Manganese Nanoparticles Functionalized by Camelia Sinesis Leaf Extract for Time Dependent Optical Density Measurements Using Colorimetry and UV-Vis Spectroscopy for Potential Dye Degradation

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ABSTRACT

Aim: Performanceevaluation of manganese nanoparticles functionalized by *Camelia Sinesis* leaf extract for time dependent optical density (OD) measurements using colorimetry and UV-Vis spectroscopy as an Innovative Dye Degradation Analysis. **Materials andMethods:** Manganese nanoparticles were functionalized and synthesized using metal precursors and *Camelia Sinesis.* Each group had a sample size of 26. Total sample size was 52. For the groups pre test power was 80%, alpha is 0.05 and their enrolment ratio is 1. Group 1 consists of optical density readings from colorimetry and group 2 from UV-Vis spectroscopy OD readings. Eosin yellow dye was used to check the dye degradation ability of the nanoparticles. Independent sample T-test was performed for the two sets of OD data at 95% confidence interval by SPSS. **Results:** UV-Vis spectroscopy obtained significantly higher mean OD (0.0614) than colorimetry (0.0520) with p value as 0.024. **Conclusion:** Nanoparticles were biosynthesized and successfully degraded eosin yellow dye. UV-Vis spectroscopy performs better in analyzing dye degradation ability of manganese nanoparticles when compared to colorimetry.

Keywords: Manganese Nanoparticles, Colorimetry, UV-Vis Spectroscopy, Innovative Dye Degradation Analysis, *Camelia Sinesis*, Optical Density, Eosin Yellow, Bioremediation

INTRODUCTION

Nanoparticles are used for breaking toxic dyes and various other materials (Franca, Pinheiro, and Lourenço 2020). proposed that nanoparticles can reduce the efficiency of chromophore and decrease the absorbance of materials like xanthene. The toxicity of any dye can give a reduction of organic material to the environment (Naseem et al 2019) most of the protocols followed for synthesis of nanoparticles is green chemical reduction technique. This study can form the basis of bioremediation and environmental cleaning attributes

In the past five years the google scholar has 17300 articles, pubmed 107 articles and science direct 5379 articles on dye degradation. In textile industries they are used for wastewater treatment and reduce pollution by AZO dyes. Silver nanoparticles can decolourise the dyes by aerobic and anaerobic processes proposed that synthesis of nanoparticles from fruit extract produced rod shaped particles with a yield of 91.78%. In L-asparagine

functionalized chromophores produce silver nanoparticles in the range of 13.5-3.7 nm (Diallo et al. 2021) proposed that sonophotocatalytic reactions of titanium dioxide nanoparticles showed 83% degradation of dyes. When the same process was experimented with E.coli the efficiency was found to be 7.34%. Among the various literature reviewed the best one for the dye degradation application was by (Ahmed et al. 2020).Previously our team has a rich experience in working on various research projects across multiple disciplines(Paramasivam and Vijayashree Priyadhar...; Rajesh et al. 2020; Gurusami et al. 2020; Prevalence of tooth loss among chroni...)

Till this date there are no studies reported on OD based time dependent degradation studies by manganese nanoparticles. Functionalized by *Camelia Sinesis* against eosin yellow dye is also a novel attempt. Absorbance based study by UV-Vis spectroscopy and colorimetry for the OD based analysis has been done for the first time. The objective of the current research is to check performanceevaluation of manganese nanoparticles functionalized by *Camelia Sinesis* leaf extract for time dependent optical density (OD) measurements using colorimetry and UV-Vis spectroscopy as an Innovative Dye Degradation Analysis.

MATERIALS AND METHODS

This project was done in microbiology laboratory, Saveetha School of Engineering, Saveetha University. It doesn't require any ethical committee approval. 2 groups were used to analyze the degradation scenario of nanoparticles. Group 1 consists of colorimetry and group 2 consists of UV-Vis spectroscopy. Sample size of both the groups consist of 26 samples each and the total sample size was 52. Pre test power was kept at 80%, alpha=0.05 and enrolment ratio as 1 (Asgher, Shah, and Iqbal 2016).

Camelia Sinesis leaf was weighted (100 mg) and extracted in (1000 ml) distilled water by boiling. Manganese (II) acetate tetrahydrate (151 mg) was dissolved in (1000 ml) distilled water. Later these two solutions were mixed at a ratio of 15:85 as represented in Fig. 1.

