum uptake of Cr(VI) was 81.81 (mg g−1) at pH 2.0, initial Cr(VI) concentration of 50.80 mg L−1and volume of 20 dm^3., Effect of pH showed that maize bran was not only removing Cr (VI) from aqueous solution but also reducing toxic Cr(VI) into less toxic Cr(III). The sorption kinetics was tested with first order reversible, pseudo-first order and pseudo-second order reaction and it was found that Cr (VI) uptake process followed the pseudo second order rate expression. Mass transfer of Cr (VI) from bulk to the solid phase (maize bran) was studied at different temperatures. Different thermodynamic parameters, viz., G°, H° and S° have also been evaluated and it has been found that the sorption was feasible, spontaneous and endothermicin nature. The Langmuir and Freundlich equations for describing sorption equilibrium were applied and it was found that the process was well described by Langmuir isotherm. Desorption studies was also carried out and found that complete desorption of Cr (VI) took place at pH of 9.5.

CHAPTER ONE

1.0 Introduction

Water (chemical formula: H_20) is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of living things. As a chemical compound, a water molecule contains one oxygen and two hydrogen atoms that are connected by covalent bonds. Water is a liquid at standard ambient temperature and pressure, but it often co-exists on earth with its solid state, ice and gaseous state (water vapour) it also exists as snow, fog, dew and cloud (Nicholas, 2002).

Water on Earth moves continually through the water cycle of evaporation and transpiration (evapo-transpiration), condensation, and precipitation and run off, usually reaching the sea. Evaporation and transpiration contribute to the precipitation over land. Water used in the production of a good or services is known as virtual water. Safe drinking water is essential to humans and other life forms even though it provides no calories or organic nutrients.

All these factors and many more, make water a substance of great importance. Form a strictly chemical point of view the remarkable thing about water is the amount of hydrogen bonding, there is, both in the solid (ice) and liquid (Raymond, 2002).

1.1 HEAVY METAL

A heavy metal is any one of a number of element that exhibit metallic properties, which includes transition metals lanthanides, actinides as well as the metalloids arsenic and antimony. Typically the term refers to elements of atomic number 21 or higher (e.g. scandium or abore) the term heavy metal chiefly arose with discussions of pollutants discharged to the environment in the form of air, water or soil contaminants. Glanze,(1996) sited that, while many heavy metals have considerable toxicity, others are considered not deemed to possess significant toxic elements including Zinc (Zn) Iron (Fe) Copper (CU) Chromium (Cr) and Cobalt (Co) are necessary for metabolic function for a large class of organisms

1.2 OCCURRENCE OF HEAVY METAL

Heavy metals are metallic components that are natural constituents of all ecosystems, moving between atmosphere, hydrosphere, lithosphere, and biosphere (Bargagli, 2000). Their distribution in the environment is a result of natural processes (volcanoes, erosion, spring water, bacteria activity) and anthropogenic activities (fossil fuel combustion, industrial and agricultural processes) for review see florae et al. 2004; Florae 2005). While compounds containing Cd, Cu, Cr, Hg, Ni, Pb and Zn are industrially produced, Cd, Au, Cl, C and Pb, are also used in home activities (Fergussion and Kim, 1991); Abdulla and Chemical-Nicka, 1990).

Therefore, metal compounds are also increasingly introduced in the environment and could finally accumulate in a biotic system (Nordberg et al 1985; Han et al, 2002). In addition, acidification (e.g. upon acid rainfall) may increase their bioavailability and possibly raise their toxic potential.

Exposure to heavy metal is potentially harmful especially for those metals - compounds, which do not have any physiological role in the metabolism of cells. The ingestion of metals via food or water could modify the metabolism of other essential elements such as Zn, Cu, Fe and Se (Abdulla and Chemical-Nicka, 1990)

1.3 HEAVY METAL TOXICITY

The heavy metals constitute a group of about 40 elements with a density greater than five (80). A feature of heavy metal physiology is that even though many of them are essential for growth, they are also reported to have comprehensively toxic effects on cells, mainly as a result of their ability to denature protein molecules. There are however, many reports in the literature of microbial resistance to heavy metals. The phenomenon of microbial ecology, especially in connection with the roles of microbes in polluted ecosystems and in the reclamation of metal - contaminated natural habitats, it is also important to understand the mechanisms of microbial tolerance because of the extensive use of some metals and metal compounds as fungicides and disinfectants.

Metal toxicity or metal poisoning is the toxic effect of certain metals in certain forms and doses on life. Some metals are toxic when they form poisonous soluble compounds. Certain metals have no biological role i.e. are not essential minerals, or are toxic when in a certain form. The toxic metals sometimes imitate the action of an essential element in the body, interfering with the metabolic process to cause illness. Many metals, particularly heavy metals are toxic, but some heavy metals are essential, and some, such as bismuth, have a low toxicity. Most often the definition of toxic metals includes at least cadmium, lead, mercury and the radioactive – metals (Bryan,1979).

