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TO IDENTIFY AND EVALUATE NANOMATERIALS SUITABLE FOR WATER PURIFICATION APPLICATIONS.

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ABSTRACT

Nanotechnology is now a game-changer when it comes to improving water filtration systems' efficiency and efficacy. An essential part of water purification is removing bacteria, viruses, and other pathogens as well as chemical pollutants. Difficulties that this method tackles by using nanoscale materials and technology. This study investigates the ways in which nanotechnology is transforming water treatment systems, advantages, and real-world applications of nanoscale solutions. It highlights how nanotechnology enhances water quality, reduces operational costs, and contributes to sustainable development goals, particularly in regions facing water scarcity and contamination crises.

Keywords: Nanomaterials, Water, Purification, Nanotechnology and Quality**.**

INTRODUCTION

In our minds, water represents life, making its actual presence secondary to its symbolic significance. Water is therefore a mythological entity. All three of these global concerns health, the environment, and the economy depend on reliable, long-term access to potable water. At present, human civilization is confronted with a major challenge in satisfying the increasing demand for potable water. Reason being: freshwater supplies are decreasing due to multiple causes, such as increased population, longer periods of drought, problems with surface and subterranean water contamination, unregulated floods, and conflicting demands from users. Because of these variables, groundwater quality is falling even more rapidly than surface water. Because of its importance as a resource, a fundamental human need, and a major national asset, water management, development, and planning must precede any use of the resource. There is a lack of water in many regions of the globe because of the rising human population and the excessive draining of underground and surface water sources in recent decades. Due to insufficient treatment and management procedures for wastewater is leading to the contamination of existing freshwater reserves, and the problem is becoming worse. The per capita water consumption in cities and towns is on the rise due to the rapid urbanization process. In light of this, it is critical to acknowledge the need of managing current water reserves to forestall water shortages in the future.

There is a current worry about the accessibility of potable water. Nearly majority of the water needed by the nation comes from underground sources. According to estimates made by the United Nations, More than two billion people rely on aquifers as a source of potable water. Irrigated agriculture, which uses groundwater for the most part, produces 40% of the world's food. Important for human survival and economic growth, groundwater accounts for almost all of the world's freshwater Groundwater is becoming more scarce and of worse quality, posing people, particularly those living in rural areas, face a significant risk, and thus, groundwater treatment is being considered by everyone. This is because clean water is becoming a scarce commodity. The globe is now experiencing a catastrophic shortage of groundwater resources due to the unchecked usage of these resources. There is no way around shifting our focus from "groundwater development" to "groundwater management"; therefore, we must strive for the most efficient and environmentally friendly use of groundwater possible. These days, it's everyone's job to check the water supply for contaminants. To meet this need, practical, affordable, and environmentally friendly water treatment methods are needed.

Groundwater conditions vary throughout India due to the country's large size and the wide variety of geological, climatological, and topographical features. The groundwater quality is constantly being compromised due to resources being used in an unsustainable way and pesticides, fertilizers, and industrial pollutants being applied without discrimination. Most of the time, agrochemicals, as well as household and business trash, contaminate shallow aquifers. The most common causes of water pollution include heat, substances that are considered nutrients, such as phosphates and nitrates, as well as heavy metals and metalloids, organic compounds, oil, sediments, microorganisms, and lubricants and industrial solvents. Pollutants are undesirable by-products of almost every industrial and goods-producing activity. When heavy metals seep into the groundwater supply, they have the potential to bioaccumulate in living things. The arsenic-affected areas of Bangladesh and India, for instance, are home to almost 100 million people. Arsenic-contaminated groundwater affects about 3,150 villages, 78 blocks, and 9 of West Bengal's 19 districts. Once contaminants have made it to aquifers, it may be very challenging and expensive to remove them, even though the process might take years. The lack of proper treatment for more than 80% of sewage in developing nations causes contamination in aquatic environments such as rivers, lakes, and coastlines.

