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Hydrilla Sp. - Freshwater Thymes, As Novel Nano Factories for Metal Nanoparticles

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ABSTRACT

Plant-mediated synthesis of metal nanoparticles is an emerging research area that continuously exploits plants from various habitats. Terrestrial plants are well known for their property of synthesizing stable nanoparticles. Different nanoparticles synthesized by plants include silver, gold, copper, zinc, etc., including their oxides. In the present research, freshwater thyme, i.e., zinc oxide nanoparticles (ZnONPs), Copper oxide (CuO) NPs, and silver (Ag) NPs were synthesized using their cell-free extract of Hydrilla sp. All the NPs were further detected and characterized by spectrophotometry, dynamic light scattering, XRD FESEM, etc. Results indicated synthesis of ZnO, CuO, and Ag NPs with average size of 312nm, 252nm, and 91.6nm and average zeta potential of -13mV, 11.1mV, and -17.4mV, respectively. Various secondary metabolites from the Hydrilla extract stabilized the NPs as indicated in the FTIR spectrum. The crystalline nature of NPs was determined by the X-ray diffraction method. FESEM elucidated the morphology and size of the nanoparticles. All purified and dry-form nanoparticles were stored and utilized for further evaluation. It can be concluded that aquatic Hydrilla sp. is capable of NP synthesis. Additional studies confirming their bioactivity in vivo and in vitro are needed to ensure their use for human use and other applications.

Keywords: Hydrilla spp., metal nanoparticles, stability, FESEM, X-ray diffraction

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I. INTRODUCTION

Nanotechnology is unceasingly evolving towards the progress of new and novel techniques for the synthesis of various nanoparticles. Nanotechnology deals with the easy nanomaterial synthesis, cost reduction, communicating anticipated biocatalytic activity, size and shape, optical properties, etc., [1]. Phytomediated synthesis of nanoparticles involves the plant material based fabrication which is a function of various secondary metabolites from plant extracts [2]. Even though there are various limitations, new entities are being explored for the development of desired nanomaterials with required characteristics [3]. Hydrilla spp. are fresh water thymes and are good source of secondary metabolites, which are capable of synthesizing various nanoparticles from wide range of metal precursors.

The silver nanoparticles (AgNPs) were reported using the fresh water Hydrilla or water thyme i.e. *Hydrilla verticilliata* extract [4], making it as a suitable candidate for the synthesis of copper oxide and Zinc oxide NPs as well. The aqueous crude extract of Hydrilla was used, which formed the dark brown colored precipitate of AgNPs [5]. The synthesized NPs were further characterized using various methods for the determination of physical and biochemical properties.

II. METHODS AND MATERIAL

Hydrilla plant samples were collected from the local water bodies near Amravati. Plant material were dried in oven for 2-3 days at 55-60 °C followed by grinding into a coarse powder (Figure 1a). 1g of Hydrilla powder was mixed in water and allowed to boil for 20 min with continuous stirring at 300 rpm. Mixture was cooled to room temperature, filtered through double muslin cloth and filtrate was collected (Figure 1b). Filtrate was further used for nanoparticle synthesis. For CuONPs synthesis 1:20 diluted hydrilla extract was mixed with 50 mM copper sulphate pentahydrate solution and boiled in an aluminium vessel till the solution becomes clear and the brown colored precipitate of CuONPs is formed at the bottom of the vessel [4, 6]. For the synthesis of AgNPs, 1 mM silver nitrate (AgNO₃) solution was mixed with the diluted hydrilla extract. Reaction mixture was exposed to sunlight for 20-3- sec until the solution turns brick red [7]. Both the reaction mixtures were individually centrifuged at 20000 rpm for 20 min at 4 °C. Pellet was collected, air dried and air tight bottle for stored in an further characterization.

Synthesized NPs were characterized by UV-visible spectrophotometric analysis to determine absorbance maximum. Further, size and zeta potential was determined by NTA (Nanoparticle Tracking and Analysis) and zetasizer. FTIR (Fourier Transform Infrared) spectrometry and XRD (X-ray diffractometry) depicted the presence of various functional groups on the surface and structure of crystal lattice respectively. FESEM was performed to confirm the structure of ZnONPs crystals [6, 7].

III.RESULTS AND DISCUSSION

CuONPs were synthesized from hydrilla extract resulted in the color change from blue to dark brown precipitate (Figure 1d) with the absorption peak at 554 nm (Figure 1c). The results correlates with the previous reports by Shende et al. [6]. Fig. 2a and 2b, represents NTA analysis and particle size distribution for CuONPs. Average size was found to be 94 nm (diameter), with standard deviation 70.7 nm with concentration of CuONPs was found to be 1 X 10⁹ particles/ml. The average zeta potential of 11.1 mV with the standard deviation of 5.49 mV (Figure 2c).



Fig. 1 a. Hydrilla powder; b. Hydrilla extract in water; c. UV-visible spectrum of CuONPs and d. Dark brown precipitate of CuONPs



Fig. 2 Characterization of CuONPs, a. NTA analysis; b. Particle distribution; c. Zeta potential analysis; d. FTIR analysis; e. XRD analysis and f. FESEM image

This indicated the synthesis of stable CuONPs using Hydrilla extract. The zeta potential value was in the range [8]. FTIR spectrum presented the stabilization of various functional groups in CuONPs (Figure 2d), which are assigned to respective wavenumber as shown in Table 1. X-ray diffraction pattern (Figure 2e) elucidated FCC (Face centred cubic) crystals of CuNPs which was confirmed on the basis of JCPDS file No. 48-1548. FESEM images (Figure 2f) confirmed the formation of irregularly spherical shaped CuONPs [6, 8].

