Original Article

Comparative Study of Green Synthesized Silver (Ag) Nanoparticles for Wastewater Treatment Over Filtration Technique for Bioremediation Application

Kullu Sai Kumar Yadav[1], Manikandan S[2*]

[1]Research Scholar,Department of Biotechnology,Saveetha School of Engineering,Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai, Tamil Nadu, India, Pincode:602105.

[2*]Project Guide,Department of Biotechnology,Saveetha School of Engineering,Saveetha Institute of Medical and Technical Sciences,Saveetha University, Chennai, Tamil Nadu, India, Pincode: 602105.

Abstract

Abstract: A simple eco-friendly green synthetic method was used to synthesize silver (Ag) nanoparticles as novel filtration beds.
Materials and Methods: The Silver (Ag) nanoparticles were created by heating *Azadirachtaindica* (Neem) leaf extract to 70°C and reducing equimolar amounts of the salt mixture.There are two groups, each containing eight samples with G power 80% and coincidence interval of 95%.
Results and Discussion: As a result, silver metallic nanoparticles were produced and analysed using UV–visible spectroscopy. UV–visible confirmed the evidence of silver nanoparticle formation. Using wastewater turbidity measurements, researchers looked at how dosage, pH, and agitation time affect turbidity reduction, P=0.04.
Conclusion: Nanoparticles of silver (Ag) had higher maximum molecular suspension removal rates. In spite of the low molecular suspension concentrations, these nanoparticles work well as a novel filtration bed. In wastewater treatment, synthesized novel Ag nanoparticles can be used as efficient metal trace absorbers while also being environmentally acceptable (using*Azadirachtaindica*).

Keywords: Nanoparticles, Green synthesis, Wastewater treatment, Novel filtration bed, Adsorption, Ag.

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INTRODUCTION

Water resources are depleting at an alarming rate as the global population grows and the climate warms (Srinivasan, Kamaraj, and VenkatesaPrabhu 2021). As a result, the most effective methods for conserving freshwater are the selective use of water resources and the reuse of wastewater (Leonel and Tonetti 2021) that has been treated for a variety of purposes. The main indicator of contaminated water is the presence of heavy metals and microorganisms (Wang, Zhu, and Mao 2021). Water contamination with heavy metals is an environmental health issue because of the numerous health risks it poses (Ali, Khan, and Ilahi 2019).

In the past five years, the total number of articles published related to this study are as follows; Science direct contained 1453 articles and Google Scholar contained 1270 articles . Waterborne pathogens like *Escherichia coli, Salmonella, Shigella, Vibrio, and Cryptosporidium* can infect people who drink contaminated water and lead to disease (Mackuľak et al. 2021; Dey et al. 2022). Because of their unique features and multiple potential uses in medicine, researchers are currently extremely interested in metal nanoparticles, notably silver (Katta and Dubey 2021). Biosynthesis is a superior method to conventional synthesis because it is more environmentally friendly, less expensive, and takes less time to complete (Tamilarasi and Meena 2020). Biologic materials include plant extracts, fungi enzymes, bacteria, and actinomycetes, which can all be used in the synthesis of nanoparticles (Vinay and Chandrasekhar 2019). However, because of their abundance and phytochemical composition, plant extracts have received most of the attention (Vinay and Chandrasekhar 2019; Girón-Vázquez et al. 2019). Bloody nose and eye problems are among the conditions for which the*Azadirachtaindica* leaf is used. Other conditions for which the Neem leaf is used include intestinal worms, ulcers, and diseases of the heart and blood vessels (Dey and Devasena 2015; Dey, Raj, and Devasena 2021).Our team has extensive knowledge and research experience that has translate into high quality publications(Bhansali et al. 2021; Jayanth et al. 2021; Sudhakar, Ravel, and Perumal 2021; Sathiyamoorthi et al. 2021; Deepanraj et al. 2021; Raju et al. 2021; Arun Prakash et al. 2020; Kamath et al. 2020; Shanmugam et al. 2021; Rajasekaran et al. 2020; Adhinarayanan et al. 2020; Rajesh et al. 2020; Aurtherson et al. 2021)

As a result, using data on the plant's reported phytochemical constituents, researchers conducted this study to see if *Azadirachtaindica* leaves extract could be used to green synthesis of Ag nanoparticles (Neem). By optimising the synthesis of silver nanoparticles utilising parameters such as pH, duration, temperature, silver nitrate (AgNO3) concentration, and leaf extract concentration, copper oxide nanoparticles coated with *Azadirachtaindica* leaf extract are presented as a novel green synthesis nanoparticle. (Habibullah, Viktorova, and Ruml 2021). As far as we know, no natural extract-based multifunctional *Azadirachtaindica* Ag nanoparticle green synthesis has been reported in the literature regarding adsorption. More information is provided on Ag nanoparticles, including information on their metal ion adsorbent properties and their application in wastewater treatment.