1.4 OBJECTIVE OF THE STUDY

The objective of this study is to investigate the adsorption of metal (lead and zinc) from aqueous solution using unmodified groundnut shell powder. The study will also determine the efficiency and effectiveness of the bio-sorbent on adsorption of lead (pb^{2+}) and zinc (zn^{2+}) from the solution based on time and mass differences.

1. It serves as a way of reducing human exposure to chromium (VI).
2. It will help to reduce heavy metal concentration from industrial waste water.
3. It is used to reduce environmental pollution by minimizing the amount agricultural wastes that letter the environment especially during harvest.

4. It will help in reducing health condition related to heavy metal exposure.

5. It will add value to agricultural waste (Gold Coast Bombax) and erect job in the process.

1.4 GOLD COAST BOMBAX

Bombax (buonopozense), commonly known as the Gold Coast Bombax or red-flowered silk cotton tree, is a tree in the mallow family. It is also known in the Dagbani language as Vabga (plural vabsi)

It is native primarily in West Africa, where it is found in rainforests from Sierra Leone in the northwest, east to Uganda and south to Gabon, typically at elevations of 900 to 1200 metres. A large tree, it often reaches heights of 40metres (130 feet) with buttress roots up to 6metres (20 feet) in diameter. The bark of younger trees is covered with spines and large deep pink-to-red flowers emerge while the tree is leafless.

Various parts of the plant are used for medicinal purposes, as food as a source of clothing fibre, as a building material, and as a dye. The fruits are eaten by animals such as the water chevrotain

Buonopozense is a large tropical tree that grows to 40metres (130 feet) in height with large buttress roots that can spread 6metres (20 feet). The conspicuous flowers emerge while the tree is leafless and are either solitary or arranged in small auxiliary cymes. The truncate calyx, that is the whorl of sepals, is 1 to 1.6cm high and is cupuliform, or cup - shaped.

Many parts of the plant are utilized for medicinal and traditional purposes. The wood is quite light, which limit its uses to canoes and other implements (Volesky, 1990)

1.6 ACTIVATED CARBON

Activated carbon, also called activated charcoal, activated coal, carbon activatus or an "AC filter". Is a form of carbon processed to have small, low-volume pore that increase the surface area available for absorption or chemical actions. Activated is sometimes substituted with active.

Due to its high degree of micro-porosity, just one gram of activated of carbon has surface area in excess of $500m^2$, as determined by gas absorption. An activated level sufficient for useful application may be attained solely from high surface area; however, further chemical treatment often enhances adsorption properties.

Activated carbon is usually derived from charcoal and, increasingly high - porosity biochar (John, 2010)

1.6 DEFINITION OF THE TERMS

- ✓ Absorption: Is a physical or chemical phenomenon or process in which atoms and molecules or ions enter some bulk phase i.e gas, liquid, or solid material.
- ✓ Adsorption: Is the adhesion of atoms, ions, or molecules from a gas, liquid or dissolved solid.
- ✓ Adsorbent: Is a material that has the ability to extract certain substances from gases, liquids or solids.
- ✓ Adsorbate: A substance that has been or is adsorbed on a surface.
- ✓ Heavy metal: Is any one or a number of elements that exhibit metallic properties.
- ✓ Toxicity: Is the degree to which a substance can damage an organism
- ✓ Bio - Accumulation: an important process through which chemicals can affect living organisms is bioaccumulation.
- ✓ Bio - sorption: Is a physiochemical process that occurs naturally in certain biomass which allows it to positively and bind contaminants onto its cellular structure.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Heavy Metal

A heavy metal is any metal or metalloid of environmental concern. The term originated with reference to the harmful effects of cadmium, mercury and lead, all of which are denser than iron. It has since been applied to any other similarly toxic metal, or metalloid such as arsenic, regardless of density (Adeyi 2001). Commonly encountered heavy metals are chromium, cobalt, nickel, copper, zinc, arsenic, selenium, silver, cadmium, antimony, mercury, thallium and lead. More specific definitions of a heavy metal have been proposed; none have obtained widespread acceptance. Criteria used to define heavy metals have included density, atomic weight, atomic number, or periodic table position. Density criteria range from above 3.5 g/cm^3 to above 7 g/cm^3. Atomic weight definitions start at greater than sodium (22.98) to greater than 40. Atomic numbers of heavy metals are generally given as greater than 20; sometimes this is capped at 92 (uranium). Bryan (2009), suggested referring to heavy metals as "all the metals in Groups 3 to 16 that are in periods 4 and greater. There is no widely agreed definition of a heavy metal.

The origin of the term "heavy metal" is not clear. An early use dates from 1817, when Gmelin divided the elements into non-metals, light metals and heavy metals. Light metals had densities of 0.860–5.0 gm/cm^3; heavy metals 5.308–22.000.

Beryllium and aluminium, although light metals, are sometimes counted as heavy metals in view of their toxicity. Beryllium exposure can result in lung and heart disorders, and possibly death; aluminium is a major inhibitor of crop growth in acid soils.

