Assessment of Charcoal in Removal of Bacteria present in Local Water Bodies

SUBMITTED BY:

Durdana Nur

ID: 13146067

To

Department of Pharmacy

In partial fulfillment of the requirements for the degree of Bachelor of Pharmacy.

BRAC UNIVERSITY

Inspiring Excellence

Dhaka, Bangladesh

November, 2017

This work is dedicated to my parents and younger brother for their love and constant support…

Certification statement

This is to certify that this project titled "Assessment of Charcoal in Removal of Bacteria present in Local Water Bodies" submitted for the partial fulfillment of the requirements for the degree of Bachelor of Pharmacy (Hons.) from the Department of Pharmacy, BRAC University constitutes my own work under the supervision of **Shahana Sharmin**, Senior Lecturer, Department of Pharmacy, BRAC University and that appropriate credit is given where I have used the language, ideas or writings of another.

Signed,

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Countersigned by the supervisor,

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Acknowledgement

All praises are solely due to Almighty Allah whose mercy enabled me to complete this research work and preparation of this thesis successfully.

I express my whole hearted sense of gratitude, sincere appreciation, immense indebtedness and profound regard to my honorable supervisor Shahana Sharmin, Senior Lecturer, Department of Pharmacy, BRAC University for her untiring guidance, valuable suggestions, affectionate encouragement, factual comments and continuous supervision throughout the period of the research work and preparation of this manuscript. I am also thankful to my honorable teachers, the chairperson of pharmacy department, Dr. Eva Rahman Kabir for their motivation and excellent guidelines.

Finally, I acknowledge my deepest sense of respect to my beloved parents and wishes to express the deepest love and affection to younger brother, relatives, friends and well-wishers for their relentless efforts, affectionate feelings, great sacrifices, blessings and co-operation in all phases of my academic pursuit.

Abstract

Benjamin Franklin said "When the well's dry, we know the worth of water". One of the crying needs in Bangladesh, especially in Dhaka city is clean water. Massive urbanization and industrialization around Dhaka has adapted a much unplanned progress that led it to facing clean water crisis. The banks of rivers and large water bodies of Dhaka are engraved under stacks of wastes. Zero investment by industries on waste water management has contaminated the rivers running over the heart of Dhaka. Moreover, the water bodies around Dhaka city, such as Gulshan Lake, have been contaminated with household and sanitary wastes. As a consequence, the locality that grew around the banks of these water bodies are deprived of clean water. The underground water has greatly withdrawn the standard that is required to meet the clean water requirements. With the complexity of the water contamination, water purification has become complex too. The contaminants are increasing exploiting different varieties making water purification an expensive mechanism. The sufferers are mostly the localities living under poverty line. Not only that they are deprived of clean water but also as they are residing beside these water bodies, they are highly exposed to water borne diseases too. Water purification that is easy and economical can reduce this dearth of clean water. Water filtration is one of the mechanisms that are frequently used. Using material that has adherent properties can be used as a good water purifier. Charcoal is one such material that has phenomenal adherent property. The dictionary meaning of charcoal is porous black solid, consisting of an amorphous form of carbon, obtained as a residue when wood, bone, or other organic matter is heated in the absence of air. Charcoal is extensively used today as it has an excellent adherent property. For the purpose of separation of unusable, inconvenient and injurious particles Activated Charcoal has profound benefit. There are many sources of Charcoal. Considering the domiciliary prospectus of Bangladesh, the dried tree parts and woods are the primary source of fuel wood. The residue after exhaustion of these fuel woods is perceived as the charcoal. The objective of this study is to evaluate the antibacterial property laid out through the adherent property of the charcoal. The study has been done on water samples collected from water bodies available in Dhaka. Following the study, the aspiration is to widespread the use of Charcoal around the locality of Dhaka who are living under poverty line and are unable to afford pure water.

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List of Abbreviation

AC: Activated Charcoal

icddr,b: International Centre for Diarrhoeal Disease Research, Bangladesh

SEM: Scanning Electron Microscope

ETP: Effluent Treatment Plant

DBPs: Disinfection By-Products

DO: Oxygen Demand

BOD: Biochemical Demand of Oxygen

COD: Chemical Demand of Oxygen

PAC: Powdered Activated Charcoal

GAC: Granulated Activated Charcoal

WHO: World Health Organization

ORT: Oral Rehydration Treatment

FIB: Fecal Indicator Bacteria

LMW: Low Molecular Weight

HMW: High Molecular Weight

EDCs: Endocrine Disrupting Compounds

NOM: Natural Organic Matter

SOC: Synthetic Organic Compounds

DAF: Dissolved Air Flotation\

pH: Power of Hydrogen

Chapter 1

Introduction

Chapter 1: Introduction

The developing populace, the expansion of industrialization and the Agricola generations require adequate water meeting the requirements of clean water. In some areas of there is lack of surface water. The shallow groundwaters stored are highly tainted. Hence, that water is of inadequate quality and over-misused. It is high time to mull over all the demonstrated water purifications that could decrease the existing debacle.

Water is crucial resource that is required for the survival of all types of living being. There would have been no existence of life without water. Safe water intended to be harmless to the being drinking or utilizing it. To avoid inconveniences like sickness the water must be contaminant free or significantly low concentration of contaminants to be on the safe side. Water might be naturally potable; likewise the instance for pristine springs, or it might be treated to be safe. Safe water is evaluated with analysis which looks for conceivably unsafe contaminants and at the same time guaranteeing the certain administrative norms (Gupta and Sunita, 2009)

Water holds parts of disintegrated chemicals and since ground water moves through rocks and subsurface soil, it needs considerable chances to dissolve different substances. Water is the practically abundant substance on earth and important for the survival of living tissue. (About 25% about living organic entities are dependent upon about solid matter remaining 75% of water). No other resources is as valuable as water to man. Water cover 75% of the Earth's surface. 97.5% of it is the salty seawater, 2.4% of it is in underground and 0.001% is held by atmosphere. 2% of the water on earth is frozen. Only and only 1% of drinking water is available on Earth (Garg and Deepshikha, 1999)
Safe drinking water is characterized as water with microbial, chemical and physical aspects that help World Health Organization (WHO) has some guidelines of standards on drinking water. There are 56 pathogens contributing in contamination. Furthermore, as parasites are "communicable" they easily spread from person to person. Typhoid, paratyphoid, salmonella, giardiasis and obviously cholera are the most observed water borne diseases. Pathogens are everywhere and arise from animal and human feces that are followed by insufficient water supply. The safety of potable water is greatly hampered by sanitation and limited garbage collection (Reily and Warren, 1980).