LITERATURE REVIEW

Rao and Sharma (2015) provided an early overview of the potential of nanotechnology in water purification, focusing on carbon nanotubes (CNTs). Their study demonstrated that CNTs exhibit outstanding surface area and adsorption capabilities for heavy metals, including lead and cadmium strong interaction with contaminants. The researchers highlighted the ability of CNT-based filters to address pollutants that conventional systems fail to remove, positioning nanotechnology as a game-changer in water treatment.

Kumar et al. (2016) investigated potential uses for nanoparticles made of metal oxides, particularly titanium dioxide (TiO_2), in photocatalytic degradation of organic pollutants. Their findings revealed that TiO_2 nanoparticles are highly effective in breaking down persistent organic contaminants, such as pesticides and dyes, when activated by ultraviolet light. The study also discussed the scalability of these photocatalysts in industrial wastewater treatment.

Patel and Singh (2017) examined the development of nanocomposite membranes, which combine polymer membranes with nanoparticles for enhanced performance. Their research emphasized that nanocomposite membranes exhibit anti-fouling properties and superior permeability, making them suitable for desalination and advanced filtration processes. They particularly noted the role of graphene oxide in enhancing membrane durability and reducing operational costs.

Desai and Mehta (2018) analyzed the effectiveness of silver nanoparticles (AgNPs) in removing microbial contaminants from water. They highlighted that AgNPs have strong antimicrobial properties, capable of inactivating bacteria, viruses, and fungi. The study provided evidence of AgNP-based filters offering decentralized solutions for clean water access in rural and disaster-hit areas.

Sharma and Gupta (2019) focused on the advancements in nanofiltration membranes for water purification. Their research highlighted that nanofiltration membranes achieve high selectivity in removing contaminants such as salts, pathogens, and organic molecules while maintaining low energy requirements. The study underscored their application in addressing both urban and industrial water challenges.

METHODOLOGY

Synthesizing nanomaterials with exact control over size, shape, and crystalline structure is now essential for many nanotechnology applications. Partitioning a large solid into ever-tinier pieces, all the way down to the nanoscale scale, is from the very top down. In this thesis, Merck's Deionised (DI) water with resistivity ethanol (C2H5OH) is employed as a solvent. The X-ray diffraction technique is the gold standard for material characterization. A material's crystalline nature, phase type, lattice parameter, and grain size are among the many variables that may be inferred from XRD data. Powder, thin film, and bulk materials are all suitable for this process. Bragg's law establishes a link between Three factors connect X-ray radiation to crystalline materials: the wavelength of the radiation, the distance between the crystal planes, and the Bragg angle, which measures the diffraction angle. X-ray diffraction occurs when X-rays reflect off of different crystallographic planes, in accordance with Bragg's law. Elements in a liquid may be quantitatively measured using AAS. The method achieves its high specificity and detection limits by capitalizing on the fact that gaseous components absorb light at very narrow wavelengths. A Systronics digital pH meter was used to test the pH of the samples. Buffer solutions with pH 4.7 and 9.2 were used for instrument calibration. The quantification of coliform bacteria was the most crucial microbiological test. To arrive at their estimate, they used Multiple Tube Dilution (MTD).

RESULTS AND DISCUSSION

Water Quality Status

With the exception of pH, all of the water quality indicators tested were within the acceptable range according to Bureau of Indian Standards. Table 1 provided the parameter range, including their maximum and minimum values. The pH was 4.90 to 8.61 just before the monsoons started. The pre-monsoon samples showed an acidic character in 92% of the total samples tested. There was a pH range of 4.70 to 8.62 throughout the monsoon. During the monsoon, 93% of the samples were acidic, but after the monsoon, 94% were acidic. The acidity of the soil or the decomposing matter around the well might be the cause of the samples' acidity.

After testing for microorganisms, it was discovered that the majority of the groundwater sources were polluted. The percentage of wells polluted with E. coli during the pre-monsoon period was 48%. Eleven percent of the samples tested positive for E. coli during the rainy season. The samples were found to be in the post-monsoon phase. 93% contaminated with total coliforn and 17% infected with E. coli. Contamination by microbes is caused by unsanitary conditions, dumping of garbage near wells, and inadequate sanitation in the region.