2.2 Contamination Sources

Heavy metals are found naturally in the earth, and become concentrated as a result of human caused activities. Common sources are from mining and industrial wastes; vehicle emissions; lead-acid batteries; fertilizers, paints and treated woods. Lead is the most prevalent heavy metal contaminant. As a component of tetra-ethyl lead it was used extensively in gasoline during the 1930s-1970s. Lead levels in the aquatic environments of industrialized societies have been estimated to be two to three times those of pre-industrial levels. Although the use of leaded gasoline was largely phased out in North America by 1996, soils next to roads built before this time, retain high lead concentrations. Lead (from lead azide or lead styphnate used in firearms) gradually accumulates at firearms training grounds, contaminating the local environment and exposing range employees to a risk of lead poisoning (Volesky, 1990).

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2.3 Entry Routes

Heavy metals enter plant, animal and human tissues via air inhalation, diet and manual handling. Motor vehicle emissions are a major source of airborne contaminants including arsenic, cadmium, cobalt, nickel, lead, antimony, vanadium, zinc, platinum, palladium and rhodium. Water sources (groundwater, lakes, streams and rivers) can be polluted by heavy metals leaching from industrial and consumer waste; acid rain can exacerbate this process by releasing heavy metals trapped in soils. Plants are exposed to heavy metals through the uptake of water; animals eat these plants; ingestion of plant- and animal-based foods is the largest sources of heavy metals in humans (Duffus, 2010). Absorption through skin contact, for example from contact with soil, is another potential source of heavy metal contamination. Heavy metals can accumulate in organisms as they are hard to metabolize (process and eliminate) (Glanze, 1996).

2.4 Detrimental Effects

Heavy metals "can bind to vital cellular components, such as structural proteins, enzymes, and nucleic acids, and interfere with their functioning." Symptoms and effects can vary according to the metal or metal compound, and the dose involved. Broadly, long-term exposure to heavy metals can have carcinogenic, central and peripheral nervous system and circulatory effects. For humans, typical presentations associated with exposure to any of the "classical" heavy metals, or chromium (another heavy metal) or arsenic (a metalloid), are shown in the table (Glanze 1996).

Element	Acute Exposure	Chronic Exposure	Main Article
Arsenic	NauseavomitingDiarrhea EncephalopathyMulti-organeffectsArrhythmia Painful neuropathy	Diabetes Hypopigmentation/ Hyperkeratosis Cancer	Arsenic poisoning
Cadmium	Pneumonitis(lung inflammation)	Lungcancer Osteomalacia (softening of bones), Proteinuria (excess protein in urine; possible kidney damage)	Cadmium poisoning
Chromium	Gastrointestinal haemorrhage (bleeding) Hemolysis (red blood cell destruction) Acute renal failure	Pulmonary fibrosis (lungs carring), Lung cancer	Chromium toxicity
Lead	Encephalopathy(brain dysfunction),Nausea Vomiting	Anemia Encephalopathy Footdrop/wristdrop	Lead poisoning
Mercury	Diarrhea,Fever Vomiting	Nausea Nephrotic syndrome (nonspecific kidney disorder), Neurasthenia (neurotic disorder), Parageusia (metallic taste), Pink Disease (pain and pink discoloration of hands and feet)	Mercury poisoning

2.5 Chromium

Chromium is a chemical element with symbol Cr and atomic number 24. It is the first element in Group 6. It is a steely-gray, lustrous, hard and brittle metal which takes a high polish, resists tarnishing, and has a high melting point. According to Bryan (1979) the name of the element is derived from the Greek word χρῶμα, *chrōma*, meaning color because many of its compounds are intensely colored. Chromium oxide was used by the Chinese in the Qin dynasty over 2,000 years ago to coat metal weapons found with the Terracotta Army. Chromium was discovered as an element after it came to the attention of the Western world in the red crystalline mineral crocoite (Lead (II) Chromate), discovered in 1761 and initially used as a pigment. Louis Nicolas Vauquelin first isolated chromium metal from this mineral in 1797. Since Vauquelin's first production of metallic chromium, small amounts of native (free) chromium metal have been discovered in rare minerals, but these are not used commercially. Instead, nearly all chromium is commercially extracted from the single commercially viable ore chromite, which is iron chromium oxide ($FeCr_2O_4$). Chromite is also now the chief source of chromium for chromium pigments. Chromium metal and ferrochromium alloy are commercially produced from chromite by silicothermic or alumino-thermic reactions, or by roasting and leaching processes. Chromium metal has proven of high value due to its high corrosion resistance and hardness. A major development was the discovery that steel could be made highly resistant to corrosion and discoloration by adding metallic chromium to form stainless steel. This application, along with chrome plating (electroplating with chromium) currently comprise 85% of the commercial use for the element, with applications for chromium compounds forming the remainder. Trivalent chromium (Cr(III)) ion is possibly required in trace amounts for sugar and lipid metabolism, although the issue remains in debate .In larger amounts and in different forms, chromium can be toxic and carcinogenic. The most prominent example of toxic chromium is hexavalent chromium (Cr (VI)). Abandoned chromium production sites often require environmental cleanup. Chromium is remarkable for its magnetic properties: it is the only elemental solid which shows antiferromagnetic ordering at room temperature (and below). Above 38 °C, it transforms into a paramagnetic state.