AgNPs showed absorption peak at 450 nm (Figure 3a) and turned colorless silver nitrate (Figure 3b) into brick red precipitate (Figure 3c). This confirmed the formation of Hydrilla mediated AgNPs [7]. Figure 4a, shows the average size as 74 nm (diameter), with standard deviation 13.2 nm. Particle distribution (Figure 4b) was higher near to 100 nm scale and concentration was 2.1 X 10⁹ particles/ml. Zeta potential (Figure 4c), average value was -17.4 mV with the standard deviation of 9.46 mV.



Fig. 3 a. UV-visible spectrum of AgNPs; b. Silver nitrate solution and c. Brick red precipitate of AgNPs



Fig. 4 Characterization of AgNPs, a. NTA analysis; b. Particle distribution; c. Zeta potential analysis; d. FTIR analysis; e. XRD analysis and f. FESEM image

This indicated the synthesis of stable AgNPs using Hydrilla extract. The zeta potential value was in the range. Stabilization of AgNPs by various secondary metabolites from extract was confirmed by the emergence of peculiar wavenumber peaks (Table 1) in the spectrum (Figure 4d).

The miller indices in XRD pattern (Figure 4e) reflected the FCC (Face Centered Cubic) structure and the crystalline nature of AgNPs. When compared with the standard file No. 04–0783 for silver from CDS (Centre for Diffraction Studies) database. FESEM imaging (Figure 4f) predicted and confirmed the irregular shaped AgNPs [4, 7]. The study include the synthesis of ZnO NPs, the characterization data of synthesized ZnO was reported [9].

The *Hydrilla* sp. mediated synthesis of Ag, CuO, and ZnO NPs can be used for the formulation of fish feed, since the cell free extract contains fairly high amount of protein, vitamin E, vitamin C and mineral elements required for normal growth and development of fish.

Spectru	Observ	ved		Functi	Compo
m	Waver	number	(cm-1)	onal	und
range	Hydr	CuO	AgN	group	present
(cm-1)	illa	NPs	Ps	assign	
	extra			ed	
	ct				
3570-	3323	3294	3441	-OH	Carboxy
3200					lic acid,

TABLE 1. FTIR analysis of CuONPs and AgNPs

					alcohol,
					water,
					phenol
2935-	2930	2370	2901	C-H	Alkanes
2915 /	,		,	strechi	/
2100-	2331		2380	ng	Alkynes
2300					
1650-	1644	1663	1654	=N-H	Seconda
1550				bend	ry
					amine
1560-	1545	1545	1477	-N=O	Aliphati
1540/	,	,	,	stretch	c nitro
1380-	1418	1467	1369	/	compou
1350		,		C-H	nd /
		1408		bendi	Alkanes
				ng	
1350-	1251		1251	-P=O	Organic
1250				stretch	phospha
				/	te/
				Hexan	Cyclohe
				e ring	xane
					ring
					vibratio
					ns
1050-	-	1084	1094	C-O	Alcohol
990				group/	, acid or
				P-O-C	esters/
				stretch	Aliphati
					С
					organic
					phospha
					te
995-	996,	-	947,	C-H	Vinyl
850	868		838	plane	compou
				bend/	nds/
				P-O-C	Aromati
				stretch	с
					phospha
					te

IV.CONCLUSION

It is thus concluded from the present study that, the aqueous extract of fresh water thyme i.e. hydrilla sp. are capable of converting a metal ion precursor into nanoparticles which are very well stabilized by the secondary metabolites present in the extract. Characterization results depicted the formation of CuONPs and AgNPs with the average size in nanometer range. Thus, fresh water hydrilla can also be used for the synthesis of sable metal nanoparticles by simple, green method.

V. REFERENCES

- Sharma D, Kanchi S, Bisetty K. 2015. Arabian
 Journal of Chemistry. doi: 10.1016/j.arabjc.2015.11.002
- [2]. Singh H, Desimone MF, Pandya S, Jasani S, George N, Adnan M, Aldarhami A, Bazaid AS, Alderhami SA. 2023. International Journal of Nanomedicine. 18:4727-4750. doi: 10.2147/IJN.S419369. PMID: 37621852; PMCID: PMC10444627.
- [3]. Desai N. 2012. AAPS Journal. 14(2):282-95. doi: 10.1208/s12248-012-9339-4. Epub 2012 Mar 10. PMID: 22407288; PMCID: PMC3326161.
- [4]. Sable N, Gaikwad S, Bonde S, Gade A, Rai M.
 Nusantara Bioscience. 4: 45-49. http://dx.doi.org/10.13057/nusbiosci/n040201
- [5]. Marslin G, Siram K, Maqbool Q, Selvakesavan RK, Kruszka D, Kachlicki P, Franklin G. 2019. Materials (Basel). 11(6):940. doi: 10.3390/ma11060940. Erratum in: Materials (Basel).
- [6]. Shende S, Ingle AP, Gade A, Rai M. 2015.
 World Journal of Microbiology and Biotechnology. 31(6), 865-73. doi: 10.1007/s11274-015-1840-3. Epub 2015 Mar 12. PMID: 25761857.
- [7]. Ingle PU, Biswas JK, Mondal M, Rai MK, Kumar PS and Gade AK. 2021. Chemosphere. 291(2),

132676.

https://doi.org/10.1016/j.chemosphere.2021.132 676

- [8]. Sumitha S, Vidhya RP, Suba Lakshmi M, Shanmugha Prasad K. 2016. International Journal of Chemical Sciences. 14, 435–440.
- [9]. Dhage DM, Ingle PU, Gade AK, Akhare YD.
 2024. In proceeding: National Conference on "Recent Advancements in Science & Technology." Vol-III (Botany, Zoology and Cosmetic Technology), Amravati, India. ISBN : 978-81-19931-25-5. pp. 30-33