



Sustainable Synthesis of Gold Nanoparticles and its Antidiabetic Activity of *Anacardium occidentale* Root Extract

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ABSTRACT

Nanoparticles are being considered as elemental building blocks of nanotechnology. The green synthesis of gold nanoparticles using the aqueous root extract of *Anacardium occidentale* by bio-reduction of Auric chloride solution was investigated in the current study. The synthesized gold nanoparticles were characterized using UV-Visible spectroscopy, Fourier Transform Infrared spectroscopy and Scanning Electron Microscope. In UV, the absorbance peak was observed at 531 nm, FTIR spectrum shows the wavelength range from 464.27 cm⁻¹ to 3364.51 cm⁻¹ and SEM image showed that gold nanoparticles are in spherical shape. Then, the biosynthesized gold nanoparticles examined for the antidiabetic and antioxidant activities and the result outcome with better percentage of potential.

Keywords: Green synthesis, Gold nanoparticle, *Anacardium occidentale*, Auric chloride, UV, FTIR, SEM, Antidiabetic, Antioxidant.

INTRODUCTION

Diabetes is a metabolic disease which causes the blood sugar level to raise thus by complicating the daily metabolism of life. Phytoconstituents plays a good role in controlling the side effects but the reason to be concerned about it is the time taken and its slow action. So to deal with it, we are conjoining the nanoparticles with these substances so as to be eco-friendly, to increase the efficiency of insulin and also to increase the normally metabolism of human body¹⁻⁴. The nanoparticles are the one which are very tiny and are of the size 1 to 100nm with numerous applications

which are synthesized by three methods-which are Physical, Chemical and Biological method⁵⁻⁷. The nanoparticle synthesis using phyto extracts have been creating waves of spirit of eco friendliness and its application in many fields specially concentrating in medical field⁸⁻¹⁰. The gold nanoparticles with 1nm to 8nm are used in diagnosis of heart diseases and cancers as the biomarkers, as good biological imaging applications. To investigate furthermore applications in gold nanoparticles, it is synthesized via green method from *Anacardium occidentale* whose common name is cashew plant. It contain riboflavin, E,C and K vitamins, antifungal, antiparasitic and anti-inflammatory properties¹⁰⁻¹⁴.



The aim of this investigation to study the anti-oxidant and antidiabetic activity of the gold nanoparticles synthesized from *Anacardium occidentale*.

EXPERIMENTAL METHODS

Preparation of the plant sample

The fresh roots of the *Anacardium occidentale* were collected from Panruti of Cuddalore district, Tamilnadu. They are washed well with normal water and then with double distilled water. After the collection, the roots were shade dried well and made into the powder sample¹⁵⁻¹⁶. The aqueous extract was prepared from the dried sample by boiling it with water which is the universal solvent, it was then filtered by using whatmann no 40 filter paper and the stock solution was collected in a brown bottle and is then refrigerated.

Synthesis of gold nanoparticles

The stock solution was prepared from the dried roots of *Anacardium occidentale* using water as the solvent for the preparation of the aqueous extract. Auric chloride solution was prepared by weighing for which the concentration ought to be 1Mm and is dissolved in double distilled water in a 50 mL standard flask. From the prepared auric chloride solution, various concentrations of the plant sample were added to the auric chloride in drop by drop manner and the optimum concentration was fixed. At about 30 seconds after the addition, the colour of the solution changes from pale yellow to ruby red colour indicating the formation of stable gold nanoparticles.

Characterizations of Gold Nanoparticle

UV-Visible spectra analysis

The main purpose of using UV-Visible spectroscopy is to determine the optical properties of the solution. This concept is mainly based on the Beer-Lambert law which states the absorbance is directly proportional to the concentration of absorbing particles present in the solution. The formations of the nanoparticles synthesized were confirmed by the measurement of the SPR band using the U-2900 spectrophotometer with 1 cm path length in a 2 mL quartz cuvette.

FTIR

Fourier-transform infrared spectroscopy is usually done to analyse the various bioconstituents

present in the plant sample, so that it is easy to identify what type of compounds present in the extract⁷⁻⁸. By doing this FTIR measurement, the molecules that act as the reducing and stabilising agents are identified.

