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Toxicity Reduction in Lake Water Using MgO and CaO Nano Adsorbent for Water Quality Improvement

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Abstract

In this present work, the effect of lignocellulosic biomasses on the water treatment efficacy of Porur lake was investigated. Microwave treated lignocellulosic biomass was prepared followed by seeding into the water samples that collected from Porur lake. Water treatment efficacy was done with a total of 28 samples that were split into two groups. 14 samples were obtained for pre-treated water (Group 1) and 14 samples were taken for novel post-treated (Group 2). Calculating power at 0.85 G. The parameters alpha and CI (Confidence interval) are taken into consideration. Using SPSS (Statistical Package for the Social Sciences) analysis, a significant value of 0.01 ($p < 0.05$) was determined. Followed by measuring water quality parameters. Determination of changes in the respective parameter of control and lignocellulose biomass treatment revealed the adsorption or water treatment efficacy. Results showed that the number of inorganic pollutants were significantly reduced in lignocellulosic biomass treated water samples that derived during the novel pre-monsoon season (significance difference of (2-tailed) 0.01($p < 0.05$)). From these findings it is very clear that lignocellulose biomass can be used in the water treatment process as their high efficacy in pollutants removal.

Keywords

Water, Water pollution, Chembarambakkam lake, Nano adsorbent, Pre-treated water, Novel post-treated water, Chlorine concentration, Parameters

Introduction

Water is essential for all life on earth and a significant resource for humans. Water is crucial for sustaining human existence as well as civilization, local economies, and local communities [1]. Water is immediately utilized for drinking, cooking, and bathing. Around the world, water is mostly used for electricity, manufacturing, and agriculture. Water pollution is the condition that occurs when a particular water body cannot be used for a certain purpose due to the presence of chemical, physical, or biological components or causes. The degree of contamination necessary for a water body to become harmed depends significantly on the type of water body, its location, and the kinds of beneficial uses it supports [2-4].

Over the past three years, Science Direct has 63 articles, whereas IEEE Xplore has 105 research pieces. Nanoparticles have become a fantastic solution for addressing the global problem of water treatment and pollution [5-9]. Fabricating nanoparticles with precisely controlled morphologies and properties has recently attracted a lot of study and development, making it a very interesting sector [10]. Nanoparticles are essentially little copies of their bulk counterparts

[11-12]. The typical nanoparticle's size in at least one spatial dimension is 100 nm or less. They have incredibly special chemical, physical, optical, electrical, magnetic, and biological properties because of their extraordinarily high specific surface area and few surface defects [13]. They are good adsorbents and effective against a wide variety of contaminants because of all these characteristics. Water treatment systems enabled by nanotechnology offer extremely effective, inexpensive solutions that rely less on traditional methods [14].

The majority of the research that has been published so far focuses on using different adsorbents to remove harmful pollutants, but there are no studies on how the season affects the effectiveness of nano adsorbent at adsorbing pollutants. In this paper we are going to treat water samples taken from the Chembarambakkam lake using the MgO and CaO nano adsorbent extracted from the neem leaf and check various water quality parameters to know whether the water quality improved by the process or not.

Materials and Method

This research was done in the Saveetha School of Engineering's Sustainable Energy lab. To compare the procedure and the outcome of the two numbers of groups in this study, two numbers of groups were chosen. For this study, a total of 28 samples and 14 sets of samples from each group were chosen.

Study area

Chembarambakkam lake is located 25 km away from Chennai, which is in the Kanchipuram district in Tamil Nadu, India. It is one of the two rain-fed resources from where water is drawn for supply to Chennai city [15].

Sample collection

As directed by APHA (1989) and WHO (2011), 2 L of water samples were taken from the Chembarambakkam lake for analysis. Water samples were collected for microbiological investigation and provided for assessment of physicochemical and biological qualities in 1,000 ml sterile, non-reactive borosilicate glass bottles.