Taking eosin yellow as (0.069 mg) in 100 ml of distilled water and diluting it gives a blank solution, zero was set for both the instruments. Group 1 used deep vision photo colorimetry as an instrument with EI model 312.

For testing Group 2, Deep vision UV-Vis spectrometer with EI model 3371 was used to calculate the OD. For both the groups OD was taken for every 15 minutes at 450 nm for 7 hours.

Statistical analysis

The software used in the current research was IBM-SPSS version 22. Independent sample T test at CI-95% was used to analyze the data. Independent variable was the wavelength of the source and the dependent variable was the OD. Analysis was done by OD from colorimetry and OD from UV-Vis spectroscopy (Asgher, Shah, and Iqbal 2016).

RESULTS

In Table 1, time dependent OD by *Camelia Sinesis* with manganese nanoparticles for colorimetry were seen to be ranging between 0.1 - 0.12. Similarly, for UV-Vis spectroscopy the absorbance ranges from 0.102 - 0.5. Colorimetry exhibited a maximum absorbance of 0.52

whereas UV-Vis spectroscopy showed a maximum value of 0.208.

In Table 2, group statistics for time dependent mean OD by *Camelia Sinesis* with manganese nanoparticles for UV-Vis spectroscopy are depicted. Mean OD was found to be 0.086 for colorimetry and 0.078 for UV-Vis spectroscopy. Standard deviation was around 0.107 for colorimetry and 0.089 for UV-Vis spectroscopy. Standard error was higher (0.021) for colorimetry than UV-Vis spectroscopy (0.017).

In Table 3, independent sample T-test for time dependent dye degradation based optical density by *Camelia Sinesis* with manganese nanoparticles using colorimetry and UV-Vis spectroscopy has been tabulated. Colorimetry obtains a statistically insignificant higher mean OD when compared to UV-Vis Spectroscopy (p=0.178).

Figure 1 illustrates the synthesis and analysis protocol opted for studying dye degradation ability of *Camelia Sinesis* functionalized manganese nanoparticles. In Fig. 2. Illustrates scanning electron microscopy image of functionalized nanoparticles. The particles synthesized were well under the nanometer range with an approximate size of 250 nm. Fig. 3. is a bar chart comparison for time dependent OD between UV-Vis spectroscopy and colorimetry. UV-Vis spectroscopy appears to give better mean OD than colorimetry for bioremediation.

DISCUSSION

Mean OD of time dependent OD from UV-Vis spectroscopy (0.086) was found to be better than the mean OD of colorimetry (0.078) and it was statistically insignificant (p value as 0.0241).

In phenolic compound based functionalization, the antioxidant stabilizes the synthesis of nanoparticles by influencing experiment temperature, pH, time and shape. The yield becomes 2 to 10 folds based on the phenolic material used for functionalizing the nanoparticle (Flores-González et al. 2018). (Loo et al. 2012) proposed that the biological materials are synthesized by nanoparticles from any leaves and used against dyes for reducing their toxicity. Silver nanoparticles have already been used as cosmetic and medicinal nanomaterial. Higher the quantity of the extract used better the efficiency of the nanoparticle against dyes and pathogens. This can go up to 100% efficient activity (Al 2021). (Gol et al 2020) proposes that antibacterial activity of glaze and ceramics with biogenic material are also the result of many functionalized bioactive agents in nanomaterials.

Major limitation of the current study is that the mechanism and mode of action of these nanoparticles on unknown samples like dyes cannot be quantified. Future studies can be towards addressing this limitation and optimizing formulas to calibrate concentration for dye degradation based on the current research.

CONCLUSION

Nanoparticles were biosynthesized and successfully degraded eosin yellow dye. Mean OD of time dependent OD from UV-Vis spectroscopy (0.086) was found to be better than the mean OD of colorimetry (0.078) and it was statistically insignificant. UV-Vis spectroscopy is superior in analyzing dye degradation ability of manganese nanoparticles when compared to colorimetry.

DECLARATIONS

Conflict of interests

No conflict of interest in this manuscript.

Authors Contributions

Author SV was involved in data collection, data analysis and manuscript writing, Author ND was involved in conceptualization, data validation and critical review of manuscript.