There are many sources of clean water such as, lake water, spring water, rainwater, well water and river water. Presence of contaminants will deteriorate the quality of water making it impure. Polluted water is a threat to human health and existence of aquatic creatures as the economic value and aesthetic property of pure water is hampered. Water Pollution occurs mainly in two ways, either by natural process (because of catastrophes like tsunami, tornadoes, increasing depth of groundwater, drought) or by anthropogenic activities (sewage, wastewater, ETP) (Fovwe and Solomon, 2014).

Bangladesh is also a developing country with a growing population. There are many water bodies around the locality which are ill-treated and stacked with wastes. By natural processes like rainfall the water bodies are filled with plentiful of water which washes away the wastes or sedimentation takes place ensuring clean water on the surface. Well the water looks clean on the surface although when examined in the lab good number of bacterial growth has been observed. The scenario is pretty common in cities like Dhaka. Huge population of Dhaka lives under poverty line who cannot afford safe water for utilization which is becoming a threat to them. If these available water bodies are treated well and if an easy way is figured out to clarify the available source of water then people living under poverty line can help themselves managing clean water. Charcoal is an ancient and economic mean for water purification.

Adherent material, Charcoal is an ancient medium used to clarify water. The use of Charcoal is an inexpensive method. Charcoal has porous structure, so when finely divided it gives a good adhering surface for to contaminants to get attached to this pure carbon molecule and thus removed easily from water.

Charcoal has antibacterial property. The porous structure of Charcoal is the key reason. In the following study, experiments had been performed to visually inspect the nature of the antibacterial property.

Charcoal is extensively produced in the household of Bangladesh by the people living under poverty line. They can use Charcoal for water purification and meet the need of water.

1.1 History of Charcoal

Since 3750 B.C Charcoal had been used for different purposes. The Egyptians and Sumerians first started using charcoal without even realizing that it is a revolutionary discovery by them (Inglezakis and Poulopoulos, 2006). Earlier they used it over wood to prevent it from rotting. Recognizing the preservative property of Charcoal, it has been capitalized as antifungal and antibacterial agent. Centuries later, the practice of storing potable water in charred barrels started. In the ships on voyages, water was stored in such charred barrels and this process has been executed till 18^{th} Century.

In the eighteenth century, purification of liquid was rendered utilizing carbons of blood, wood and animals. In 1773, while performing gas treatment, Scheele first observed the particular adsorptive properties of charcoal (the. Precursor of activated carbon). Then, in 1786, Lowitz implemented the use charcoal in decolorizing solutions. He was the first to lay out the methodic explanation of the adsorptive power of charcoal in liquid medium (Sontheimer, Crittenden and Summers, 1988).

In that era, sugar refinery industries were looking for a good an effective method to decolorize sugar syrup. For its limited porosity wood charcoal was not meeting the requirements. An English sugar refinery, as a decolorizing agent wood charcoal had been used in 1794 (Inglezakis and Poulopoulos, 2006).

The use of wood charcoal as decolorizer in sugar refinery was kept secret till the first patent evolved from England in 1812. Although by 1805 the use of wood charcoal was a common practice in all French sugar refineries and eventually by 1808 it was all over in Europe. In 1822 Bussy showed that the decolorizing properties of carbons depend highly on the thermal processing, source of the material and the particle size of the charcoal. He constituted an AC in combination with thermal and chemical processes. Later in the Nineteenth century, Schatten of Germany investigated the manufacturing and regeneration of bone charcoal. Eventually Stenhouse introduced charcoal air filters for vapor and gas removal in the London sewage system. In 1862, Lipscombe advanced in making a carbon material which was used to purify potable water. This advancement rendered the commercial application of AC initially for potable water later wastewater management. In 1865, Hunter realized the unique adsorption property of carbon that has been procured by burning the shells of coconut. In 1881, while demonstrating the uptake of gases by carbon, Kayser used the term "adsorption" for the first time as the coherent property of carbon (University Of Kentucky, Center for Applied Energy Research, History of Carbon (accessed 29January 2010)).

Activated Charcoal was first produced on an industrial scale in the early Twentieth Century then Europe witnessed major developments. However, at the beginning the only form of Activated Carbon available was the Powdered Activated Carbon (PAC) (Sontheimer, Crittenden and Summers, 1988).

In the First World War the manufacturing of Granular Activated Carbon (GAC) boosted in large-scale production to adsorb the poisonous gas. GAC was used in gas masks. Eventually GAC was used in air purification, solvent recovery andwater treatment. GAC has greater adsorption range than PAC (University Of Kentucky, Center for Applied Energy Research, History of Carbon (2010)).

As of now, issues in drinking water treatment are much more thansmell andtastecontrol. Control of various natural and inorganic contaminants in water is some major consideration for water purification. Presence of Synthetic Organic Compounds (SOC) caught attention in 1960s. In the 1970s it was perceived that sterilization of water with chlorine gas or chlorine-containing mixes prompted the age of natural compounds named Disinfection By-Products (DBPs). DBPs are threats on health (Sontheimer, Crittenden and Summers, 1988). GAC has turned out to be successful in removal of SOC and DBPs.