Lignocellulosic biomass preparation

For the quick precipitation procedure, 10 ml of 100 mg/L neem leaf extract was added to a beaker holding 60 ml of 0.5 M $Mg(NO_3)_2$ solution before being slowly mixed with 0.1 M NaOH. This resulted in the creation of Nano-MgO. Using magnetic control, continuous stirring was done for 24 h at 60 °C. 20 ml of 0.2 M NaOH was gradually added, and the mixture was agitated for 3 h. The resulting solution underwent a 100 °C reflux. To extract the product, the supernatant was removed, and the settled particles centrifuged. This was then calcined for 2 h at 600 °C in a muffle furnace to produce a fine powder of nano-magnesium oxide [16].

Treatment process

One liter of water was sampled, and four 250 ml conical flasks were used to hold the lignocellulosic biomass made from water hyacinths. One gram of this nanomaterial was added evenly to the water samples in each conical flask. The conical flask is then placed in a rotary shaker for 8 - 10 days, after which a water sample is filtered and provided for testing to determine whether the use of nano adsorbent in the water treatment process was successful in lowering the physical, chemical, and biological parameters that were over the allowable range [17].

Physicochemical parameters

A test must be performed on the water before it is used for industrial, agricultural, or domestic uses. The water must be tested using a number of physical-chemical elements. The only criteria in determining the parameters for a water test are the intended use of the water and the level of necessity for its quality and purity [18]. Different kinds of floating, dissolving, suspended, microbiological, and bacteriological pollutants are present in water. Physical tests should be carried out to evaluate the substance's physical characteristics, such as temperature, color, odor, pH, turbidity, TDS, etc. [19]. Chemical tests should be carried out to evaluate the substance's dissolved oxygen content, alkalinity, hardness, and other characteristics [20].

Biological parameters

In the water sample taken from the Chembarambakkam lake, biological metrics include the total coliforms and *Escherichia coli* concentrations. Even reasonably clean lake water might have a variety of microorganisms in it. The two most often employed indicator microorganisms for home water quality testing, total coliforms, and faecal coliforms, are utilized to determine whether the water is contaminated even though the majority of these bacteria are harmless [16].

Surface rivers microbiological quality is influenced by a number of factors, including runoff from slum areas, sewage treatment facility discharges, and pollution from excrement of both human and animal origin. Water is considered contaminated when it contains infectious and parasitic organisms. Faecal coliforms, the most common bacterial biomarker of faecal contamination, are used to assess the microbiological quality of drinking water [21].

Statistical analysis

Using the statistical application SPSS v.26, a t-test analysis was performed with pre-treatment and post-treatment used as independent variables and mean chloride concentration as the dependent variable. The G-graph, the t-test table, and the descriptive table were obtained for the test results [22].

Results

Water samples are tested, physicochemical, and biological parameters values are obtained. Table 1 shows chloride (Cl) and sulphate values from Chembarambakkam lake water samples taken pre-treatment and novel post-treatment. Table 2 displays paired sample data for pre- and post-monsoon water samples while accounting for Cl concentration. Pre-treated water has a mean value of 118.9714, higher than the mean

Table 1: Chloride and sulphate values from Chembarambakkam lake water samples taken pre-treatment and novel post-treatment.

S. No.	Parameters	Pre-treated	Post-treated
1	Chloride	168.2	102
		168.1	102.4
		168.2	102.6
		168.5	102.2
		164.3	102.5
		168.5	102.6
		168.4	102.3
2	Chloride	168.2	102
		168.1	102.4
		168.2	102.6
		168.5	102.2
		164.3	102.5
		168.5	102.6
		168.4	102.3

Table 2: Paired sample statistics show standard deviation for novel pre-treated and novel post-treated water samples with a sample size of 14.

		Mean	N	Std. deviation	Std. error mean
Pair 1	Pre-treated	118.9714	14	50.62321	13.52962
	Post-treated	78.8286	14	24.43243	6.52984

value of novel post-treated water, which is 178.8286 [23, 24].

Table 3 shows the mean Mg concentration for both the pre-treated and novel post-treated water samples is relevant and has a high correlation value, as shown by the paired samples correlation, which has a sample size of 14 times for each sample [25]. Table 4 shows the paired sample test of two groups and 14 samples from pre-treated and post-treated, demonstrates a significant variation in pre-treated and novel post-treated water samples.

Figure 1 represents the output of two groups of water samples from pre-treated and post-treated times versus Cl amount variation in each time. From the graph we can conclude that post treated water sample has less Cl concentration than pre-treated water samples.