Scanning Electron Microscope

The Scanning Electron Microscope is employed for the determination of the morphology of the synthesized metal nanoparticles. The principle of the SEM is same as that of the optical microscope, but it measures the electrons scattered from the sample rather than that of the photons. The working of the SEM is by the use narrow beam of highly energetic electron at the surface of the sample to give the signals which are in turn giving the information about the topographical, morphological and compositional informations.

Antioxidant activity (DPPH free radical scavenging activity) determination

Here the antioxidant activity of gold nanoparticles was studied using the DPPH stability by examining the scavenging effect on the free radical. About 40 μ l of the gold nanoparticles were added to the DPPH solution. The mixture was shaken vigorously and left undisturbed for 5 min and using the spectrophotometer, the absorbance was measured at 540nm. A graph was plotted using percent inhibition versus concentration curve and the inhibition for 50% was determined.

ALPHA-Glucosidase inhibitory assay

The α -glucosidase activity of the synthesized gold nanoparticle was studied. The solution of p-nitrophenyl glucopyranoside (p-NPG) was added to pH 6.9. 100 μ L of α -glucosidase (1.0 U/mL) and the solution used were all incubated previously for 10 min at various concentrations of the nanoparticles. The reaction is started by adding the nanoparticles dissolved in buffer. It was then incubated for 20 min at temperature 37°C and the reaction was brought to an end by adding sodium carbonate. The yellow colour of the solution determines activity. Here also the inhibition was studied by the inhibition formula. The 50% inhibition of enzyme activity was derived graphically.

RESULTS AND DISCUSSION

Qualitative analysis

The quantitative analysis of *Anacardium occidentale* root extract was done and the results are tabulated in Table 1. The *Anacardium occidentale* root extract shows the following list of phytoconstituents like resin, phenol, quinines, glycosides, flavanoids, sapanoids, proteins etc.

Table 1: Qualitative analysis of *Anacardium occidentale* root extract

Sl.No	Phytoconstituents	Name of the plant	Presence
1	Tannin	<i>Anacardium occidentale</i>	++
2	Emodin	<i>Anacardium occidentale</i>	-
3	Quinones	<i>Anacardium occidentale</i>	++
4	Coumarin	<i>Anacardium occidentale</i>	-
5	Flavanoids	<i>Anacardium occidentale</i>	+
6	Xanthoprotein	<i>Anacardium occidentale</i>	-
7	Anthocyanin	<i>Anacardium occidentale</i>	+
8	Alkaloid	<i>Anacardium occidentale</i>	+
9	Proteins	<i>Anacardium occidentale</i>	+
10	Carbohydrate	<i>Anacardium occidentale</i>	+
11	Terpenoids	<i>Anacardium occidentale</i>	+
12	Phlobatanin	<i>Anacardium occidentale</i>	-
13	Leucoanthocyanin	<i>Anacardium occidentale</i>	-
14	Terpenoids	<i>Anacardium occidentale</i>	+
15	Saponoid	<i>Anacardium occidentale</i>	++
16	Resin	<i>Anacardium occidentale</i>	+
17	Anthroquinone	<i>Anacardium occidentale</i>	-
18	Carbohydrate	<i>Anacardium occidentale</i>	+

Visual observation

The gold nanoparticles were synthesised by taking the auric chloride solution of 1mM concentration and thus by gradually adding the *Anacardium occidentale* Root extract to it. The colour changes from colourless to ruby red colour. This colour remained unchanged for more than a month which was periodically checked at regular intervals.

UV-Visible spectroscopy

The absorbance peak for gold nanoparticles was observed at 531nm. These are due to the colour change in the nanoparticles which was observed due to the shift resulted from the Surface Plasmon Resonance (SPR) band. Thus, by the periodic observation by using UV-Visible spectroscopy, the Bio-reduction of the nanoparticles due to which the auric chloride changed its colour from colorless to ruby red.

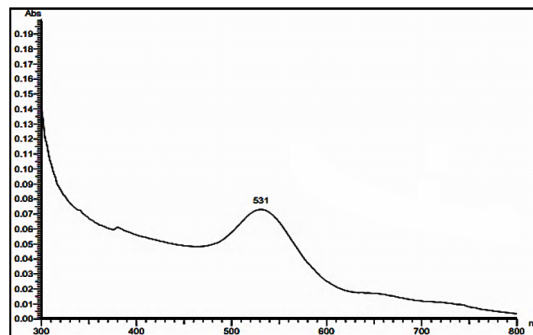


Fig. 1. UV-Visible spectra of gold nanoparticles

FTIR

Fourier-transform infrared spectroscopy is usually done to analyse the various bioconstituents present in the *Anacardium occidentale* Root extract and to identify what type of compounds present in the extract which are acts as the reducing and stabilizing agents.