MATERIALS AND METHODS

This study was conducted in the Microbiology Laboratory of Saveetha School of Engineering, The experiment's overall sample size will be 16 ((Habibullah, Viktorova, and Ruml 2021)). Group 1 is conventionally treated wastewater and Group 2 is nanoparticles treated wastewater. The G power value is 80% and criteria (CI) will be 95%. The sample preparation is done as given below

Part 1: Green synthesis of Ag nanoparticles

Azadirachtaindica extract preparation:

Fresh *Azadirachtaindica* leaves were washed thoroughly with clean water before being rinsed thoroughly with double distilled water. For 20 minutes at 60 °C, boil 10 g *Azadirachtaindica* leaves in 100 mL double-distilled water.*Azadirachtaindica*leaf extracthas been obtained.

Green synthesis of Silver (Ag) nanoparticles:

In 50 mL of double distilled water, 1 wt% silver nitrate was dissolved. To the silver nitrate solution mixture, 5 mL of *Azadirachtaindica*extract was added. The solution mixture is incubated at 90°C for 2 hours. Solution mixture turned into a smoky brown colour indicates the formation of Ag nanoparticlesFiltered and dried to obtain Ag nanoparticles as powder. Figure 1 represents the schematic flowchart of the preparation of Silver Nanoparticles.

Part 2: Construction of a typical wastewater residue adsorption and filtration bed

The fluidized bed has been currently divided into multiple cells; each was measuring 3 cm to 5 cm and the total filtration bed sized around 2 feet. The cells were sized so that in a normal loading cycle, one or two beds had been filled. After locating a suitable source of crushed rock, and sorted.This is achieved by sifting crushed rock material through a succession of sieves. In sieves, metal wire screens are often linked to a wooden frame. Gravel and sand are filtered through successively finer screens before being divided into heaps based on size. Each size of material in the biosand filter's structure serves a distinct purpose. The coarse sand particles had been filled to the bottom above the filter, and the sieved sand particles had been filled in decreasing order. Coconut coir is interspersed in the middle of the gravel sand bed. The coir itself retains moisture, preventing rapid drainage and soil drying. Coir's dual drainage and retention properties help it manage moisture in both heavy clay and dry sandy soils. The Ag nanoparticles bed had been spreaded in the second top next to the activated charcoal, and above that very fine sand has been filled and sludge has been flooded over it for waste residue filtration and adsorption. The filtrate was collected, and the absorbance was measured at 390 nm (using UV spectrometer) to determine the residue suspension. Figure 2 represents the Schematic diagram of the novel filtration bed.

STATISTICAL ANALYSIS

The IBM SPSS software Version 26 application is used to compare results such as mean,standard deviation and standard deviation error. The dependent variables are conventionally treated wastewater and silver nanoparticles treated wastewater. There are no independent variables ((Habibullah, Viktorova, and Ruml 2021)). In order to study statistical significance, an independent samples-t-test was used.

RESULTS

Wastewater treatment was carried out for both traditionally treated wastewater and wastewater treated with nanoparticles. Table 1 shows the physicochemical parameters (turbidity and color) of conventionally treated wastewater and silver nanoparticle treated wastewater.

Compared to traditionally treated wastewater (0.2423), a significant reduction in suspension was found in nanoparticles treated wastewater (0.1529). Table 2 compares the mean, standard deviation, and standard error of traditionally treated wastewater versus silver nanoparticle-treated wastewater.

The independent sample T test reveals no statistical difference between traditionally and nanoparticles-treated water, although there is a mean difference between water treated with nanoparticles and water treated with conventional procedures. Table 3 shows a significant value of P=0.04, when comparing the Independent sample T test values between groups. Figure 3 compares the mean bar graphs of conventionally treated and Ag nanoparticles-treated wastewater.

DISCUSSIONS

According to this study, the usage of nanoparticles for wastewater treatment results in a high reduction rate in the suspension present in wastewater when compared to traditionally treated wastewater.