Table 1 The minimum and maximum level of several water quality indicators

Parameters	Pre monsoon		Monsoon		Post Monsoon	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum

pH	**4.90(±0.15)**	**8.61(±0.65)**	**4.70(±0.10)**	**8.62(±0.60)**	**4.75(±0.20)**	**8.53(±0.69)**
Colour, Hazen	**ND**	**21.0(±2.48)**	**ND**	**3.70(±2.68)**	**ND**	**44.20(±3.98)**
Turbidity, NTU	**ND**	**85.0(±1.18)**	**ND**	**2.20(±1.20)**	**ND**	**9.30(±1.38)**
Electrical Conductivity, μS/cm	**30.0(±1.23)**	**346.0(±5.83)**	**29.0(±1.30)**	**331.0(±4.33)**	**29.0(±1.30)**	**395.0(±6.19)**
Total Dissolved Solids, mg/l	**20(±1.33)**	**204.0(±4.73)**	**14.0(±1.15)**	**213.0(±3.65)**	**17.0(±1.10)**	**252.0(±4.18)**
Total Hardness, mg/l	**8.0(±0.61)**	**176.0(±8.61)**	**4.0(±0.10)**	**160.0(±5.13)**	**4.0(±0.90)**	**128.0(±2.96)**
Sulphate, mg/l	**ND**	**52.0(±3.63)**	**0.04(±0.01)**	**18.92(±3.46)**	**0.32(±0.05)**	**23.44(±3.45)**
Chloride, mg/l	**7.98(±0.62)**	**64.0(±2.62)**	**0.96(±0.10)**	**38.45(±1.15)**	**7. 66(±1.22)**	**39.28(±2.92)**
Nitrate-N, mg/l	**ND**	**5.13(±1.20)**	**0.08(±0.01)**	**7.45(±1.10)**	**0.25(±0.02)**	**5.75(±1.26)**
Calcium, mg/l	**1.60(±0.07)**	**36.80(±20.7)**	**1.6(±0.15)**	**40.0(±1.15)**	**1.20(±0.20)**	**25.60(±2.37)**
Magnesium, mg/l	**ND**	**20.41(±2.46)**	**0.97(±0.10)**	**7.78(±2.11)**	**0.97(±0.10)**	**15.55(±2.25)**
Iron, mg/l	**ND**	**0.98(±0.16)**	**ND**	**0.72(±0.15)**	**ND**	**3.75(±1.46)**

Manganese, mg/l	**ND**	**0.17(±0.05)**	**ND**	**0.28(±0.06)**	**ND**	**0.07(±0.05)**
Sodium, mg/l	**2.80(±0.20)**	**28.40(±1.60)**	**1.20(±0.08)**	**25.60(±1.18)**	**2.80(±0 .40)**	**26.40(±1.90)**
Potassium, mg/l	**0.10(±0.33)**	**3.70(±1.73)**	**0.10(±1.31)**	**8.90(±1.31)**	**ND**	**7.50(±0.93)**
Total Coliform, MPN /100ml	**<2**	**≥24**	**<2**	**≥24**	**<2**	**≥24**
Faecal Coliform, MPN/100ml	**<2**	**≥24**	**<2**	**≥24**	**<2**	**≥24**