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REFERENCES

1. Ahmed, Adeel, Muhammad Usman, Bing Yu, Xin Ding, Qiaohong Peng, Youqing Shen, and Hailin Cong. 2020. "Efficient Photocatalytic Degradation of Toxic Alizarin Yellow R Dye from Industrial Wastewater Using Biosynthesized Fe Nanoparticle and Study of Factors Affecting the Degradation Rate." *Journal of Photochemistry and Photobiology. B, Biology* 202 (January): 111682
2. Basnet et al, D., ed. 2021. "Biogenic Synthesis of Ag-ZnO Nanocomposites: Characterization, Mechanisms, and Applications." In *Zinc-Based Nanostructures for Environmental and Agricultural Applications*, 13–36. Elsevier.
3. Diallo, A., N. Tandjigora, S. Ndiaye, Tariq Jan, I. Ahmad, and M. Maaza. 2021. "Green Synthesis of Single Phase Hausmannite Mn3O4 Nanoparticles via Aspalathus Linearis Natural Extract." *SN Applied Sciences*. https://doi.org/10.1007/s42452-021-04550-3.
4. Flores-González, M., M. Talavera-Rojas, E. Soriano-Vargas, and V. Rodríguez-González. 2018. "Practical Mediated-Assembly Synthesis of Silver Nanowires Using Commercial Camellia Sinensis Extracts and Their Antibacterial Properties." *New Journal of Chemistry = Nouveau Journal de Chimie* 42 (3): 2133–39.
5. Franca, Rita Dias Guardão, Helena Maria Pinheiro, and Nídia Dana Lourenço. 2020. "Recent Developments in Textile Wastewater Biotreatment: Dye Metabolite Fate, Aerobic Granular Sludge Systems and Engineered Nanoparticles." *Reviews in Environmental Science and Biotechnology* 19 (1): 149–90.
6. Garg, Nidhi, Santanu Bera, Lori Rastogi, Anand Ballal, and M. V. Balaramakrishna. 2020. "Synthesis and Characterization of L-Asparagine Stabilised Gold Nanoparticles: Catalyst for Degradation of Organic Dyes." *Spectrochimica Acta. Part A, Molecular and Biomolecular Spectroscopy* 232 (May): 118126.
7. Gol et al, F. 2020. "Green Synthesis and Characterization of Camellia Sinensis Mediated Silver Nanoparticles for Antibacterial Ceramic

Applications." *Materials Chemistry and Physics* 250 (August): 123037.

8. Loo, Yuet Ying, Buong Woei Chieng, Mitsuaki Nishibuchi, and Son Radu. 2012. "Synthesis of Silver Nanoparticles by Using Tea Leaf Extract from Camellia Sinensis." *International Journal of Nanomedicine* 7 (August): 4263–67.
9. Maurício, Rita, Joana Jorge, Rita Dias, João P. Noronha, Leonor Amaral, Michiel A. Daam, António P. Mano, and Mário S. Diniz. 2020. "The Use of Peracetic Acid for Estrogen Removal from Urban Wastewaters: E2 as a Case Study." *Environmental Monitoring and Assessment* 192 (2): 114.
10. Naseem et al, K. 2019. "Catalytic Reduction of Toxic Dyes in the Presence of Silver Nanoparticles Impregnated Core-Shell Composite Microgels." *Journal of Cleaner Production* 211 (February): 855–64.

TABLES AND FIGURES

Table 1. Time Dependent Dye Degradation Based Optical Density By *Camelia Sinesis* with Manganese Nanoparticles using Colorimetry and UV-Vis Spectroscopy. Colorimetry obtains a maximum absorbance of 0.5 whereas UV-Vis obtains a maximum absorbance of 0.208

Time (minutes)	UV-Vis Spectroscopy (nm)	Colorimetry (nm)
0	0.179	0.5
15	0.171	0.03
30	0.52	0.06
45	0.204	0.05
60	0.102	0.04
75	0.056	0.09
90	0.047	0.08
105	0.032	0.07
120	0.021	0.07
135	0.014	0.07
150	0.208	0.07
165	0.128	0.12
180	0.042	0.12
195	0.004	0.08
210	0.013	0.07
225	0.071	0.07
240	0.062	0.08
255	0.057	0.08

270	0.047	0.06
285	0.032	0.06
300	0.026	0.05
315	0.021	0.04
330	0.017	0.03
345	0.011	0.03
360	0.09	0.02
375	0.06	0.01

Table 2. Group statistics forTime Dependent Dye Degradation Based Optical Density By *Camelia Sinesis* with Manganese Nanoparticles using Colorimetry and UV-Vis Spectroscopy. Colorimetry obtains a higher mean OD when compared to UV-Vis Spectroscopy

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
OD	**Colorimetry**	26	0.0788	0.08999	0.01765
	UV-Vis Spectroscopy	26	0.0860	0.10748	0.02108

Table 3. Independent sample T test for Time Dependent Dye Degradation Based Optical Density By *Camelia Sinesis* with Manganese Nanoparticles using Colorimetry and UV-Vis Spectroscopy. Colorimetry obtains a statistically insignificant higher mean OD when compared to UV-Vis Spectroscopy.