1.2 General Use of Activated Carbon

Today the use of AC is beyond industrial use and water purification. AC plays active role in environmental pollution control. The utility of AC is found in different liquid phase process alcoholic beverages production, food processing, decolorization of oils and fats, in sugar refining, purification of chemicals (amines, gylcerin, glycol, etc.), enzyme purification, coffee decaffeination , refining of liquid fuels, personal care, purification in electroplating operations, gold recovery, textile, fabric purification, in production plant of cosmetics and pharmaceutical industries andin different industrial applications in the chemical and petrochemical industries. Gas phase applications includerecovery of sulfur, removal of sulfur-containing toxic components from exhaust gases, recovery of organic solvents anduse in gas masks and biogas purification. AC is also used in veterinary and medical applications, nuclear and vacuum technologies, eradication of pesticide residues and soil improvement (Cecen, 2011)

1.3 Application of Activated Carbon in Environmental Pollution

In Twentieth century with the rising concern on environmental pollution, the use of AC in environment preservation was introduced. Today the use of AC is beyond industrial use and water purification. AC plays active role in environmental pollution control. AC is a common ingredient used in removal of various inorganic and organic contaminants from surface water (lake, stream, and river), groundwater, and waste water (Cecen, 2011).

1.4 Activated Carbon in Drinking Water Treatment

The main reason behind using AC for drinking water treatment is for its unique adsorption property. History reveals that in 1910 the first application of AC in the form of GAC was for dechlorination of chlorinated water happened in Reading, England (Hung, Lo, Wang, Taricska and Li, 2005). In the 1930s and1940s, in Europe, for disinfection purpose in water high doses of chlorine was used. This contributed in growth of contamination in surface waters. Hence, for removal of chlorine GAC filtration was used. Unlike the adsorptive aspects of AC, dechloration process is described as removal of chlorine by catalytic reaction. However, the use of GAC in dechloration has been banned as excess haloforms were formed with chlorine in the filters. For taste and odor treatment of water AC has been used since 1920s (Hendricks. D, 2006). AC was effectively used in removal of chlorephenols. In USA PAC was used for the first time for control of taste and odor in drinking water in 1929–1931 (Sontheimer, Crittenden and Summers, 1988).

GAC filters were first introduced in Germany in 1929 and in1930 in USA in 1930 for taste and odor control. By 1932 the use of PAC was all over USA in about 400 water treatment plants and this has increased to 1200 water plants by 1943.By 1970 the use of charcoal in water plants all over the world crossed over 10000 (Sontheimer, Crittenden and Summers, 1988). Later Dissolved Air Floatation was introduced in whichPAC was used as adsorbent for water treatment. DAF is a water treatment technology (Wang, 2007).

In early 1960s when ACwas used in the form of GAC or PAC in water treatment, the main aim was the removal of taste and odor. During the era of industrialization, water was highly polluted in Europe, for removal of odor causing species GAC filters were a frequent necessity. Although GAC regeneration was also needed.After investigating it revealed that pretreatment of water with ozone will solve the problem and the bed life of GAC will increase. For this case Mulheim process was developed (Sontheimer, Crittenden and Summers, 1988).

Today the problems of drinking water has extended beyond taste and odor control. Organic and inorganic compounds present in water are another major concern regarding water treatment. Synthetic Organic Compounds (SOC) present in water is an important point that caught attention in 1960s. Beginning in the 1970s while using disinfectant in water like chlorine gas or other chlorine compounds, it led the formation of organic compounds which are termed as Disinfection By-Products (DBPs) collectively and these are threats to health (Sontheimer, Crittenden and Summers, 1988). The key constituents for the formation of DBP are Natural Organic Matter (NOM). Again pretreatment of water was leading to formation of bromate by-product which is hazardous. Hence, for NOM and DBP control use of AC was a reliable method for decades. Mostly GAC filters were in use according to the type of water incorporated with sand and disinfection. SOCpresent in surface and groundwater effects the water received for treatment or even in the municipal and industrial waste water which were sent for treatment.The increased use of fertilizers and pesticides in agriculture is another strong source of pollution for water. Further,discharges into surface waters from non-point sources likeurban runoff also adds to pollution. Surface and ground raw water supplies contain many organic compounds such asherbicides, phenols, pesticides, aliphatic and aromatic hydrocarbons and their chlorinated counterparts, surfactants, dyes, organic sulfur compounds, amines, nitro compounds, ethers andEndocrine Disrupting Compounds (EDCs) which are newly emerging substances. 800 or more organic and inorganic substances are present in drinking water and more suspected to be identified in near future (Bansal and Goyal, 2005). Therefore, concerns are frequently expressed about the presence of these compounds, which can be present at levels as low as ng L^{-1} or µg L^{-1}. It has been proventhat these substance are suspected or for sure has hazardous effecton health and environment. Efforts are expensed to control and eradicate them,and one of the best method is by adsorption using AC.

1.5 Activated Carbon in Wastewater Treatment

Pesticides, herbicides, poly nuclear aromatics, aromatic solvents, chlorinated aromatics, phenolics, chlorinated solvents, high-molecular-weight (HMW) aliphatic acids and aromatic acids, HMW amines and aromatic amines, esters, ethers, fuels, surfactants, alcohols and soluble organic dyes these are all easily removed from water by adsorbing using AC. Compounds having low molecular weight (LMW) and high polarity, such as LMW amines, glycols, nitrosamines and certain ethers cannot be removed easily (Hendricks, 2006). Compounds falling into these categories are mostly present in Industrial effluents, in municipal waste water and in the worst situation also found in drinking water supply. AC became an important material as an adsorptive material in 1960s for treatment of municipal and industrial wastewaters.

1.6 Properties of Charcoal

To define the chemical nature of charcoal the two most irreplaceable features are the moisture content together with the ash content. Moisture reduces the calorific or heating esteem of charcoal. Thus, charcoal fresh from the furnace holds generally short of what 1% for moisture. Although, the moisture might reach 5-10%, as absorption of moisture from the humidity of the air itself is rapid. Moreover, at increased hygroscopicity, the moisture in charcoal can reach to 15% or more. The moisture content of pure charcoal is 5-15% of the gross weight. The charcoal's powder content varies around 0.5% or more than 5% relying upon crude materials. Good quality charcoal normally has the powder content from claiming around 3% unless the material screened 4 mm in the residue the ash content may be about 5-10% (Ukrfuel.com, 2015).

