# Green Synthesis of Gold Nanoparticles Using *Momordica charantia*

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Abstract

*Momordica charantia* leaves have antioxidant properties due to the presence of phytochemicals. The antioxidant properties of the phyto chemicals present in the extract could be exploited for the green synthesis of gold nanoparticles. Synthesized gold nanoparticles are characterized by UV–visible spectroscopy, FTIR, XRD, EDAX and TEM analysis. A clear color change from pale-yellow to ruby-red is observed within a minute, indicating *M. charantia extract* mediated transformation of chloroauric acid into colloidal GNPs ($Au^{3+} \rightarrow Au^{0}$).The formation of gold nanoparticles is confirmed by the observation of the surface plasmon resonance band at 538 nm. The average size of GNPs is found to consist of well-dispersed nearly spherical particles having size around 14.34 nm. Energy dispersive X-ray (EDAX) spectrometers confirms the presence of elemental gold signal of GNPs. The nanoparticles are found to be highly crystalline as evidenced by the peaks in the XRD pattern corresponding to Bragg reflections from the (1 1 1), (2 0 0), (2 2 0) and (3 1 1) planes of the fcc structure. *Momordica charantia* leaves are used as reducing as well as stabilizing agent for the preparation of gold nanoparticles

Keywords: *Momordica charantia* GNPs, XRD , TEM, SEM, Green synthesis

## INTRODUCTION

Nanoparticle research is an intense scientific research due to its wide potential application in biomedical, optical & electronic fields. Nanoparticles are a narrow bridge in between bulk materials and molecular (atomic) structures.[1]. The use of plants for the fabrication of nanoparticles because of its spontaneous, economical, eco-friendly protocol, suitable for large scale production and single step technique for the biosynthesis process [2]. The main mechanism considered for the synthesis of nanoparticles mediated by the plants is due to the presence of phytochemicals.

In the present study, we selected the leaves of *Momordica charantia* (Family: Cucurbitaceae) as reductant for the synthesis of GNPs. It is commonly known as bitter gourd and it is an important plant used for fever, cold, flu, malaria, cancer and tumors, high cholesterol, and psoriasis [3]. The *M. charantia* leaf extract contains tannins, flavonoids, steroids, protein, carbohydrates, poly phenols, glycosides, terpenoids and triterpenoids. These active constituents are responsible for the reduction of metal ions in to its nano size [4].

## MATERIALS AND METHODS

### Green Synthesis of GNPs

The gold nanoparticles (GNPs) are prepared by mixing *M. charantia* leaf extract with 1 mM chloro auric acid in a 100 ml conical flask. The content of the flask were mixed together and irradiated in a micro oven for 60 s.

### Characterization of GNPs

#### UV–Visible Spectroscopy

UV–visible spectrophotometer is the one of the important techniques for analysis of synthesized GNPs. After the synthesis, the pure GNPs were characterized by UV–visible absorption spectrophotometer. The color change in reaction mixture (metal ion solution + plant extract) was recorded through visual observation. Synthesized GNPs was confirmed by sampling the absorption maxima was scanned by UV–visible

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spectrophotometer at the wavelength of 400–800 nm.

### HR-TEM Analysis

HR-TEM images were obtained by using TEM, PHLIPS, CM200, 200Kv in SAIF MUMBAI. The typical HR-TEM images obtained for GNPs sample under different magnifications.

### EDAX Analysis

The presence of elemental gold in synthesized nanoparticles were measured by High Resolution Field Emission Electron Microscope with EDS, nano manipulation system available in SRM University, Chennai. Dry powder of green GNPs was loaded on the stub using double sided adhesive conductive carbon tapes and analyzed.

### X-ray Diffraction (XRD) Measurement

Determination of crystallinity, phase purity, lattice properties and identification of GNPs was done by XRD studies using powder diffractometer with Cu-K$\alpha$ radiation, operating at 40 kV and a current of 40 mA (X-ray Diffractometer, XPERT-PRO, at SRM University, Kattankulathur).

### FTIR Analysis

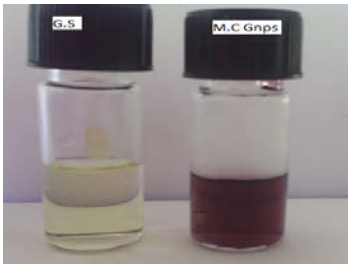
The interaction between phytocomponents and gold nanoparticles was analyzed by Fourier transform infrared (FTIR) analysis. FTIR spectrum of the powder (KBr) pellet was recorded using Perkin-Elmer 1600 FTIR spectrophotometer with a resolving power of 4 $cm^{-1}$.