2.6 Chromium Passivation

Chromium metal left standing in air is passivated by oxygen, forming a thin protective oxide surface layer. This layer is a spinel structure only a few atoms thick. It is very dense, and prevents the diffusion of oxygen into the underlying material. This barrier is in contrast to iron or plain carbon steels, where the oxygen migrates into the underlying material and causes rusting. The passivation can be enhanced by short contact with oxidizing acids like nitric acid. Passivated chromium is stable against acids. The opposite effect can be achieved by treatment with a strong reducing agent that destroys the protective oxide layer on the metal. Chromium metal treated in this way readily dissolves in weak acids (Bryan, 1979).

Chromium, unlike metals such as iron and nickel, does not suffer from hydrogen embrittlement. However, it does suffer from nitrogen embrittlement, reacting with nitrogen from air and forming brittle nitrides at the high temperatures necessary to work the metal parts (Bryan, 1979).

2.7 Chromite Ore

Chromium is the 22nd most abundant element in Earth's crust with an average concentration of 100 ppm. Chromium compounds are found in the environment, due to erosion of chromium-containing rocks and can be distributed by volcanic eruptions. The concentrations range in soil is between 1 and 300 mg/kg, in sea water 5 to 800 µg/liter, and in rivers and lakes 26 µg/liter to 5.2 mg/liter. Chromium is mined as chromite ($FeCr_2O_4$) ore. About two-fifths of the chromite ores and concentrates in the world are produced in South Africa, while Kazakhstan, India, Russia, and Turkey are also substantial producers. Untapped chromite deposits are plentiful, but geographically concentrated in

Kazakhstan and southern Africa. Although rare, deposits of native chromium exit. The relation between Cr (III) and Cr (VI) strongly depends on pH and oxidative properties of the location, but in most cases, the Cr(III) is the dominating species, although in some areas the ground water can contain up to 39 μg/litre of total chromium of which 30 μg/litre is present as Cr(VI).

2.8 Chromium Isotopes

Naturally occurring chromium is composed of three stable isotopes; ^{52}Cr, ^{53}Cr and ^{54}Cr with ^{52}Cr being the most abundant (83.789% natural abundance). 19 radioisotopes have been characterized with the most stable being ^{50}Cr with a half-life of (more than) 1.8×10^{17} years, and ^{51}Cr with a half-life of 27.7 days. All of the remaining radioactive isotopes have half-lives that are less than 24 hours and the majority of these have half-lives that are less than 1 minute. This element also has 2 metal states.

^{53}Cr is the radiogenic decay product of ^{53}Mn (half-life = 3.74 million years). Chromium isotopic contents are typically combined with manganese isotopic contents and have found application in isotope geology. Mn-Cr isotope ratios reinforce the evidence from ^{26}Al and ^{107}Pd for the early history of the solar system. Variations in ^{53}Cr/^{52}Cr and Mn/Cr ratios from several meteorites indicate an initial ^{53}Mn/^{55}Mn ratio that suggests Mn-Cr isotopic composition must result from in-situ decay of ^{53}Mn in differentiated planetary bodies. Hence ^{53}Cr provides additional evidence for nucleosynthetic processes immediately before coalescence of the solar system. The isotopes of chromium range in atomic mass from 43 u (^{43}Cr) to 67 u (^{67}Cr). The primary decay mode before the most abundant stable isotope, ^{52}Cr, is electron capture and the primary mode after is beta decay. ^{53}Cr has been posited as a proxy for atmospheric oxygen concentration. Chromium is a member of the transition metals, in group 6. Chromium (0) has an electronic configuration of $4s^13d^5$, owing to the lower energy of the high spin configuration. Chromium exhibits a wide range of possible oxidation states, where the +3 state is most stable energetically; the +3 and +6 states are most commonly observed in chromium compounds, whereas the +1, +4 and +5 states are rare (Michael, 2010).

2.9 Uses of Chromium

The strengthening effect of forming stable metal carbides at the grain boundaries and the strong increase in corrosion resistance made chromium an important alloying material for steel. The high-speed tool steels contain between 3 and 5% chromium. Stainless steel, the main corrosion-proof metal alloy, is formed when chromium is added to iron in sufficient concentrations, usually above 11%. For its formation, ferrochromium is added to the molten iron. Also nickel-based alloys increase in strength due to the formation of discrete, stable metal carbide particles at the grain boundaries. For example, Inconel 718 contains 18.6% chromium. Because of the excellent high-temperature properties of these nickel superalloys, they are used in jet engines and gas turbines in lieu of common structural materials (Nicholas, 2002).