The volatile matter in charcoal other than water is liquid and tarry residue. This volatile matter cannot be removed in the process of carbonization. The volatility is reduced at high temperature in a prolonging process. Otherwise the volatility increases. The fixed carbon content is charcoal is 50%-95%. Carbon content is important as it is responsible for reducing the iron oxides of the iron ore to manufacture metal. Hence at least temperatures (300°C) the charcoal yield will be almost half of the content with maximum volatility. At carbonization temperatures of 500-600°C volatility is reduced and counter yields may be 30%. At temperatures about around 1000°C the volatile content is quite absent and yields is around 25%. Practically, the volatile content ranges from 40% (maximum) or 5% (minimum) (Ukrfuel.com, 2015).

So, charcoal has amoderately low moisture (5%-15%). Those volatile matter and the ash content are associated to the amount of fixed carbon and relies determinedly on the carbonization temperature fluctuating starting with 300 ° c to 1000 ° c. Low carbonization temperatures facilitates higher yield for charcoal but in that case this charcoal is of poor quality, contains acidic tars making it corrosive. The carbon content of charcoal should be about 75% and the final carbonization temperature of around 400-500°C (Ukrfuel.com, 2015).

1.7 Morphological analysis of samples by SEM

The SEM images of charcoal flour (a,b,c and d) (a and b) and the WPC sample Type A (c and d), and polypropylene filled with charcoal sample (e and f), taken at different magnifications are presented in Figure. The images in Figure (a) and (b) reveal, the average particlesize of charcoal flour is within 80-100 μm and is highly porous. The estimated range of average size of the elliptic pores can be of 5-15 μm. The SEM images reveal that the wood fibres are equally and homogenously distributed in the polymer matrix. In these figures, a strong interfacial adhesion between the wood fibers and polymer matrix can also be clearly seen. Figure (e) and (f) shows that in the microstructure, two distinctive domains were observed. In Figure (e) as a result of intense mixing and shear forces while melting processes, the porous charcoal particles formed irregular stacks possibly due to the collapsing anddestructuring of porous structure(Ayrilmis, Kwon, Han and Durmus, 2015).

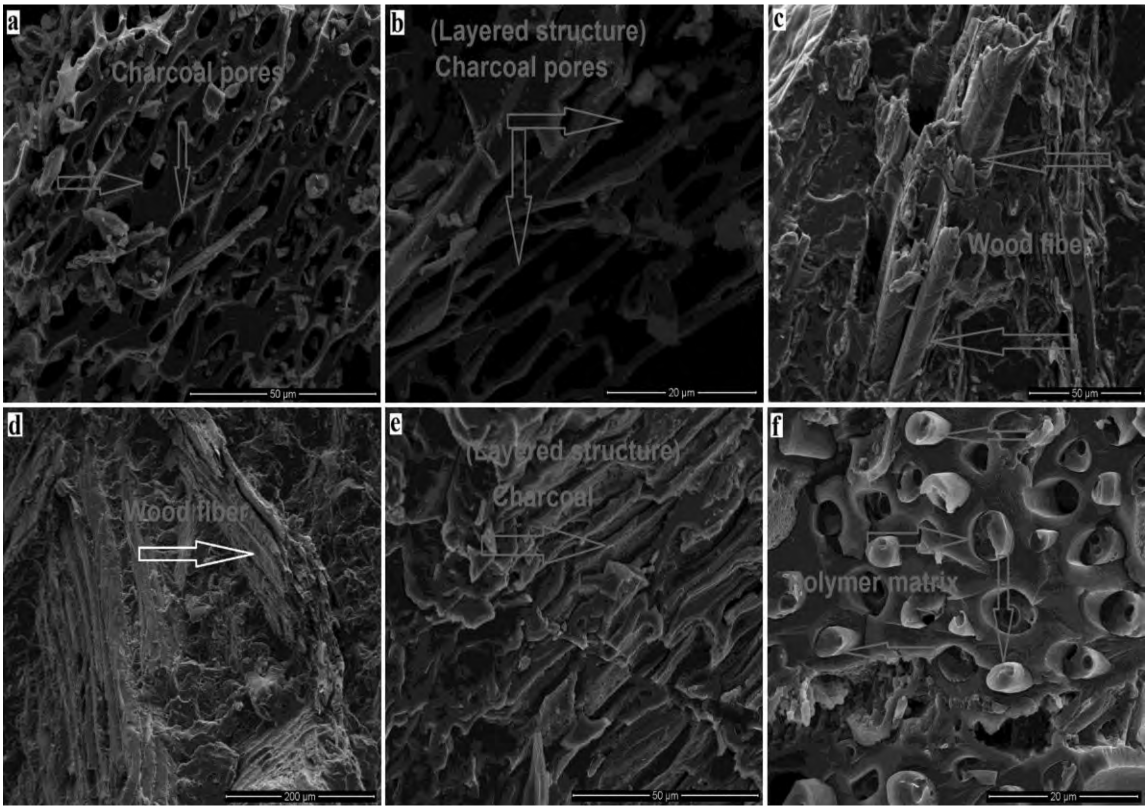

Fig 1.7.1: The Scanning Electron Microscope (SEM) images of Charcoal.

1.8 Clean Water Crisis in Bangladesh

Bangladesh is one of the over populated countries in the world having population of about 160 million living within 57,000 square miles. About 4 millions are deprived of safe water and 85 millions are deprived of improved sanitation. One of the predominant problems for developing countries like Bangladesh is acute water crisis, in accordance with lack of access to safe water because of increased population, random contamination of surface and ground water, improper water sharing with neighbouring countries, mismanagement in preserving rain water and the failure of the administration to take initiatives to provide safe water and sanitation to its citizens. The WHO estimates that 60% of the population has to endure the problems of unsafe water (Haq, 2014).