Discussion

All living things require water to survive, and it is a precious natural resource. Water is a renewable resource for the environment since it may ingest up to a certain level of pollution without losing quality [26]. The natural process of eutrophication lowers water quality and is harmful to societal development. The bulk of Chennai's lakes experienced a sharp decline in size as a result of the aggressive, fast development process and unmanaged encroachment [27, 28]. The push for urbanization and pollution both decreased the water's portability [29]. Residents in the neighborhood are more likely to get sick from drinking contaminated water. It is crucial to regularly evaluate the lake's water quality. Color, flavor, smell, temperature, turbidity, solids, and electrical conductivity are examples of physical qualities. Chemical characteristics include things like alkalinity, Cl, hardness, pH, dissolved oxygen, and biological oxygen needs [30, 31]. In this research we have analyzed pre-treated and post-treated using various EIA methods and compared both values.

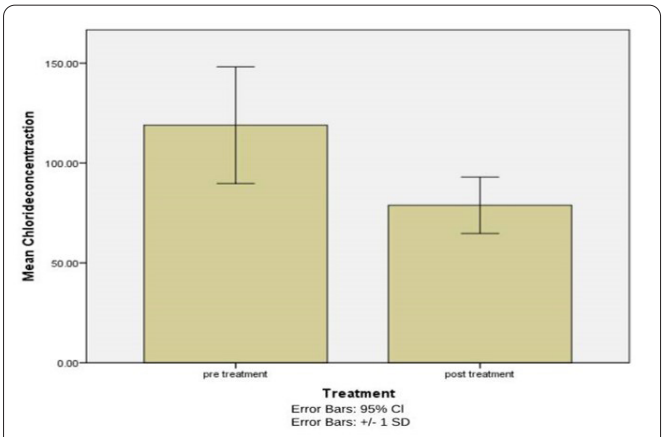

Figure 1: Cl concentration in Chembarambakkam lake is examined between pre-treated water and novel post-treatment. In comparison to post-monsoon water, novel post-treated water has a higher mean Cl concentration value. On the X-axis are fresh pre- and post-monsoon water samples. Mean TDS on the Y-axis with +/-1 SD and 95% CI.

Nanotechnology is the most promising and under-researched area of science in the twenty-first century. It has the ability to manufacture materials with peculiar and uncommon properties that humans have never previously encountered. One of the largest issues facing the modern world, the treatment of wastewater, has lately shown that it can help [26]. Because of their large specific surface area, discontinuous characteristics, and quick dissolution, reactivity, and sorption, nanomaterials exhibit special size-dependent features (such as super para magnetism, localized surface plasmon resonance, and quantum confinement effect). These particular nano-based properties enable the development of novel high-tech materials for more effective water and wastewater treatment processes, such as membranes, adsorption materials, nano catalysts, functionalized surfaces, coatings, and reagents [20, 32-34].

The key advantage of the study is the treatment's extremely cost-effectiveness, environmental friendliness, ease of waste disposal, and management of biological resources; however,

Table 3: Paired samples correlation shows the significance and correlation of mean TDS for both the novel pre-treated and post-treated water with a sample size of 14 for each sample.

		N	Correlation	Sig.
Pair 1	Pre-monsoon and post-monsoon	14	1.000	0.000

Table 4: The paired samples sample test revealed a substantial variation in the mean TDS value of novel post-treated and pre-treated water samples from Chembarambakkam lake.

	Paired differences						T	Df	Sig. (2-tailed)
		Mean	Std. deviation	Std. error mean	95% CI of the difference				
					Lower	Upper			
Pair 1	Pre-treated - Post-treated	40.14286	26.20395	7.00330	25.01	55.27257	5.732	13	0.13

this process requires a lot of time for large-scale production.

Conclusion

Nanotechnology principles-based adsorbents as nano adsorbents play an important role in water treatment process. However, the effectiveness of adsorbents is highly influenced by various physiochemical or biological parameters. In this study, the metal oxide-based nanocomposites adsorption efficacy was highly influenced by seasonal variation. High adsorption efficacy was recorded during novel pre-monsoon water samples. These findings clearly revealed the consideration of seasonal variation in the water treatment process followed by the effective treatment distribution to the public.

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None.

Conflict of Interest

None.

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