The relative high hardness and corrosion resistance of unalloyed chromium makes it a good surface coating, being still the most "popular" metal coating with unparalleled combined durability. A thin layer of chromium is deposited on pre-treated metallic surfaces by electroplating techniques. There are two deposition methods: Thin, below 1 μm thickness, layers are deposited by chrome plating, and are used for decorative surfaces. If wear-resistant surfaces are needed then thicker chromium layers are deposited. Both methods normally use acidic chromate or dichromate solutions. To prevent the energy-consuming change in oxidation state, the use of chromium (III) sulphate is under development, but for most applications, the established process is used.

In the chromate conversion coating process, the strong oxidative properties of chromates are used to deposit a protective oxide layer on metals like aluminium, zinc and cadmium. This passivation and the self-healing properties by the chromate stored in the chromate conversion coating, which is able to migrate to local defects, are the benefits of this coating method. Because of environmental and health regulations on chromates, alternative coating methods are under development.

According to Raymond, (2002) Chromic acid anodizing (or Type I anodizing) of aluminium is another electrochemical process, which does not lead to the deposition of chromium, but uses chromic acid as electrolyte in the solution. During anodization, an oxide layer is formed on the aluminium. The use of chromic acid, instead of the normally used sulfuric acid, leads to a slight difference of these oxide layers. The high toxicity of Cr(VI) compounds, used in the established chromium electroplating process, and the strengthening of safety and environmental regulations demand a search for substitutes for chromium or at least a change to less toxic chromium(III) compounds.

- **Dye and pigment**

The mineral crocoite (lead chromate $PbCrO_4$) was used as a yellow pigment shortly after its discovery. After a synthesis method became available starting from the more abundant chromite, chrome yellow was, together with cadmium yellow, one of the most used yellow pigments. The pigment does not photodegrade, but it tends to darken due to the formation of chromium(III) oxide. It has a strong color, and was used for school buses in the US and for Postal Service (for example Deutsche Post) in Europe. The use of chrome yellow declined due to environmental and safety concerns and was replaced by organic pigments or alternatives free from lead and chromium. Other pigments based on chromium are, for example, the bright red pigment chrome red, which is a basic lead chromate ($PbCrO_4 \cdot Pb(OH)_2$). A very important chromate pigment, which was used widely in metal primer formulations, was zinc chromate, now replaced by zinc phosphate. A wash primer was formulated to replace the dangerous practice of pretreating aluminum aircraft bodies with a phosphoric acid solution. This used zinc tetroxychromate dispersed in a solution of polyvinyl butyral. An 8% solution of phosphoric acid in solvent was added just before application. It was found that an easily oxidized alcohol was an essential ingredient. A thin layer of about 10–15 μm was applied, which turned from yellow to dark green when it was cured. There is still a question as to the correct mechanism. Chrome green is a mixture of Prussian blue and chrome yellow, while the chrome oxide green is chromium(III) oxide.

Chromium oxides are also used as a green color in glassmaking and as a glaze in ceramics. Green chromium oxide is extremely light-fast and as such is used in cladding coatings. It is also the main ingredient in IR reflecting paints, used by the armed forces, to paint vehicles, to give them the same IR reflectance as green leaves.

- **Synthetic ruby and the first laser**

Natural rubies are corundum (aluminum oxide) crystals that are colored red (the rarest type) due to chromium (III) ions (other colors of corundum gems are termed sapphires). A red-colored artificial ruby may also be achieved by doping chromium(III) into artificial corundum crystals, thus making chromium a requirement for making synthetic rubies. Such a synthetic ruby crystal was the basis for the first laser, produced in 1960, which relied on stimulated emission of light from the chromium atoms in such a crystal

- **Wood preservative**

Because of their toxicity, chromium(VI) salts are used for the preservation of wood. For example, chromated copper arsenate (CCA) is used in timber treatment to protect wood from decay fungi, wood-attacking insects, including termites, and marine borers.[42] The formulations contain chromium based on the oxide CrO_3 between 35.3% and 65.5%. In the United States, 65,300 metric tons of CCA solution were used in 1996.

- **Tanning**

Chromium(III) salts, especially chrome alum and chromium(III) sulfate, are used in the tanning of leather. The chromium(III) stabilizes the leather by cross linking the collagen fibers. Chromium tanned leather can contain between 4 and 5% of chromium, which is tightly bound to the proteins. Although the form of chromium used for tanning is not the toxic hexavalent variety, there remains interest in management of chromium in the tanning industry such as recovery and reuse, direct/indirect recycling use of less chromium or "chrome-less" tanning are practiced to better manage chromium in tanning.

- **Refractory material**

The high heat resistivity and high melting point makes chromite and chromium(III) oxide a material for high temperature refractory applications, like blast furnaces, cement kilns, molds for the firing of bricks and as foundry sands for the casting of metals. In these applications, the refractory materials are made from mixtures of chromite and magnesite. The use is declining because of the environmental regulations due to the possibility of the formation of chromium(VI).

