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Silver Nanoparticles are used in the Purification of Drinking Water to Fight Water-Borne Bacteria

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Abstract

In the indigenous medical system, plants are employed to cure a variety of diseases since they are abundant in secondary metabolites. Germs that enter the mouth through water and food are to blame for the illnesses that plague many underdeveloped nations and the mortality of children. Furthermore, it has been calculated that poor sanitation, contaminated water, or a lack of access to water are responsible for up to 80% of all diseases and illnesses in the world. As a result, this study examines the ability of Moringa oleifera seed powder to filter water and assesses how seed extracts fare against a few bacterial growths. Flavonoids, tannins, steroids, alkaloids, and saponins were all found, according to the phytochemical screening. The antibacterial impact of the extracts on microorganisms was evaluated using the well diffusion method. Using Moringa oleifera seed (MOS) as a reducing/capping agent, silver nanoparticles (AgNPs) that are economical and environmentally friendly are synthesized here. By using FTIR and UV-Vis spectroscopy, the produced nanoparticles were examined, and their use in the Dip technique of drinking water filtration was investigated.

Keywords: Purification, antibacterial, silver nanoparticle, and moringa oleifera

Introduction

A essential requirement for all living things, including humans, is access to water. A worldwide issue is the lack of adequate access to clean water for communities, particularly in underdeveloped nations where rural populations depend on potentially poisonous and pathogenic water from rivers, dams, and streams for domestic use. Drinking such contaminated water might result in serious health issues like cholera, typhoid, dysentery, and diarrhea. Today, every continent suffers from a lack of clean, drinkable water.

Nearly 75% of the world's population currently lives in developing countries, and 2.1 billion people lack access to clean drinking water at home, according to recent data. In developing countries, where 1.2 billion people still lack access to safe drinking water, more than 6 million children die from diarrhea each year. Discovering technologies to purify river water for residential use could be a solution to the current drinking water shortage in rural areas of developing nations.

The issue with utilizing Moringa seed to purify water is that it merely prevents the formation of water pathogens, not completely eliminating them. The positive charge of the proteins (MOCP) in the seeds attracts the negatively charged dirt particles that are suspended, causing coagulation, flocculation, and sedimentation to clear the water. This also holds true for E. coli bacteria that have a negative charge. While moringa seeds are great coagulants for clarifying turbid water, they lack the antibacterial properties associated with seeds that have been treated with silver to act as an antibacterial agent.

The report presents the outcomes of experiments using silver as an antibacterial agent and Moringa seed powder as a coagulant material in a single system. Silver has the benefit of not being poisonous to people in addition to having antimicrobial characteristics. It is exceptionally long-lasting, has low doses of environmental impact, and may be reused.

Materials and Methods

Example of Drinking Water Gathering: The household tap was used to gather water samples. 2000 ml of drinking water samples were collected in sterile plastic bottles and stored for later use in sterile containers.

A Sample of Drinking Water is analyzed: Large amounts of sewage and industrial effluent are dumped into water bodies nowadays as a result of the growing population, industrialization, agricultural activities, and urbanization, which contaminates drinking water. The following water quality parameters were examined with the purpose of evaluating the water bodies' water pollution status:

1. Physical Analysis
2. Chemical Analysis
3. Biological Analysis

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Physical Analysis of Water

a) Color: Polluted water may be colored; pure water is colorless. Additionally, color can reveal organic materials. 15 TCUs (True Color Units) is the highest threshold at which the color of drinking water is acceptable.

b) Turbidity - Clear, light-transmitting water is free of turbidity. Turbidity in the water may be a sign of water contamination.

b) Taste and smell - Pure water never has a taste or smell. Any taste or smell could be an indication of water pollution.

d) Temperature - Determining whether water is drinkable or not does not immediately depend on its temperature. However, the temperature is a crucial physical component that affects water quality in natural water systems like lakes and rivers.

To determine if there have been any changes in the physical parameters of the water sample, such as turbidity, taste, odor, color, and temperature, an analysis of the water sample's physical characteristics was conducted from day 1 to day 7.

Chemical Analysis of Water

a) pH of Water: The acid-base balance of water can be evaluated using the pH parameter. It also serves as a gauge for the water's acidic or alkaline quality. The amount of dissolved carbon dioxide (CO_2), which causes water to produce carbonic acid, essentially determines pH. From 0 to 14, the pH scale is used. For seven days at room temperature, the pH of the water sample was monitored. A pH meter was used to measure the water sample's pH.

b) Estimation of Carbonate and Bicarbonate: By titrating a known volume of water with standard sulfuric acid while utilizing phenolphthalein and methyl orange as indicators, it is possible to measure the amounts of carbonate and bicarbonate in the water. when the water sample is treated with phenolphthalein by adding a drop. The absence of carbonate in the water can be seen by the pink color not developing.