In developing countries like Bangladesh the problems regarding water safety is water pollution by harmful microorganisms. Studying different roles played by microorganism as well as presence of organic and inorganic pollutant we can have a clear concept about the level of water pollution. Aquatic microorganisms occupy a key positioning the tropic level by providing rich nourishment for the next higher level of aquatic life and thus human health and other animals may affect. In Bangladesh about 80% of all diseases are associated with waterborne pathogens. Presence of pathogenic microorganisms makes water unsafe for human consumption. Diseases like diarrhea, typhoid, cholera, bacillary dysentery among the populationlead when consumption of unhygienic drinking water and uses of unsafe water for daily purposes is prevalent. The abundance and diversity of widely distributed microorganisms may be used as an indicator for the suitability of water. Microbiological impairment of drinking, bathing, irrigation, or recreational water is commonly monitored using*Escherichia coli* concentration as an indicator of fecal indicator bacteria (FIB) to indicate the fecal pollution in water which contributes in microbial analysis of water. Poverty and poor sanitation triggers cholera caused by toxic *Vibrio cholerae* is a major public health problem in developing countries. The outbreaks of cholera occur in regular seasonal pattern (Real, Khanam, Mia and Nasreen, 2017). Deprivation of safe water and improved sanitation facilities in rural areas, over population and unhealthy management of disposing waste in urban centers, all contribute to the water and sanitation crisis in Bangladesh.

A study conducted by Caldwell et al. (2006) says before introducing tube-well water, diarrhea was a significant reason for death, particularly among adolescent kids. Despite of oral rehydration treatment (ORT), produced by International Centre for Diarrheal Disease Research, Bangladesh (ICDDR,B), extraordinarily diminished the event of deaths from diarrhoeal diseases, it didn't diminish the occurrence of diarrhea. The mortality due to diarrhea is not until now solved even with ORT. Thus diarrhea is still a major cause of mortality in Bangladesh.

The requirements to diminish diarrhea are the supply of safe water, sanitation, and good hygiene practices. Alongside these three ideal efforts, in many other countries like Bangladesh the supply of clean and safe water is mandatory. The prologue of tube-wells assured cheaper means of safe water than proper sanitation. It is also easier to address about safe water than hygiene for which extensive public education is required. Tube-wells is the cheapest solution to meet the safe water requirements moreover, easy to install, minimum maintenance and micro-free groundwater supply to the household direct and that also in plentiful quantity (Caldwell et al. 2006)

The spread of tube-well reduced the mortality from diarrhea collaboration with ORT and other treatments. Previously after investigations carried out by ICDDR,B showed that the rate of mortality is reduced in a very limited range. Safe water for drinking was of subsidiary importance due to the hazard of surface water through washing of utensils, cooking and washing hands (Sommer and Woodward, 1972).

Investigations reveal that the supply of safe water by the means of tube-well reduces the diarrheal mortality but when the sanitation facility is taken into consideration the reduction range of mortality is highly affected. Esrey et al. through a survey of the accessible data found that when both the factors for safe water and proper sanitation is considered then by 65% the rate of diarrheal infection is reduced. On the other hand, by only consideration of the safe water factors minimizes the reduction rate of diarrheal infection by 20.8% (Esrey, Potash, Roberts and Shiff, 1991).

To some extent the safe water requirements can be met by only tube-well. Although when an over populated city like Dhaka with unplanned urbanization is considered then overpumping of ground water arises as a problem. Researchers of Bangladesh say, overpumping of groundwater to supply in Dhaka could be jeopardizing the future water supply for the citizens living in the outskirts of the city center. The 15 million people of Dhaka shares the common water management problems like the other mega-cities. The groundwater level of Dhaka has already dropped to 200 feet in 50 years and to be more precise approximately 9 feet per year (University of Delaware. September 28, 2016).

An often-neglected consequences of these actions in mega-cities is the quality reduction of water and supply of clean water in the community. The water sources are extremely stressed and highly contaminated by toxic metals, organic materials and other pollutants.To keep a balance on water supply the surrounding water bodies of Dhaka have to be brought forth. These water bodies can act as primary distributaries of safe water supply. These water bodies are already in use by the localities in bathing, washing and fishing. Although for intensive domestic purposes like drinking and cooking this water becomes useless. About 80% of the diseases observed in Bangladesh and especially in Dhaka are waterborne pathogens (GoB-UNICEF, 1992-1999). Focusing on these points, the following examination was attempted to observe the safe use of charcoal to transform a nearby water supply in usable safe water by expelling the pathogens from the water. The adhering property of the charcoal will play active role in evacuation of these pathogens.

1.9 Objective of the Study

Some of the water bodies located in the cities of Bangladesh are left untouched. The water of these water bodies are impure and ill-treated. Although AC has been extensively used in the process of water purification, these water sources have never been undergone through any kind of treatment. The aim of this study is to collect such water sample and perform primary study to visually observe the eradication of bacteria by Charcoal. The final objective is to proof visually the eradication of bacteria by Charcoal from the water samples on agar plates in the microbiology lab.

Chapter 2

Literature Review

Chapter 2: Literature Reviews

The use of Charcoal for water purification is an ancient mean and an established one. Although the use of charcoal has not been simplified so that common people can be exposed to it. Studies show charcoal retrieved from waste wood especially bamboo is very useful one for purification. Bamboo is one of the common waste wood or fire wood found in Bangladesh.

AC also known as activated carbon or activated coal is a kind of carbon that has high porosity consequently a large surface area is available contributes in chemical reaction and mostly in adsorption. (Caron, 2008).

According to WHO the AC produced from Nigerian bamboo is good for removal of bad taste and odour of water. The range of pH is within 6.8-8.4.The reason behind such high pH is the presence of ligands like carbonate, aluminum, magnesium and zinc in the B. vulgaris resulting increased negative charge density on the surface of adsorption along with the attraction of metallic ions hence permitting the adsorption on the cell surface(Ijaola, Ogedengbe and Sangodoyin, February 2013). This has been endorsed by Addagalla et al, (2009), and Lim et al, (2010).