- **Catalysts**

Several chromium compounds are used as catalysts for processing hydrocarbons. For example, the Phillips catalyst, prepared from chromium oxides, is used for the production of about half the world's polyethylene.[45] Fe-Cr mixed oxides are employed as high-temperature catalysts for the water gas shift reaction. Copper chromite is a useful hydrogenation catalyst.

- **Other use**

Chromium(IV) oxide (CrO_2) is a magnetic compound. Its ideal shape anisotropy, which imparts high coercivity and remnant magnetization, made it a compound superior to the γ-Fe_2O_3. Chromium(IV) oxide is used to manufacture magnetic tape used in high-performance audio tape and standard audio cassettes. Chromates can prevent corrosion of steel under wet conditions, and therefore chromates are added to drilling muds. Chromium(III) oxide (Cr_2O_3) is a metal polish known as green rouge. Chromic acid is a powerful oxidizing agent and is a useful compound for cleaning laboratory glassware of any trace of organic compounds. It is prepared by dissolving potassium dichromate in concentrated sulfuric acid, which is then used to wash the apparatus. Sodium dichromate is sometimes used because of its higher solubility (50 g/L versus 200 g/L respectively). The use of dichromate cleaning solutions is now phased out due to the high toxicity and environmental concerns. Modern cleaning solutions are highly effective and chromium free. Potassium dichromate is a chemical reagent, used as a titrating agent. It is also used as a mordant (i.e., a fixing agent) for dyes in fabric.

2.10 Environmental Issues

As chromium compounds were used in dyes and paints and the tanning of leather, these compounds are often found in soil and groundwater at abandoned industrial sites, now needing environmental cleanup and remediation per the treatment of brownfield land. Primer paint containing hexavalent chromium is still widely used for aerospace and automobile refinishing applications

In 2010, the Environmental Working Group (EWG) studied the drinking water in 35 American cities, the first nationwide analysis measuring the presence of the chemical in U.S. water systems. The study found measurable hexavalent chromium in the tap water of 31 of the cities sampled, with Norman, Oklahoma, at the top of list; 25 cities had levels that exceeded California's proposed limit.]Concentrations of Cr(VI) in US municipal drinking water supplies reported by EWG are within likely, natural background levels for the areas tested and not necessarily indicative of industrial pollution]as asserted.

2.11 GOLD COAST BOMBER

Bombax buonopozense, commonly known as the Gold Coast Bombax or Red-flowered Silk Cotton Tree, is a tree in the mallow family. It is also known in the Dagbani language as Vabga (plural Vabsi). It is native primarily in West Africa, where it is found in rainforests from Sierra Leone in the northwest, east to Uganda and south to Gabon, typically at elevations of 900 to 1200 metres. A large tree, it often reaches heights of 40 metres (130 feet) with buttress roots up to 6 metres (20 feet) in diameter. The bark of younger trees is covered with spines and large, deep pink-to-red flowers emerge while the tree is leafless.Various parts of the plant are used for medicinal purposes, as food, as a source of clothing fibre, as a building material, and as a dye. The fruits are eaten by animals such as the water chevrotain. *B. buonopozense* is a large tropical tree that grows to 40 metres (130 feet) in height with large buttress roots that can spread 6 metres (20 feet). The bark is covered in large, conical spines, especially when young, but shedding them with age to some degree. The branches are arranged in whorls. The leaves are compound and have 5 to 9 leaflets and 15 to 25 secondary veins. They are set on long petioles that typically measure between 22 and 14 cm. The individual leaflets have entire margins and are also quite large, measuring from 8 to 23 cm in length by 3 to 7.5 cm in width. The undersides of the leaflets may be either glabrous (i.e. hairless) or puberulous (i.e. very finely haired). The buds are conical.

The conspicuous flowers emerge while the tree is leafless and are either solitary or arranged in small axillary cymes. The truncate calyx, that is the whorl of sepals, is 1 to 1.6 cm high and is cupuliform, or cup-shaped. It is also deciduous, meaning that it does not persist on the fruit. The petals are deep pink or red in colour and are 5.5 to 9.5 cm in length by 2.5 to 3.7 cm in width. The numerous stamens are arranged in bundles with two whorls. The fruits are oblong and fairly large, being 8 to 18 cm in length by 3.5 to 6 cm in diameter. They are glabrous, either rigged or angular, and loculicidal, meaning that they open spontaneously at maturity along the capsule wall in between the sections of the locule. They contain many seeds that are 5 to 6 mm in length, all of which have a woolly indumenta, that is a cotton-like fibre covering (Robert, 1997).

CHAPTER THREE

3.0 CHEMICAL, EQUIPMENT AND MATERIAL USED

3.1 CHEMICALS: Chromium (VI) ion

3.2 SAMPLE: Aqueous Solution, Gold Coast Bombax (Activated Carbon)

3.3 EQUIPMENT/ APPARATUS

Atomic absorption spectrophotometer

Weighing balance

Pestle and mortar

Measuring cylinder

Volumetric flask

Beakers

Conical flask

Distilled water

Crucible

Spatula

Wash bottle

Funnels

Aluminum foil

Strip of litmus paper

3.4 SAMPLE AND SAMPLING TECHNIQUES

3.5 PREPARATION OF GOLD COAST BOMBAX

Gold coast Bombax which is known as bio sorbent sample was collected from one of the major source. It was sun dried for weeks in order to remove the moisture content in it, it was grounded with mortar and pestle, this is to make it in a powder form for proper adsorption and finally stored with a nylon bag or tight polythene in order to avoid much absorption of moisture from the surrounding.