Independent Samples Test								
	Levene's Test for Equality of Variances		**t-test for Equality of Means**					
	F	**Sig.**	**t**	**df**	**Sig. (2-tai**	**Mean Differen**	**Std. Error Differe nce**	**95% Confidence Interval of the Difference**

						led)	ce		Low er	Up per
O D	**Equal variances assumed**	1. 86	0.1 78	- .25 9	5 0	0.7	- .007	0.0274 9	- .062	.04 8
	Equal variances not assumed			- .25 9	4 8	0.7	- .007	0.0274 9	- .062	.04 8

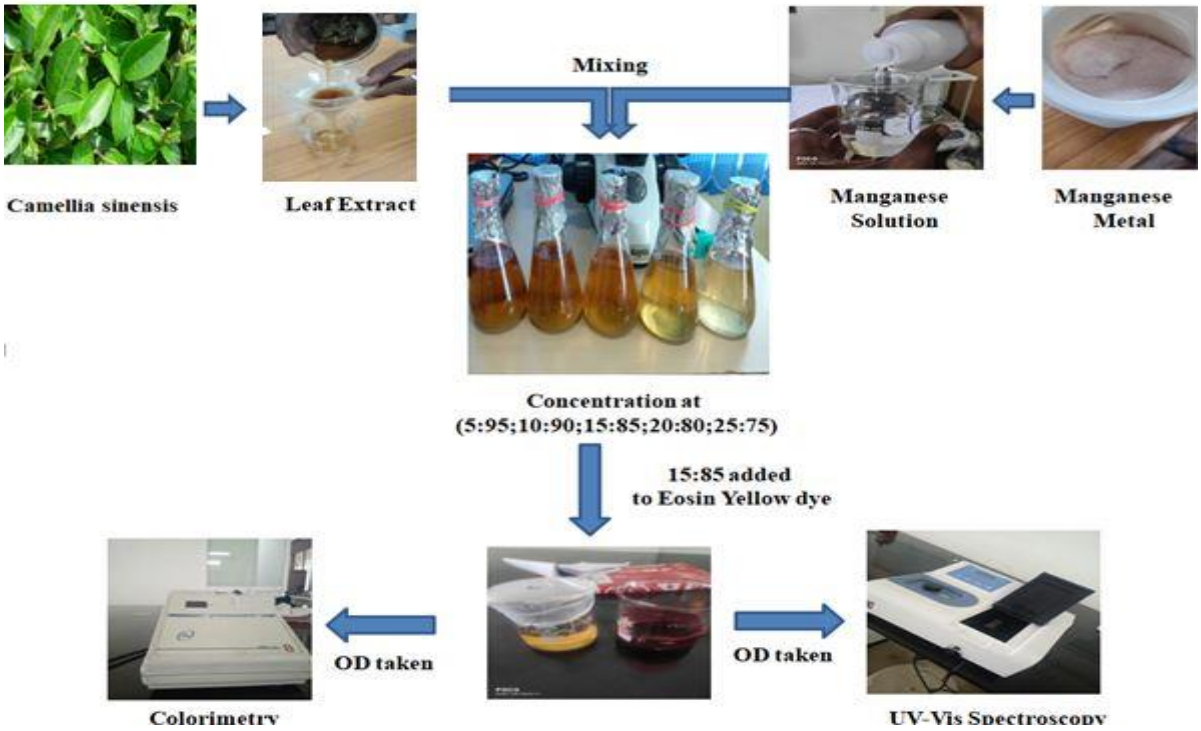

Fig. 1. Schematic representation of manganese nanoparticle synthesis from *Camelia Sinesis* and testing using UV-Vis spectroscopy and colorimetry