Amuda and Ibrahim (2006), correlated the adsorption efficiency ofGAC produced from coconut shell (Acid and barium chloride activation) with the adsorption efficiency of commercially produced carbon (Calgon carbon F-300) with corresponding organic matter found in beverage industrial wastewater. For adsorption efficiency analysis of the two activated carbons Freundlich adsorption isotherm was used. Result showed that at every doses of carbon used, AC from coconut shell was capable of higher adsorption for organic matter which is designated as the COD or chemical oxygen demand than the commercial carbon Calgon (F– 300).

Studies on water pollution of the local lakes are evident that those lakes are ill-treated and stacked with wastes around the banks.

Study by Karim et al. (2012) says, out of 14 recovered strains from the Gulshan Lake samples, 7 of them were Gram positive and & of them were Gram negative. The Gram positive strains contained 4 rod shaped, spore former and members of genus *Bacillus.* The other 3 were the members of *Planococcus citreus* and *Lactobacillus plantarum.* Four distinct species have been found under the genus *Bacillus*,viz. *B. polymyxa*, *B. subtilis*, *B. anthracis* and *B. alvei*.7 Gram-negative strains were Enteric Bacteria which were short rod and non-spore former. These isolated strains are under the genera *Pseudomonas*, *Neisseria*, *Morganella*, *Escherichia*, *Aeromonas* and *Enterobacter*. The number of aerobic heterotrophic bacteria and abundance of coliform and faecal coliform group in the water is evident of significant level of the microbial pollution of the lake water. *Escherichia coli* and *Enterobacter aerogenes* are some of the coliform group of bacteria which are also aerobic and facultative anaerobic bacilli. Theses produce acid and gas from the fermentation of lactose(Maier *et al*. 2000).*E*. *coli* and *Enterobacter* sp. were also found in the sample while studying. Bacteria like *E*. *coli* and *Pseudomonas* sp. are found, undoubtedly indicates that the lake water is also contaminated with fecal and sewage pollution. *Psudomonas aeruginosa* is used as a sewage indicator. The lake is extensively used for like washing or bathing or even for swimming. As a result the floating people are the one to be affected by the water borne diseases such as diarrhea, dysentery and typhoid etc. Even the cultivated fishes are prone to be contaminated by these pathogens and become the carrier which can be easily transmitted to the people infecting them with water borne diseases. Charcoal treatment exempted all of these strains contaminating the lake water over the time.

Chapter 3
Materials and Method

3. Materials and Method

3.1 Area of Study

Water samples are collected from 5 water bodies located in Dhaka. They are Gulshan Lake, Niketan lake, Hatirjheel Lake, Dhanmondi Lake and Bonosree Lake. Surrounding these lakes a large number of populations settled down. By time, these settlements have turned to society with domestic and nondomestic infrastructures. These lakes are the sources of fresh water. Unfortunately all of them are ill-treated. The BOD value of the water samples are within the 10mg/L (standard 0.2mg/L). The COD value of the samples is within the rangeof 280-600mg/L (standard 200-500mg/L). The visual observation bacteria removal on agar plates will be done using these water samples. The pH of the samples is measured. The normal range of pH for safe water is within 6 to 8.5.

Table 3.1.1: pH of the collected water samples.

Sample	pH
Gulshan Lake	7
Niketon Lake	6.93
Bonosree	6.93
Hatirjheel	7.1
Dhanmondi Lake	7.2

3.2 Collection of Charcoal

The charcoal that is used in the experiment is the domestically produced charcoal in mud stoves. The charcoal comprises of old bamboo and other fire woods. The Charcoals are crushed and sieved. Before using the powdered charcoal it is dry heated in the dry heat oven at 70^0C for 15-20 minutes making it moisture-free. Powdered form of Charcoal is used in the following experiment.

3.3 Activity of Charcoal on Referential Bacterial Strains

4 strains of bacteria (2 gram positive and 2 gram negative bacteria) are taken as reference to visualize the activity charcoal at different quantity. 4 strains are *Vibrio cholera* (-), *Bacillus subtillis* (+), *E. coli* (-) and *Stapylococcus aureas* (+).

For each bacteria 3 different amounts are taken viz. 800mg, 500mg and 200mg. For each bacteria, 4 test tubes have been prepared. In each of them contains 8mL of distilled water, bacteria strains stirred in it with the loop that is used to take small amount of strain and adding a specific amount of charcoal out of 3 in the test tube (these steps should be done under laminar flow). The test tubes are vortexed by 5 minutes each to disperse the powder of charcoal in the water. After vortexing the bacterial water containing test tubes, it has been filtered using filter paper. This process is repeated for other two quantities of charcoal. One test tube out of four should be charcoal free as it will be the blank in the agar plate. The agar plate is divided into 4 divisions. Divisions are individually marked as Blank, 200mg, 500mg and 800 mg respectively. The 4 filtered bacterial water is then swapped using a cotton swap on the marked agar plate medium accordingly. The agar plates with swapped filtrate are left in incubator overnight. Successive results have been observed. Charcoal successfully removed most of the referential bacteria. The most prominent result has been observed in filtrates treated with 800mg of charcoal. Note that, every apparatus should be properly sterilized.

3.4 Activity of Charcoal on Water Samples

Before using the water samples for charcoal activity examination it should be primarily filtered by filter paper removing the insoluble substances like moss, lichen, algae etc. Then the filtrate water is placed aside for later use. From the filtrate water samples, taken 8mL with each of the three Charcoal quantities (200mg, 500mg and 800mg) along with a blank (untreated water sample). For each water samples, 4 test tubes are prepared. In each of them contains 8mL of any specific water samples and adding a specific amount of charcoal out of 3 in the test tube. The test tubes are vortexed by 5 minutes each to disperse the powder of charcoal in the water sample. After vortexing the water sample containing test tubes, it has been filtered using filter paper. This process is repeated for other two quantities of charcoal. One test tube out of four should be charcoal free as it will be the blank in the agar plate. The agar plate is divided into 4 divisions. Divisions are individually marked as Blank, 200mg, 500mg and 800 mg respectively. The 4 filtered bacterial water is then swapped using a cotton swap on the marked agar plate medium accordingly. The agar plates with swapped filtrate are left in incubator overnight. The swapping should be done under Laminar Flow.