1.6 PREPARATION OF STANDARD SOLUTION:

The stock solution containing 1000 mg/L of Cr (VI) was prepared by dissolving 3.73 g of A. R. grade K2CrO4, 2H2O in 1000 ml double distilled water. Required initial concentration of Cr (VI) standards were prepared by appropriate dilution of the above stock Cr (VI) solution.

3.7 CALCULATION

1. Preparation of Cr (VI)

Molar conc. = 50.80

Specific gravity = 1.18

Relative molecular mass of Cr (VI) = (52g/mol)

$$\text{Concentration of Cr (VI)} = \frac{\text{molar conc. X specific gravity X \% by mass}}{\text{Molar mass}}$$

$$\frac{50.80 \text{ X } 52 \text{ X } 1.18}{52} = 59.9\text{mol/dm}^3$$

The concentration of Cr (VI) is obtained with the use of the formula: $C_1V_1 = C_2V_2$

Where ; C_i = 59.9mol/dm3

C_2 = 50.80mol/dm3

V_1 = ?

$V_2 = 20\text{cm}^3$

$59.9 \text{X} V_1 = 20 \text{X} 50.80$

$V_1 = 16.96\text{cm}^3$

Therefore; $V_1 = 17 \text{ cm}^3$

3.8 BATCH ADSORPTION STUDIES

Batch adsorption studies simply means the method or various used to determine adsorption, when is a reasonable interaction between the prepared solution and the sample (Gold coast bombax).The studies was based on the mass and time difference for the both prepared solution of zinc and lead with powdered sample.

The first part of the experiment was done using different masses of absorbent (Gold coast bombax) of 0.2g, 0.4g, 0.6g, 0.8g and 1.0g with 20cm3 of each of the prepared solution. The solution and the absorbent was mixed and allowed to interact at an interval of one hour each. Filtration was carried out for each mixture and the adsorbent was collected into different labeled sample bottles, while the adsorbent was discarded.

The procedures was repeated for the time differences of each experiment using the same mass of the sample and the same volume of the solution at different time of interaction: 30, 60, 90, 120, 150 minutes, each was also filtered & absorbed obtained for proper studies.

The concentration of Chromium (VI) ion before and after interaction were determined using atomic adsorption spectrophotometer (AAS)

The percentage adsorption was calculated using the expression before (Erden et al, 2004).

$$\%RE = \frac{C_1 - C_f}{C_1} \times 100$$

Where C_1 = Initial concentration of heavy metal

C_f = Finial concentration of heavy metal

%RE = Percentage of Chromium removal

CHAPTER FOUR

4.0 Data Analysis

4.1 Results of the analysis are presented in the table below

Table 1

Absorption of Chromium (VI) ion from solution at different contact time (Mins)

Time(mins)	Mass(g)	Volume(dm^3)	Initial(mg/l)	Final(mg/l)	RE(%)
60	0.2	20	50.80	31.00	38.97
120	0.2	20	50.80	23.35	54.03
180	0.2	20	50.80	18.80	62.99
240	0.2	20	50.80	15.94	68.62
300	0.2	20	50.80	09.24	81.81

