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SYNTHESIS OF GOLD NANOPARTICLES BY THE FLOWER EXTRACTS OF *TABEBUIA ARGENTIEA* AND THEIR ANTIOXIDANT ACTIVITY

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ABSTRACT

Biosynthesis of nanoparticles by plant extracts is currently under exploitation. Plant extracts are very cost effective and eco-friendly and thus can be an economic and efficient alternative for the large-scale synthesis of nanoparticles. The current study revealed that the aqueous flower extracts of Tabebuia argentiea were used and compared for their extracellular synthesis of gold nano-particles. Stable gold nanaoparticles were formed by treating aqueous solution of $AuCl_3$ with the plant flower extracts. The formed gold nano-particles were characterized by scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). The flower extracts act as reducing as well as encapsulating agent for the gold nanoparticles. The SEM revealed the formation of spherical gold nanoparticles with the average particles size of 56 nm. Antioxidant activity of gold nanoparticles was carried out and found to be more significant antioxidants.

KEY WORDS

Gold nanoparticles, Chloroauric acid, SEM, EDX, Antioxidant activity

INTRODUCTION

Nanotechnology is gaining tremendous impacts in the present century due to its capability of modulating metals into their nano size. Plant/Flower extracts are very cost effective and eco-friendly and thus can be an economic and efficient alternative for the large-scale synthesis of nanoparticles [1]. With the advancement of technologies and superior scientific understanding paved a way for research and development in the plant biology towards intersection of nanotechnology. Nanoparticles are of numerous scientific interests as they are effectively a bridge between bulk materials and atomic or molecular structures. It is cost effective and less tedious purification steps [2]. Biological mediated synthesized gold nanoparticles (GNPs) are have extensive applications in the biosensing, catalytic, drug delivery, therapeutic and diagnostic fields [3-7].

Tabebuia argentea (Bignoniacae) is a large and yellow flowering tree and it is contained with phenolic and poliophenolic compounds. Phenolic compounds can be used as cytotoxic, antimicrobial and antifungal agents [8]. To the best of our knowledge, GNPs synthesis by *Tabubea argentea* is reported for the first time by reducing a solution of gold chloride. In our study we report a yellow method for the synthesis of gold nanoparticles at room temperature by using flower extracts of *Tabubea argentea* as readucing / stabilizing

agents and the probable mechanism for the formation of nanoparticles.

MATERIALS AND METHODS

Preparation of *Tabebuiea argentiea* flower extracts.

Gold chloride solution (Thomas Baker, Pvt, Ltd., Mumbai, India) was used without purification further. Fresh flowers were collected from Shridevi Institute of engineering and technology and authenticated by the department of Botany, Tumkur University, Tumakuru, Karnataka, India. The collected flowers were washed in distilled water and 20 g of flowers were boiled in 100 ml of double distilled water in order to obtain a concentration of 10 mg/mL. The filtered extract was centrifuged thrice at 10,000 rpm for 10 min at 4 °C (REMI cooling centrifuge) to eliminate cell debris. The obtained supernatant was then filtered through Whatmann filter paper No1 and used for the synthesis gold nanoparticles. Gold chloride solution and flower extract were diluted using double-distilled water.

Flower extract – mediated synthesis of GNPs

GNPs were synthesized by mixing 10 mL of flower extracts with 100 mL of gold chloride solution and stirred for 10 min at room temperature. Reduction happened quickly as indicated by reddish brown color after 30 min, indicating the genesis of GNPs. The GNPs achieved were purified by REMI cooling centrifuge at 10,000 rpm for 30 min.

SEM and EDX of GNPs

The morphology of the GNPs was determined by scanning electron microscope (SEM) (Ultra 55 Model-II, Carl Zeiss SEM machine). The sample was scattered on a slide and covered with platinum in an auto fine coater. The SEM was also equipped with energy-dispersive X-ray analysis (EDX) detector for complete elemental analysis.

XRD analysis

A few grams of dried GNPs were coated on an XRD grid and the spectra were recorded by employing a Rigaku diffractometer at a voltage of 40 keV and a current of 30 mA with Cu-Kα radiation with a wavelength of 1.5418 Å.