Ganguly et al. demonstrated that heavy metals may be extracted from waste water and used as an adsorbent to remove various contaminants present in wastewater (Ganguly et al. 2021). According to Prasad et al. nanoparticles operate as nanosorbents for the removal of heavy metals and organic contaminants, and when doped with additional metals, their activity increases significantly (Prasad et al. 2019)**.** Beena Mathew et al. concluded that thephotocatalytic activity of silver nanoparticles improves the efficiency of dye removal in wastewater (Mathew 2018). Silver nanoparticles developed by Mohammed TahaMoustafa et al. exhibit strong antibacterial action against both gramme positive and gramme negative microorganisms (Moustafa 2017). According to Abhishek Kumar Bhardwaj et al. silver nanoparticles and their supporting materials can deactivate bacteria and viruses 99 % to 100% (Bhardwaj et al. 2021).

The restriction includes the following elements: Nanotechnology is now exceedingly expensive, and creating it might be as well, because of the high expense of getting precursors. Furthermore, nanotechnology based products are more expensive since they are more difficult to create. Nanotechnology has improved the quality of life, but it has also increased pollution, both in the water and the air. Nanotechnology pollution, on the other hand, is pollution at the nanoscale. Because of this form of pollution, biological life is at significant risk. The dangers of nanoparticles have received little attention. As a result, just a handful more are focused on water filtration. Studies related to characterization and the activity of silver should be performed in future. Opportunities are available for studying metal oxides for wastewater treatment, as well as antimicrobial and antibacterial properties.

CONCLUSION

As treated with nanoparticles (0.15), wastewater dispersion is significantly reduced when compared to conventionally treated wastewater (0.25), according to the study. The turbidity of the wastewater is reduced by silver oxide nanoparticles with a statistical significance of p= 0.04.

DECLARATION

Conflict of interest

No conflict of interest in the manuscript.

Authors contribution

Author SKY was involved in data collection, data analysis, and manuscript writing. Author SM was involved in the conceptualization, data validation, and critical review of the manuscript.

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TABLE AND FIGURES

Table 1. The physicochemical parameters (turbidity and colour) of conventionally treated wastewater and wastewater treated with silver nanoparticles.

GROUP	TURBIDITY	COLOUR
CONVENTIONALLY TREATED	0.24	Pale yellow
SILVER NANOPARTICLES TREATED	0.15	Colour less

Table 2. The mean, standard deviation and standard error comparison of conventionally treated wastewater and wastewater treated with silver nanoparticles. As treated with nanoparticles (0.15), wastewater dispersion is significantly reduced when compared to conventionally treated wastewater (0.25).

	GROUP	N	MEAN	Std.Deviation	Std.Error Mean
ABSORBANCE	**CONVENTIONALLY TREATED**	8	0.2423	0.00167	0.00059
	SILVER NANOPARTICLES TREATED	8	0.1529	0.00189	0.00067

Table 3. Comparison of the Independent sample T test values between the groups shows the significant value of P=0.04. The turbidity of the wastewater is reduced by silver oxide nanoparticles with a statistical significance of p= 0.04.

Independent Sample Test										
		Levene's Test for Equality of variances		**T-test for Equality of Means**						
		F	**Sig.**	**t**	**df**	**Sig(2. tailed)**	**Mean diff**	**Std. diff erro r**	**5%confidence interval of the difference**	
									Lower	**Upper**
Absorba nce	**Equal variances assumed**	0.431	0.04	100.42	14	.000	0.08938	.000 89	0.08747	0.09128
	Equal variances not assumed			100.42	13.79 8	.000	0.08938	.000 89	0.08746	0.09129