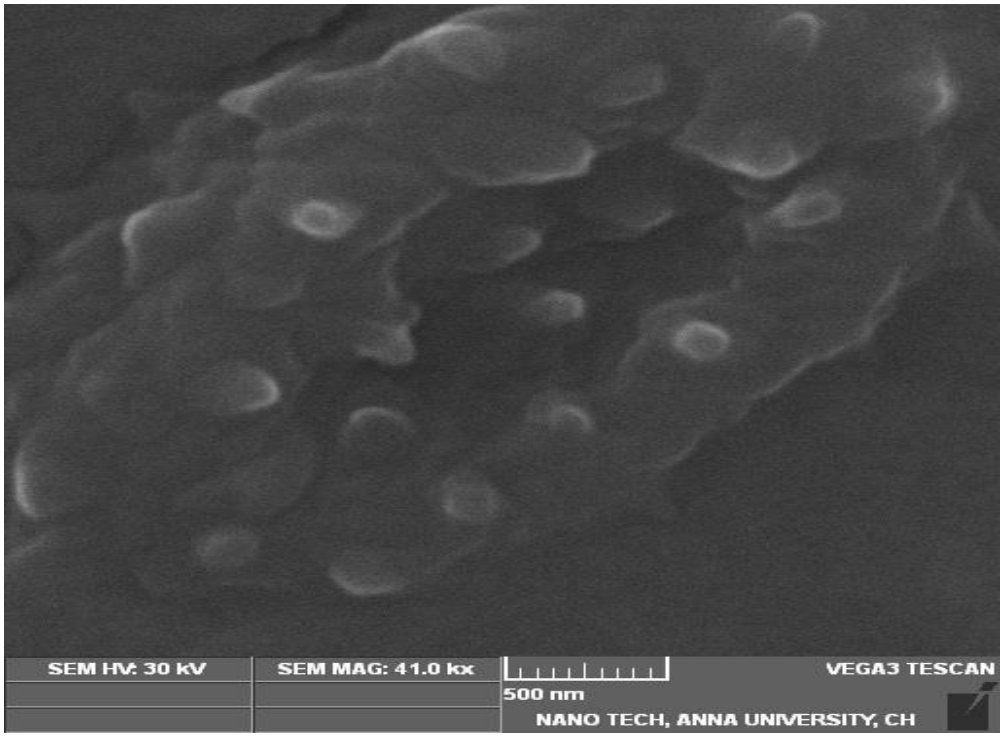

Fig. 2. SEM image of synthesized manganese nanoparticles from *Camelia Sinesis.* Size of the particles were below 500 nm in dimension.

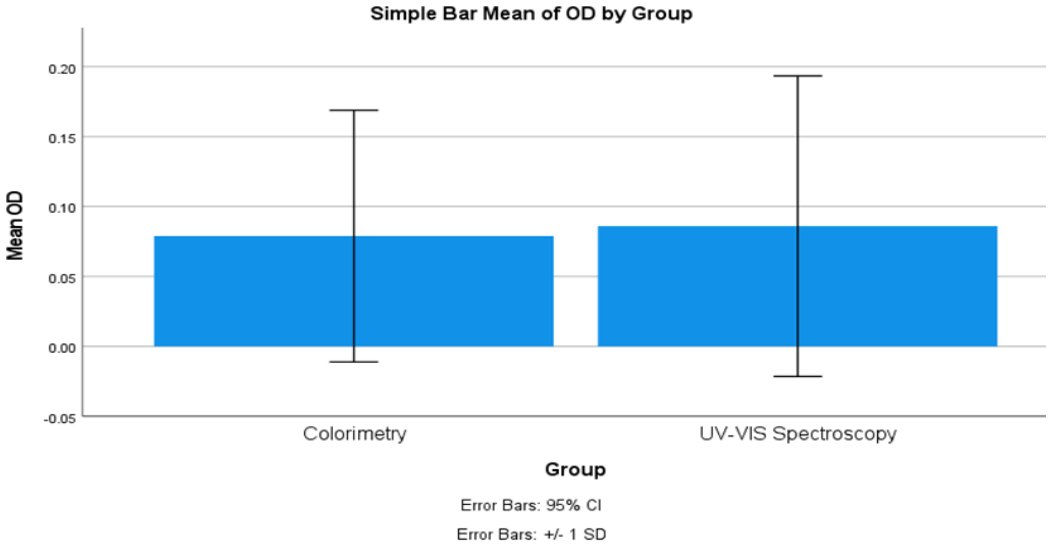

Fig. 3. Bar chart comparison for Time Dependent Dye Degradation Based Optical Density By *Camelia inesis* with Manganese Nanoparticles using Colorimetry and UV-Vis Spectroscopy. UV-Vis Spectroscopy. Colorimetry Obtains a statistically insignificant higher mean OD when compared to UV-Vis Spectroscopy. X axis: Colorimetry vs UV-Vis Spectroscopy; Y axis: Mean OD. SD+/- 1