***In vitro* antioxidant activity**

Reducing power assay

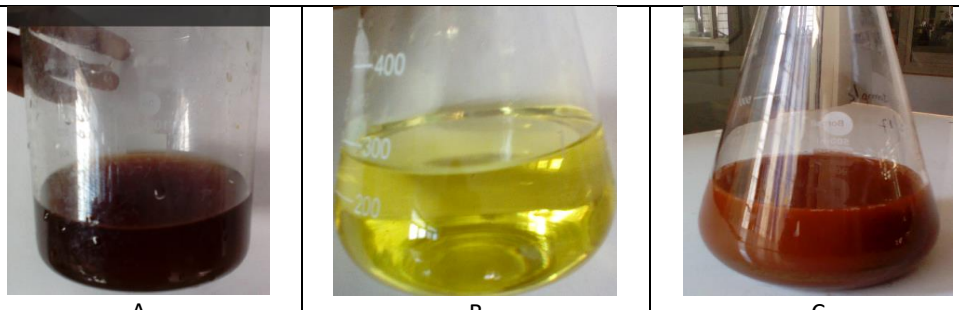
The reducing capacity of GNPs was determined as described by Oyaizu *et al*. [9] with some experimental modifications. The reaction mixture consists of 1ml distilled water with different concentrations (100 - 500µg/mL) of GNPs, 1.0ml of 0.2M sodium phosphate buffer (pH 6.6) and 1.0ml of 1% potassium ferricyanide (w/v). The mixture was incubated at 50˚C for 20 min. and allowed for cooling at room temperature. 1.0ml of 10% trichloroacetic acid (w/v) was added and the mixture was centrifuged at 3000rpm for 10min. The upper layer (1.0 ml) was mixed with 1.0ml of distilled water and 1.0ml of 0.1% ferric chloride, and the absorbance was measured at 700nm. Ascorbic acid was used as a standard. Higher absorbance indicates higher reducing power of the sample. The relative percentage reducing power of the sample was calculated by using the formula [10].

(A-Amin) / (Amax - Amin) × 100

Here, Amax = absorbance of maximum absorbance tested, Amin = absorbance of minimum absorbance tested and A = absorbance of sample. Assays were carried out in triplicate.

RESULTS AND DISCUSSION

As the pale brown color aqueous extracts of *Tabubea argentea* flowers mixed with gold chloride solution, it was turned into reddish brown color within 3o min and indicating the formation of GNPs. The change in color confirmed that phytochemicals present in the flower extracts diminish the gold metal ions to GNPs (Fig 1).



A B C

Fig 1. Synthesis of gold nanoparticles. A. flower extracts, B. gold chloride solution and C. formation of silver nanoparticles.

SEM and EDX

The scanning electron microscopy (SEM) image further ascertains that the Gold nanoparticles are predominantly spherical in morphology with their sizes ranging from 56 to 75 nm and have an average size of about 69 nm (Fig 2). Energy-dispersive X-ray spectroscopy (EDX) illustrated the chemical nature of synthesized gold nanoparticles. The peak was obtained at the energy of 3 keV, for gold, and also some of the weak peaks for C, O, Cl, Au, Mg, Si,T,S and K were found. The emission energy at 3 keV indicates the reduction of gold ions to element of gold. The quantitative analysis using EDX showed high gold content of followed by carbon, oxygen, and chlorine (Fig 3).