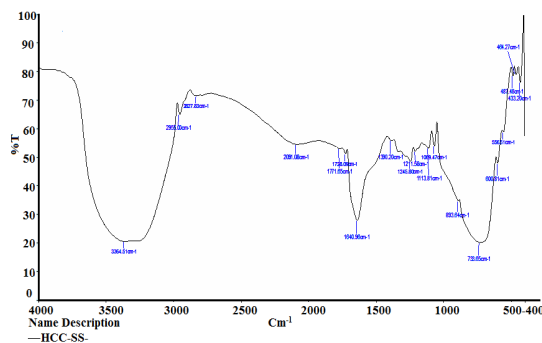


Fig. 2. FTIR of *Anacardium occidentale* root extract

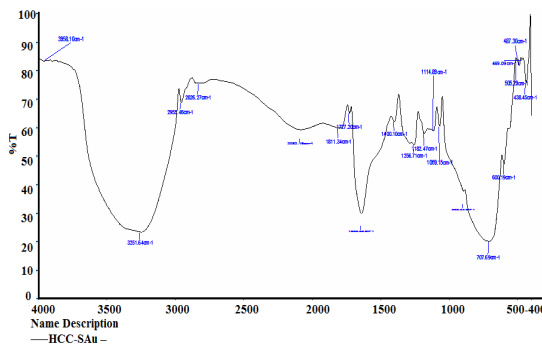


Fig. 3. FTIR spectrum of synthesised gold nanoparticles

The Table 2 shows the comparison of FTIR regions of the *Anacardium occidentale* root extract and the synthesised gold nanoparticles. Due to the presence of these functional groups the root extract of *Anacardium occidentale* shows good therapeutic applications and it is especially used in the treatment of diabetes.

Table 2: Comparison of FTIR of the *Anacardium occidentale* root extract and gold nanoparticle

FTIR of the <i>Anacardium occidentale</i> root extract		FTIR of the gold nanoparticle
BAND (cm ⁻¹)	FUNCTIONAL GROUPS	FUNCTIONAL GROUPS
3364.31 cm ⁻¹	NH stretching aliphatic 1° amine	NH stretching aliphatic 1° amine
2933 cm ⁻¹	CH stretching alkane	-
2827 cm ⁻¹	CH stretching aldehyde	-
2001 cm ⁻¹	N=C=C carbodiimide	N=C=C carbodiimide
1728 cm ⁻¹	Weak CH bending aromatic compound	Weak CH bending aromatic compound
1390 cm ⁻¹	CH bending aldehyde	CH bending aldehyde
1069 cm ⁻¹	S=O stretching sulfoxide	S=O stretching sulfoxide
1211 cm ⁻¹	C-O stretching vinyl ether	C-O stretching vinyl ether
1245 cm ⁻¹	Medium C-N stretching	Medium C-N stretching
1110 cm ⁻¹	Strong C-O stretching aliphatic ether	Strong C-O stretching aliphatic ether
813 cm ⁻¹	Medium C=C bending alkene	Medium C=C bending alkene

Scanning Electron Microscope

The SEM was performed for the analysis of the size, shape and surface morphology and it reveals that the synthesized gold nanoparticles are of spherical shape. Fig. 4, shows the synthesized gold nanoparticles were more or less uniform in size and shape. The SEM images of the synthesised gold nanoparticles using the *Anacardium occidentale* root extract shows the surface topography and it reveals that the synthesised gold nanoparticles are of spherical shape. The spherical shapes are clearly shown in the figure below.