When phenolphthalein is titrated against a typical sulphuric acid solution including carbonate and bicarbonate, phenolphthalein begins to lose its pink color as bicarbonate replaces half of the carbonate in the water sample. Indicating the amount of carbonates in water is therefore twice this value. A few drops of methyl orange are added to the colorless solution, and the ratio of methyl orange to sulfuric acid is adjusted until the color turns pinkish red.

c) Estimation of Calcium: The physiology of human cells and bones depend heavily on calcium, which is the fifth most prevalent element in the crust of the earth. The human body stores about 95% of its calcium in bones and teeth. Humans who are deficient in calcium may develop rickets, have trouble clotting their blood, experience bone fractures, etc. Ammonium oxalate is added to an acetic acid media to cause calcium to precipitate as calcium oxalate. The precipitate is dispersed in diluted H_2SO, chloride-free washed, and titrated against N/10 $KMnO_4$.

Biological Analysis of Water

a) Spread plate technique: A tiny inoculum can be dispersed with an L-rod on the surface of a Petri plate containing growth medium that has been hardened with agar using the spread plate technique. It produces countable colonies that are equally dispersed.

b) MPN Technique – Detection of Potability of Water: To find out if there are coliform bacteria in the water.

Presumptive Test: The presumptive test is specifically designed to identify the presence of coliform bacteria in the water sample. A lactose fermentation broth containing an upside-down glass vial receives measured aliquots of the water to be examined. Because these bacteria can consume lactose, employing this medium makes it easier to detect them. The development of species other than coliform bacteria is inhibited by the addition of the surface tension depressant bile salt to this experimental lactose fermentation medium. Any tube that develops gas is a strong indicator that there are coliform bacteria in the sample.

Confirmed Test: Presumptive tests that are positive or uncertain imply that the water sample is unfit for human consumption. A positive lactose broth tube obtained from the presumptive test must next have selected EMB streaked from it. Eosin methylene blue contains the dye methylene blue, which prevents Gram-positive organisms from growing. EMB develops a complex when an acidic environment is present, which precipitates out onto the coliform colonies and leaves them with dark centers and a green metallic sheen.

Completed Test: The final analysis of the water sample is the result of the test. It is utilized to look at the coliform colonies that are utilized in verified tests. Gram staining is carried out using isolated colonies that have been selected from the confirmatory test plate and put into a tube of lactose broth. Gram-negative bacilli are an additional indicator of the presence of E. coli and of a successful completed test when they are found under a microscope.

Results

Table 1: Physical analysis results of drinking water sample

Physical Parameters	Test Results
Temperature	27.7°c
Odour	Odourless
Taste	Tasteless
Colour	Colourless
Turbidity	No turbidity

Table 2: Chemical analysis results of drinking water sample

Chemical Parameters	Test Results
pH	7.00
Carbonate and Bicarbonate	Absent
Copper	Absent
Calcium	Absent

Summary and Conclusion

The quality of the water that is ingested is crucial because it directly affects health. Water that is contaminated or impure can lead to health issues, so it is important to safeguard and clean up the natural water supplies that have been severely harmed by human activity. Rural residents are primarily reliant on natural water resources, and for them, access to clean drinking water continues to be a major problem. Although there are numerous methods used in water filtration, most people cannot readily afford them.

An abundance of phytochemicals and antioxidants can be found in the extract made from Moringa oleifera seed water, which serves as both a capping and reducing agent for the environmentally friendly manufacture of silver nanoparticles. Ag NPs for drinking water filtration were effectively created using Moringa oleifera seed extract. They were low-cost and non-toxic.

Silver's antibacterial qualities entirely destroy E. coli bacteria in the turbid water that was clarified by moringa seed powder. Moringa seed powder is a great coagulant for clearing turbid water from polluted drinking water. A simple, effective, and reasonably priced technique for disinfecting and cleaning water for use in rural areas has been developed by combining the coagulant property of moringa seed powder with the antibacterial activity of silver.

Silver nanoparticles combined with Moringa oleifera seed powder suppress the coliform bacteria in the water sample.

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