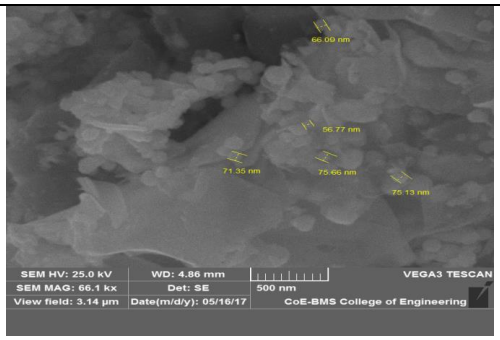


Fig 2. SEM images of GNPs

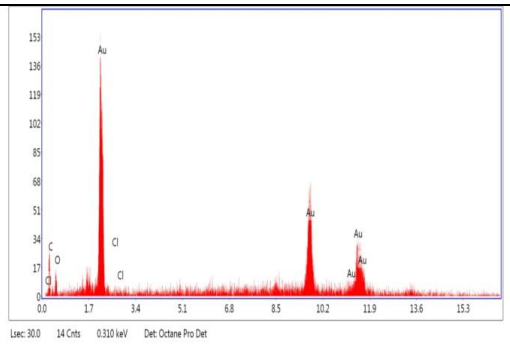


Fig 3. EDX of GNPs

XRD analysis

XRD pattern of synthesized GNPs is represented in figure 4. The scanning range (2θ) was fixed between 20° and 80° and diffraction peaks were observed at 2θ values of 38.17°, 44.37°, 364.56°, and 77.54°, which corresponded to the (111), (200), (220), and (311) reflections of face-centered gold [11].

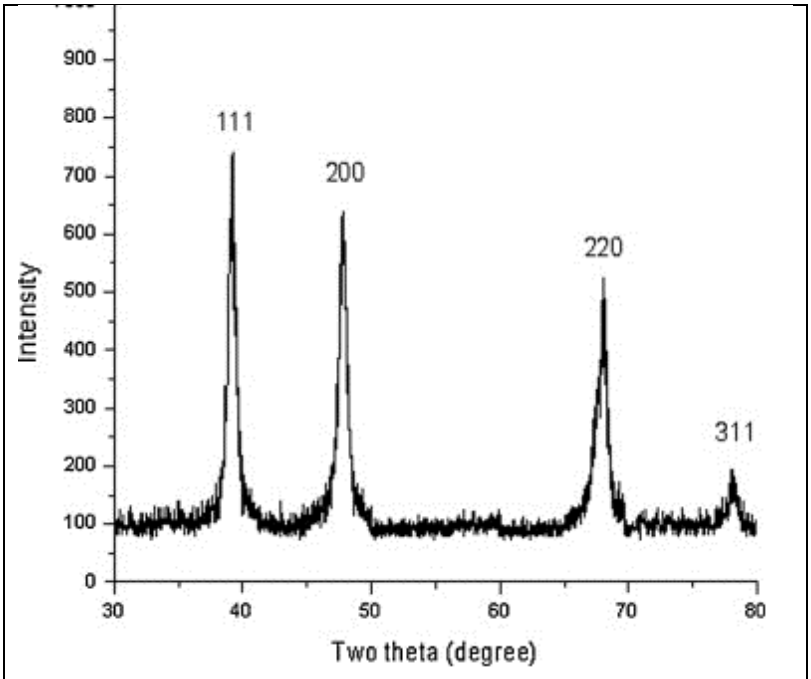


FIG 4. XRD Patterns of GNPs synthesized *Tabubea argentea* flower extracts.

Antioxidant activity

The synthesized silver nanoparticles exhibited a maximum reducing power of 71.46% at 500 µg/ml concentration whereas for ascorbic acid (standard) was found to be 100% (table 1). Naveena and Prakash reported the antioxidant activities of GNPs [12].

Table 1. Reducing power assay of silver nanoparticles and ascorbic acid.

Concentration of synthesized silver nanoparticles and ascorbic acid	(%) scavenging	
	synthesized silver nanoparticles	Ascorbic acid
100	26.17±0.071[b]	27 ±0.063[e]
200	31.51±0.067[c]	32.13 ±0.064[d]
300	37.59±0.051[e]	38.95 ±0.065[c]
400	46.89±0.062[d]	69.35 ±0.071[a]
500	71.46±0.073[a]	100 ±0.069[b]

Values are mean ± standard deviation of triplicate analyses. Results of each concentration of silver nanoparticles were analyzed separately. Different letters in the same row are significantly different ($p<0.05$) as measured by Tukey's B test.

CONCLUSIONS

The medicinally significant flower extracts of *Tabubea aurgentea* was found to act in synthesis of gold nanoparticles as reducing and capping agent. The synthesized gold nanoparticles had spherical shape with the average size of 69 nm. The SEM results indicated that the produced gold nanoparticles were stable and elemental composition was confirmed by XRD and EDX. Our study also suggested that the gold nanoparticles synthesized by biological method had notable antioxidant activity.

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