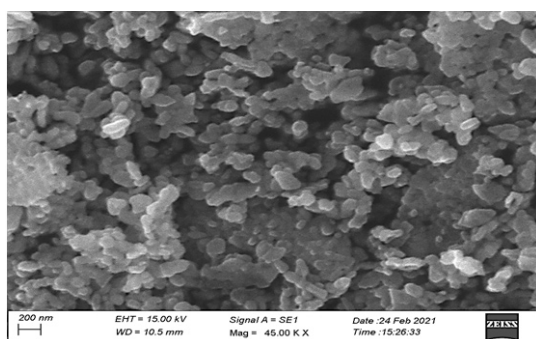


Fig. 4. SEM image of the gold nanoparticles

Antioxidant Activity of the Gold Nanoparticles by DPPH Method

The result showed that the gold nanoparticles synthesised using *Anacardium occidentale* root extract had better percentage antioxidant activities at high concentrations when compared with ascorbic acid (Table 3). The compound showed 74% activity at concentration 100 µg/mL while ascorbic acid gave 94.69% at the same concentration.

Table 3: Antioxidant activity of the AuNP

S.No	Concentrations	Scavenging Effect (%)	
		Sample	Ascorbic acid
1	20 (µg/mL)	60±0.75	41.60±1.37
2	40 (µg/mL)	65±0.88	66.85±1.35
3	60 (µg/mL)	69±0.12	76.74±1.40
4	80 (µg/mL)	71±0.52	82.34±1.43
5	100(µg/mL)	74±0.48	94.69±1.58

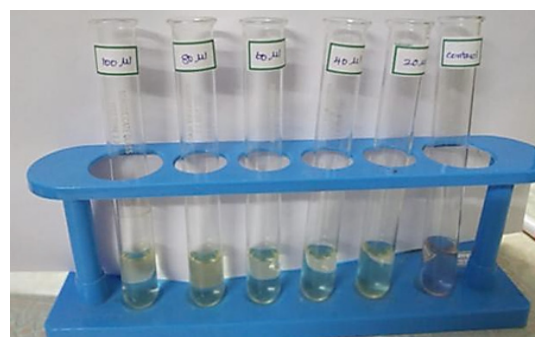


Fig. 5. Antioxidant activity of AuNPs

Antidiabetic Activity of gold *In vitro* α-glucosidase Inhibitory assay

The percentage of the inhibition of gold nanoparticle at 20-100 µg/mL concentrations of the root extract showed a dose dependent increase in percentage inhibition. The percentage inhibition varied from 47+0.63 to 79+0.26 for the highest concentration to the lowest concentration.

Table 5 : α-glycosidase inhibitory activity of AuNPs

S. No	Concentrations	Alpha glycosidase (%)	
		sample	Acarbose
1	20 (µg/mL)	47±0.65	72.70 ±1.40
2	40 (µg/mL)	58±0.59	62.34±1.37
3	60 (µg/mL)	60±0.59	75.48±1.42
4	80 (µg/mL)	63±0.42	84.54±1.47
5	100 (µg/mL)	79±0.26	95.68±1.38

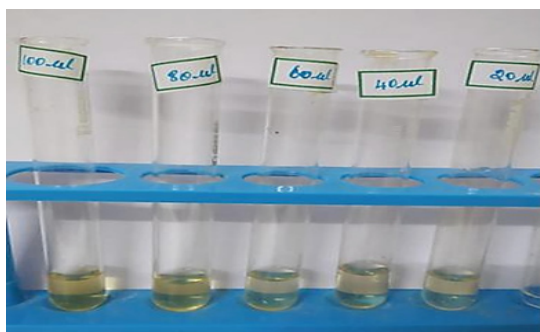


Fig. 6. α -glycosidase inhibitory activity of AuNPs

CONCLUSION

The green synthesis of nanoparticles caught the attention of everyone due to its reduced toxicity and its eco-friendly approach. The green synthesis of gold nanoparticle using *Anacardium occidentale* root extract is an effective green method by which the phytoconstituents are potentially utilized to its maximum ability. Qualitative analysis was done using the *Anacardium occidentale* root extract and various

phytoconstituents like tannin, saponin, phenol, quinine, flavanoid, terpenoid, carbohydrate, alkaloid in it. Bio-synthesis of gold nanoparticles was done using *Anacardium occidentale* root extract. The UV absorption peak obtained at 533 nm. FTIR analysis done to find out the functional group responsible for the reductant for the formation of the gold nanoparticle SEM analysis showed the spherical shape of the gold nanoparticles. The investigation of antioxidant activity of the gold nanoparticle resulted in 74% potential. The antidiabetic activity of the gold nanoparticle has potential at 79% in *In vitro* α -glucosidase inhibitory assay.

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Conflicts of Interest

The authors declare no conflict of interest.

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