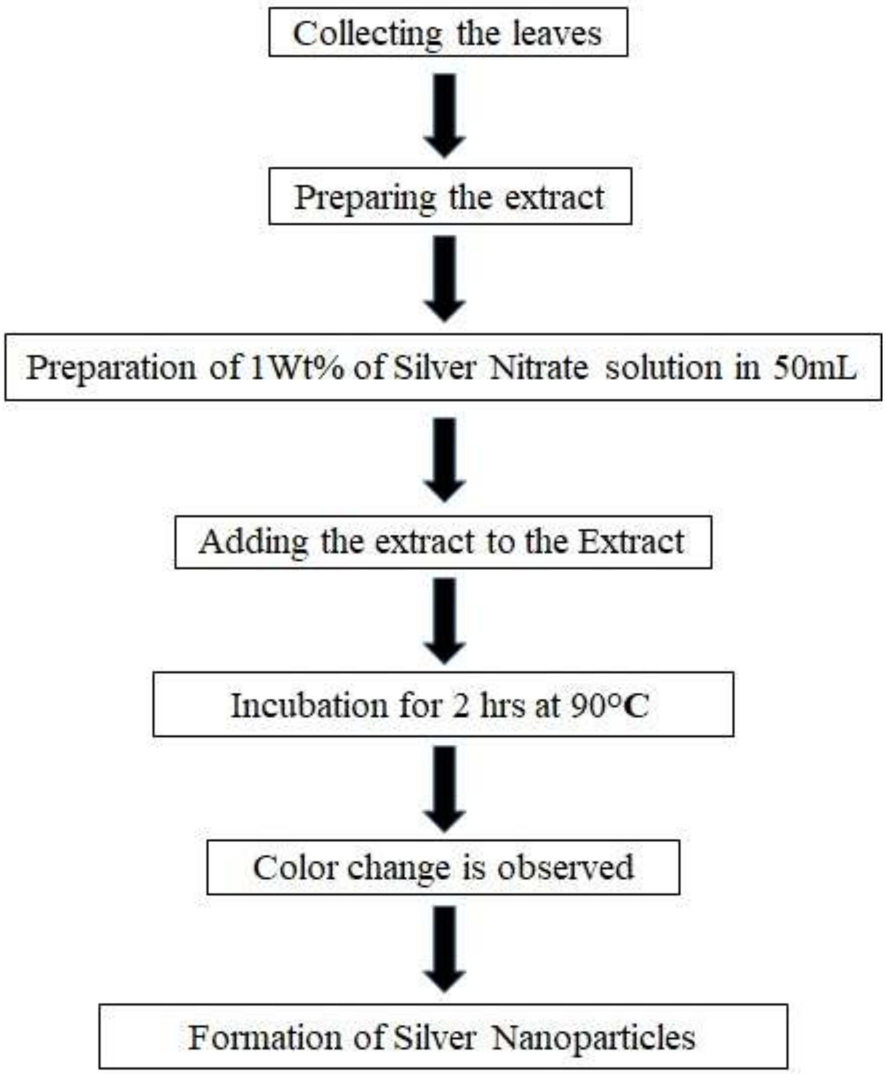

Fig. 1. Flowchart representation of the green synthesis of Silver Nanoparticles.

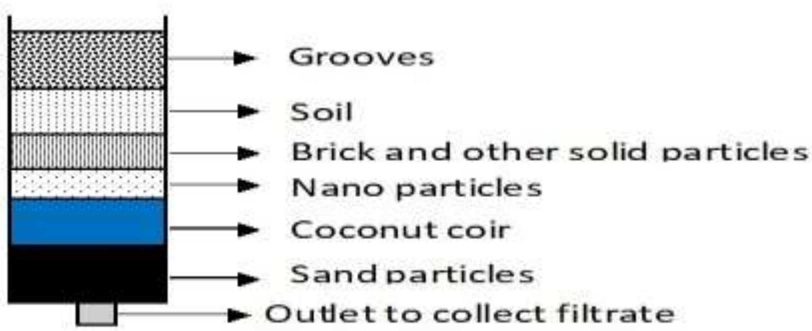

Fig. 2. Schematic representation of nanoparticles incorporated with a sand bed filter.

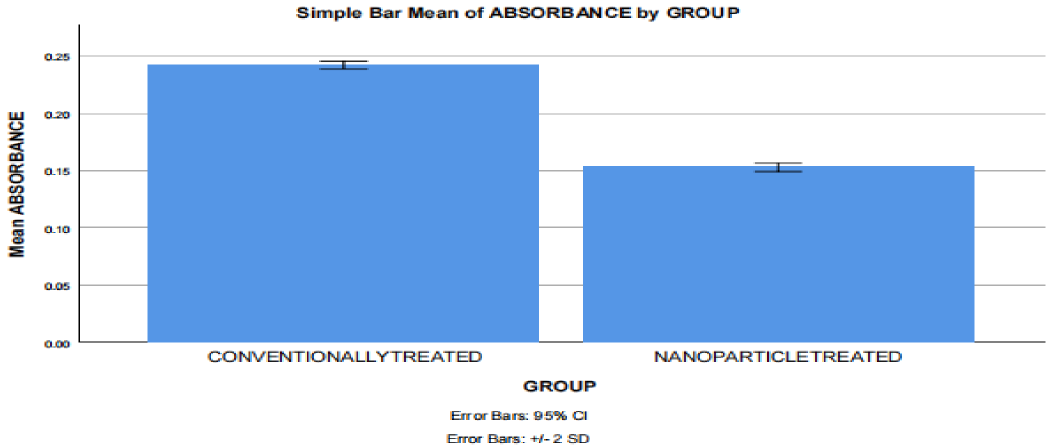

Fig. 3. Graphical illustration of the differences between the mean bar graphs of conventionally treated and Ag nanoparticles-treated wastewater. X axis: Conventionally Treated Groups; Y axis: Mean absorbance: SD+-2.