ND-Not Detected

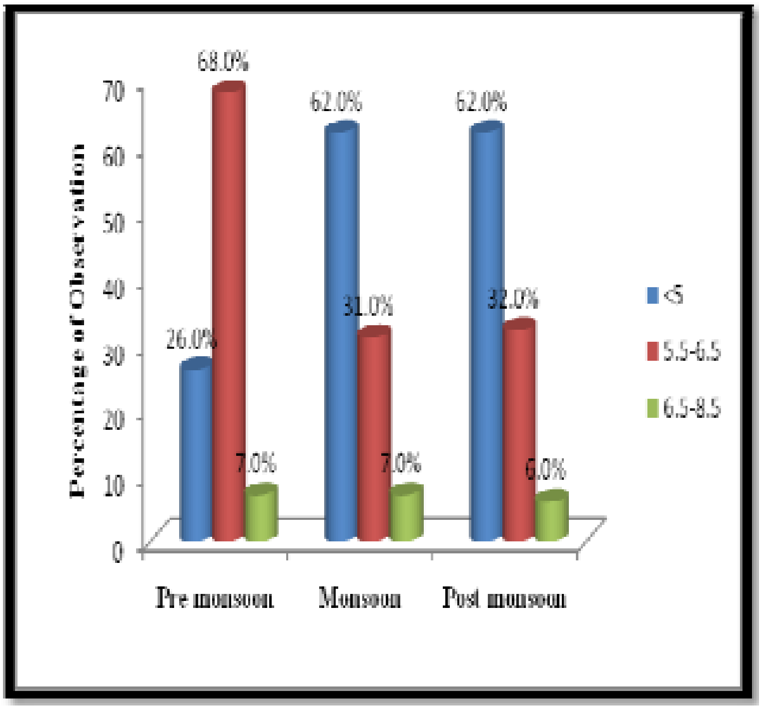

Fig 1: Seasonal variation of pH

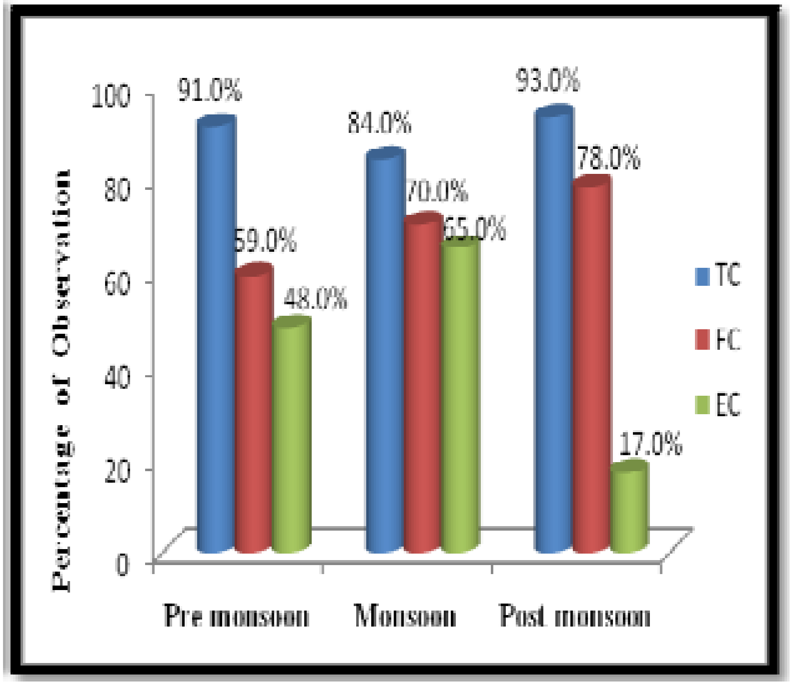

Fig 2: Seasonal variation of Total Coliforms & E.Coli

Classification of Water Type

Hydrogeochemical features were used to categorize the groundwaters in the research region. four distinct kinds of groundwater were identified in the research region. Chemists studying groundwater found that bicarbonates and calcium were the most common cations and anion in every sample. In fresh groundwater that had not been impacted by saltwater intrusion, bicarbonate and calcium ions predominated in the hydrogeochemical makeup. In the research region, two main kinds of hydrochemical water were found: A combination of calcium, magnesium, and bicarbonate, as well as calcium, sodium, and bicarbonate,. Sung-Wook Jeen et al. (2001) found that weak acids and alkaline earths predominate in water's chemical characteristics.

Half of the groundwater samples in the research region were of this kind, whereas the other half were of a different type. a Piper diagram showing the amounts of key ions in water samples from the Kunnamangalam Panchayat.