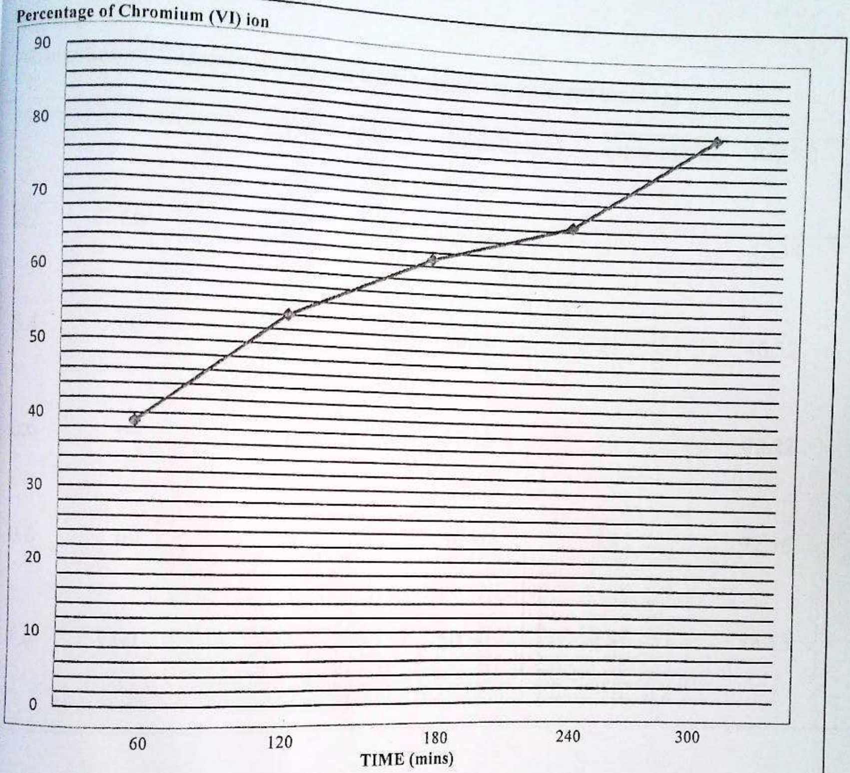
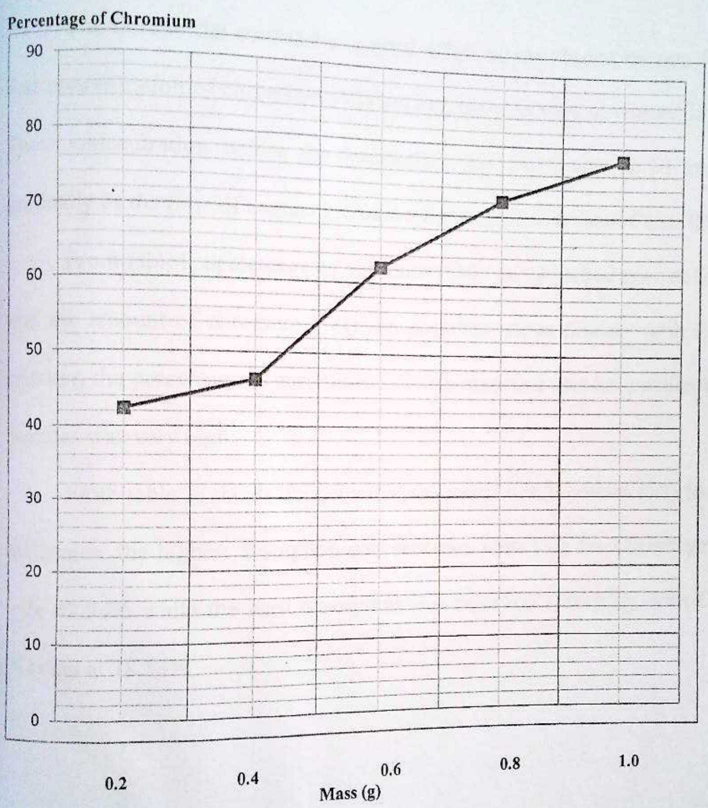

Percentage of Chromium (VI) ion
90
80
70
60
50
40
30
20
10
0
60
120
180
240
300
TIME (mins)

Table 2

Absorption of Chromium (VI) ion from solution at different mass (g)

Mass(g)	Time(mins)	Volume(dm^3)	Initial(mg/l)	Final(mg/l)	RE(%)
0.2	60	20	50.30	29	42.34
0.4	60	20	50.30	27	46.32
0.6	60	20	50.30	19	62.22
0.8	60	20	50.30	14	72.16
1.0	60	20	50.30	11	78.13


Percentage of Chromium
90
80
70
60
50
40
30
20
10
0
0.2
0.4
0.6
0.8
1.0
Mass (g)

4.2 Discussion of the Result

The time of the contact has a great effect on the absorption rate for the fact that concentration of chromium (VI) ion decreases as time of contact is increases. Their concentration before the interaction was 50.80 and 50.30 and reduces gradually as the time of contact increase when treated with Gold Coast (Bombax).

From table1, percentage of chromium (VI) ion absorbed against time shows that the amount of chromium (VI) ion absorbed varies directly with time, at 60 minutes, the percentage of chromium (VI) ion absorbed was low, while that of 300 minutes was very high.

From table 2, shows the percentage removal of Chromium (VI) ion by mass difference, the highest absorption was recorded with 1.0g for Chromium (VI) ion with 42.34% while the least absorption was recorded with 0.2g, with Chromium (VI) ion at 78.13%

CHAPTER FIVE

5.0 Conclusion and Recommendation

The aim and objective of this research project was achieved, as the result obtained confirmed it. The investigation revealed the ability and effectiveness of gold coast (Bombax) activated carbon in absorbing metals such as chromium (IV) ion in aqueous solution in water based on this result and analysis obtained from this research work the following conclusion can be made.

- Gold coast (Bombax) is quite effect as an absorbent in the treatment of heavy metal
- Absorption is highly dependent on the contact time and mass.
- Agricultural waste (Bombax), now have value as a cheap product for metal absorbent. Gold coast can be used to reduce the concentration of these heavy metals in the environment.

Recommendation

Agricultural waste are abundant and inexpensive and therefore can be used for water purification in chemical and manufacturing industries like breweries, radiator manufacture, battery manufacture, water board etc. generally, can be useful in environmental remediation.

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