Chapter 4
Observation and Results

4. Observation and Results

4.1: Observation and Results

After leaving overnight, the petridishes have been observed carefully. It showed that the Charcoal treatment has been successful to remove bacteria from the water samples because of it's adhering property and porous structure. The photos of the agar plates are given in the following:

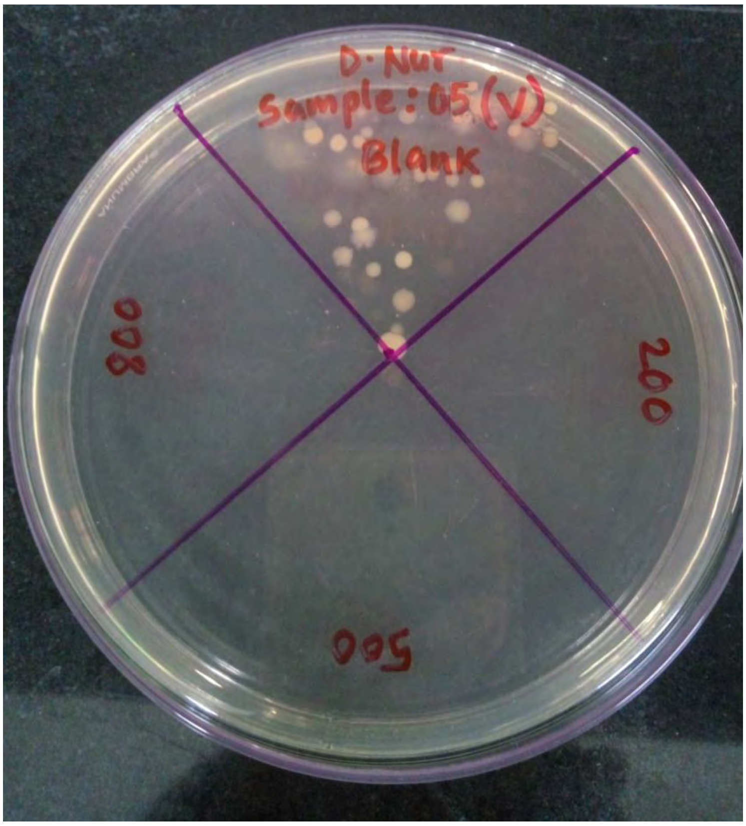

Fig 4.1.1: Removed Bacterial from Gulshan Lake sample

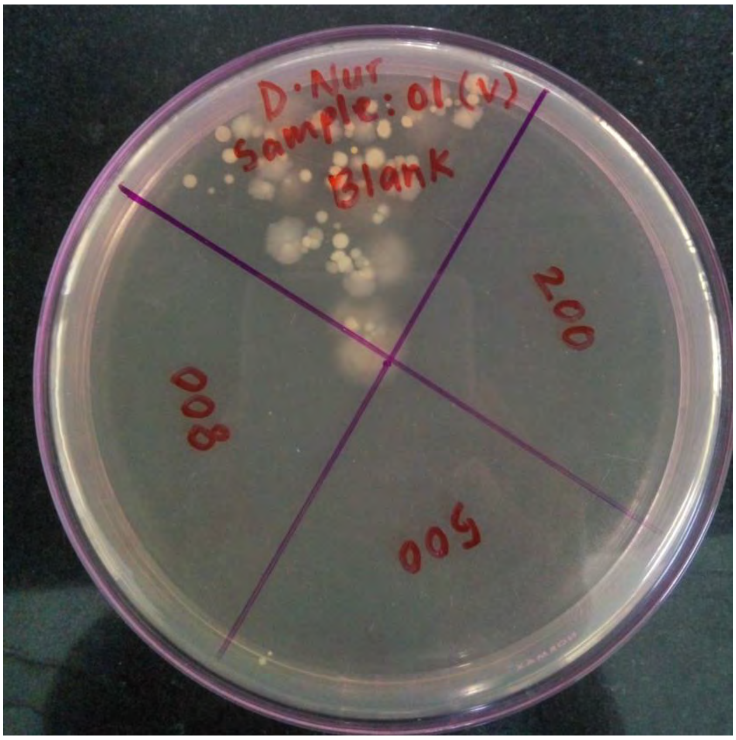

Fig 4.1.2: Removed Bacterial from Niketon Lake sample

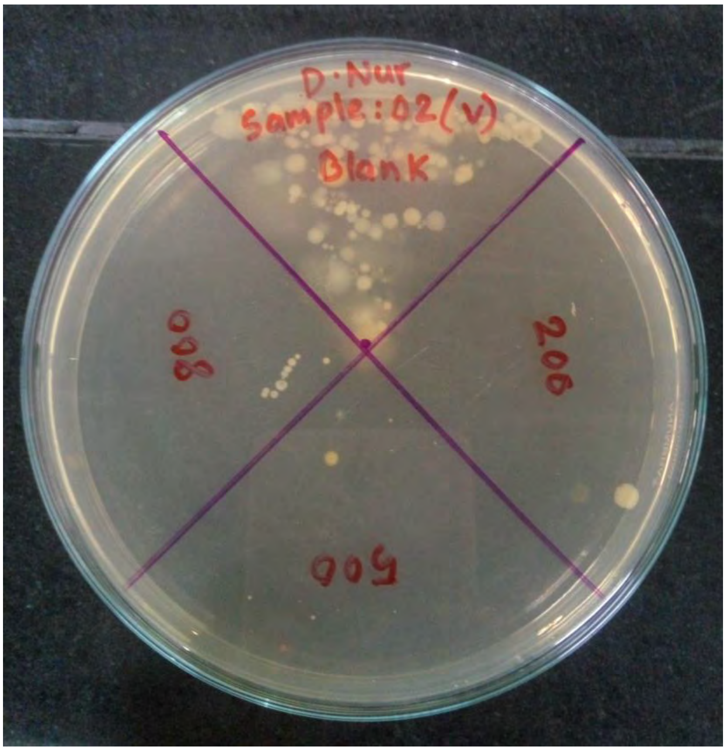

Fig 4.1.3: Removed Bacterial from Bonosree Lake sample

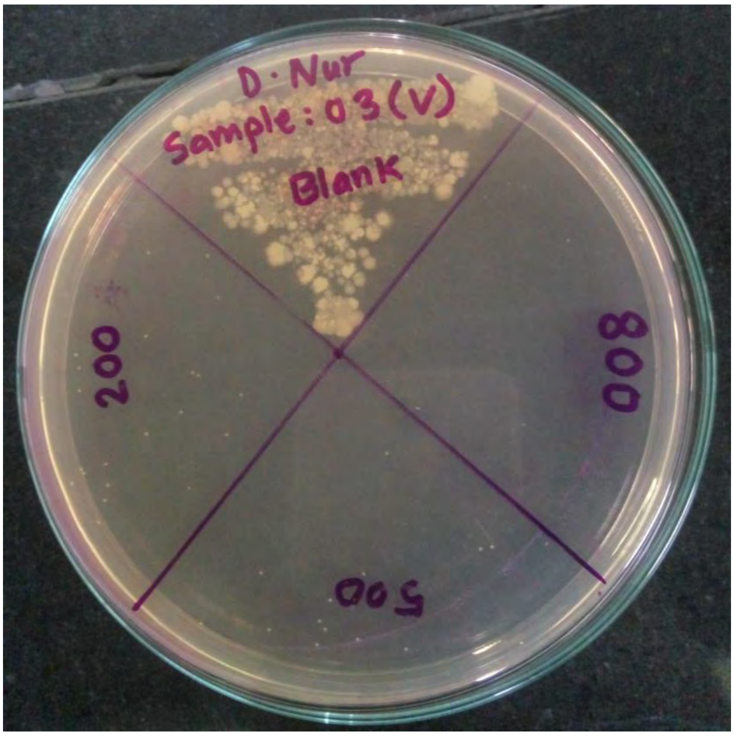

Fig 4.1.4: Removed Bacterial from Hatirjheel Lake sample

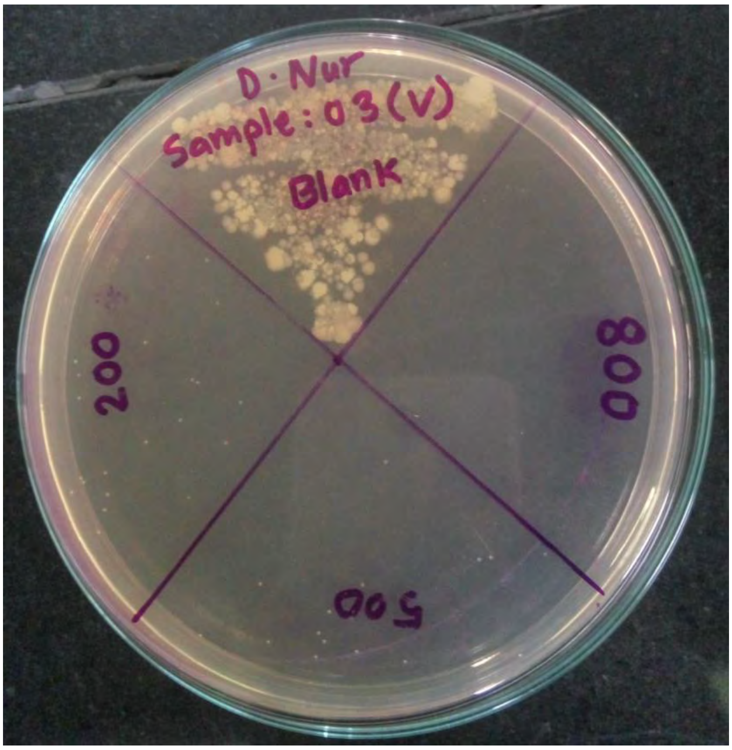

Fig 4.1.5: Removed Bacterial from Dhanmondi Lake sample

To see whether the powdered charcoal is reusable, 20mL water sample of Gulshan Lake was taken in a beaker with 20mg of powdered charcoal and mixed rigorously. This charcoal mixed water has been left for 4 nights (96 hours). Then the water is filtered and then the filtrate has been swapped with a cotton swap on an agar petridish beside a blank. It has been observed that the charcoal becomes contaminated like that of the water samples.

Fig 4.1.6 Growth of bacteria in water treated with charcoal and left for 4 nights observed in agar plate.

4.2 Discussion