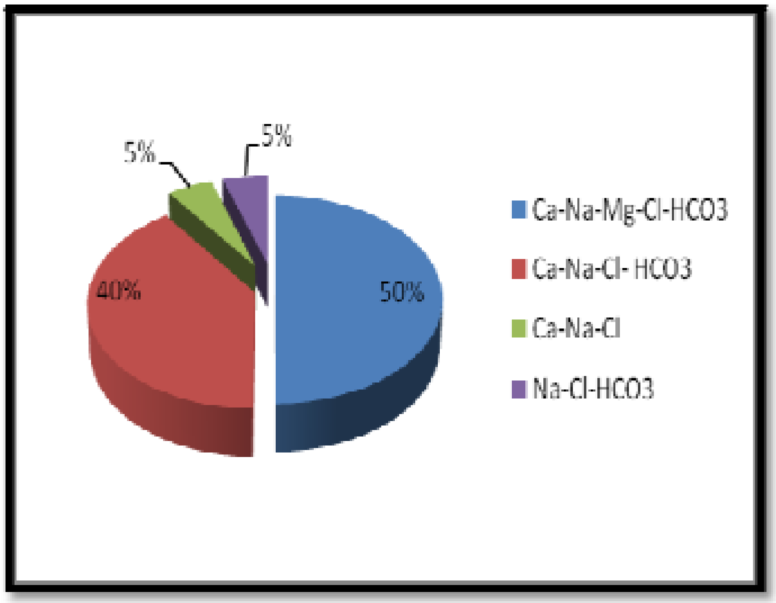

Fig 3 Classification of groundwater types during post-monsoon

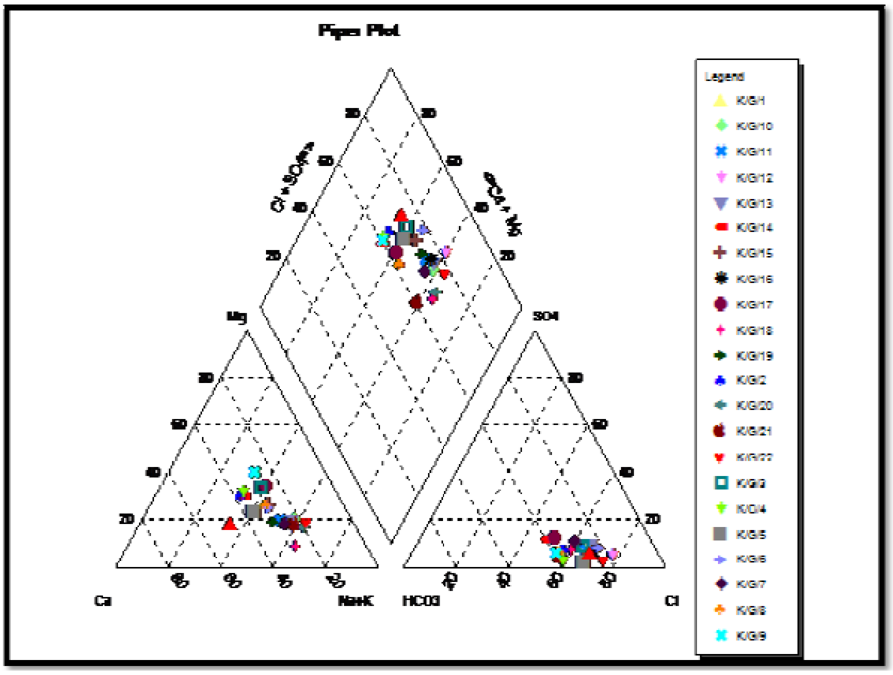

Fig 4 Piper diagram of groundwater during post-monsoon

CONCLUSIONS

The main reason to disinfect drinking water samples is to kill any harmful bacteria that may be present, which is known as pathogenic contamination. Nano silver disinfection technology has shown promise in early studies and may be a good fit for this application. Additionally, the function of iron nanoparticles as an adsorbent in purifying water was examined. The use of appropriate adsorbents in an adsorption-friendly environment allows for a highly successful and cost-effective method of removing metals or dyes from water streams. To reduce biological and chemical pollutants in water to safe levels, several nanostructured have been effectively manufactured for use in remediation and decontamination operations. Using a hydrothermal synthesis technique, several nanostructures with various morphologies were produced.

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