The charcoals are not reusable. Used charcoals can be hazardous as the surface area of each particle of charcoal is covered with the bacteria that it had adsorbed from the water samples. As a result, there are some possibilities of microbes to proliferate within the waste charcoal powder solution. It is to be mentioned that Charcoal does not kill bacteria. Rather it just carries the bacteria with itself during filtration. The pH of the water samples are measured after charcoal treatment. The pH remains within the range of safe water. The color of the water samples is improved. The color seems to be close enough to crystal clear. No particle found to be floating or suspended in the water samples.

Chapter 5

Conclusion

5. Conclusion

The study has revealed the old ancient facts of charcoal that it is useful and economic for using in water filtration process. The study has been performed with powdered charcoal. By visibility it is evident that charcoal has a unique adhering property and porous structure that is able to captured minute ingredients within it's structure. These minute ingredients are mostly hazardous for health, making that water fail the requirements of safety. The result is about 95% success in removal of bacteria but not killing them. Leaving the contaminated charcoal will help the bacteria to proliferate. This study can be implemented in the urban area, where a good number of population is living under poverty line and are unable to ensure safe water for use due to economic circumstances. For this very reason, they are the first to suffer from water borne diseases. Charcoal is a very common ingredient to them and it is produced domestically on daily basis. Thus, implementing the study here, at least a type of water can be ensured which is free from bacteria.

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