## RESULTS AND DISCUSSION

### Synthesis of Gold Nanoparticles

The gold nanoparticles (GNPs) were prepared by mixing 2.5 ml of *M. charantia* leaf extract with 25 ml of 1 mM chloro auric acid in a 100 ml conical flask. The content of the flask were mixed together and irradiated in a micro oven for 60 s. As shown in the Figure 1 the color change from yellow to deep ruby-red indicated the formation of GNPs. A clear color change from pale-yellow to ruby-red was observed within a minute, indicating *M. charantia extract* mediated transformation of chloro auric acid into colloidal GNPs($Au^{3+} \rightarrow Au^{0}$)[5].

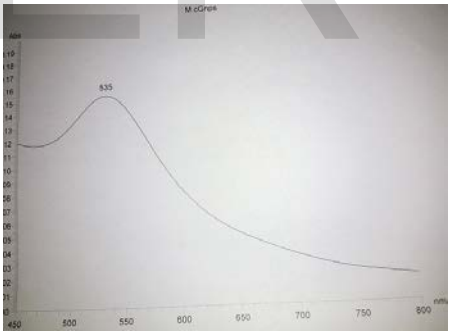
Fig.1 Visual observation of formation of GNPs.




### UV–Visible Spectroscopy

SPR measurements were carried out to confirm the presence of GNPs in the deep ruby-red solution. Figure 2 shows a major bands centered ~535 nm. The bands are broad and the intensity increases indicating increase in production of GNPs. Interestingly, the position of the SPR band observed at the initial stage of reaction remained almost unaffected even after several hours, implying non-agglomeration of the nanoparticles presumably due to the capping of nanoparticle surface by phytochemical constituents.[6]

Fig. 2 UV–Vis spectrum of GNPs




### HRTEM Analysis

Figure 3a shows the HR-TEM image for GNPs synthesized using *M. charantia* leaf extract. The synthesized GNPs were mostly oval in shape. However, a few large particles with a regular hexagonal shape were also observed. The average diameter of GNPs was ~14.34 nm. Selected area electron diffraction (SAED) pattern for the GNPs are given in Figure 3b. The ring like pattern indicates the crystalline structure of GNPs [7].

Fig. 3a HR-TEM images of GNPs

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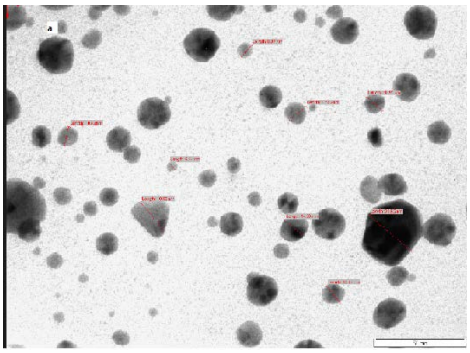
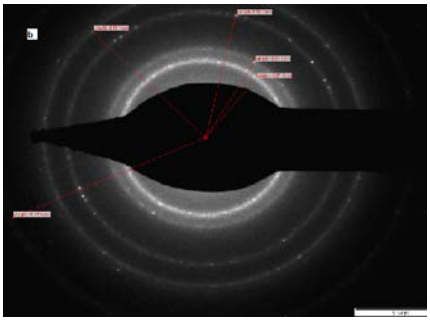


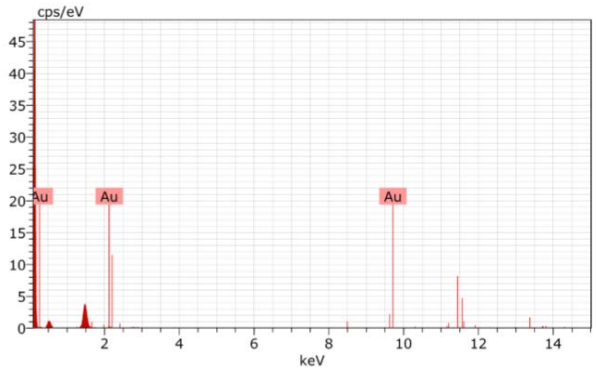
Fig. 3b SAED Pattern of GNPs



EDAX Analysis

Analysis of synthesized GNPs through EDAX measurements confirmed the presence of elemental gold Figure 4. EDAX spectrum shows the presence of strong elemental gold peak (95.95 wt%) confirming the presence of gold nanoparticles. Another weak peak corresponding to elemental aluminum could arise from impurities present in the plant extract [8].

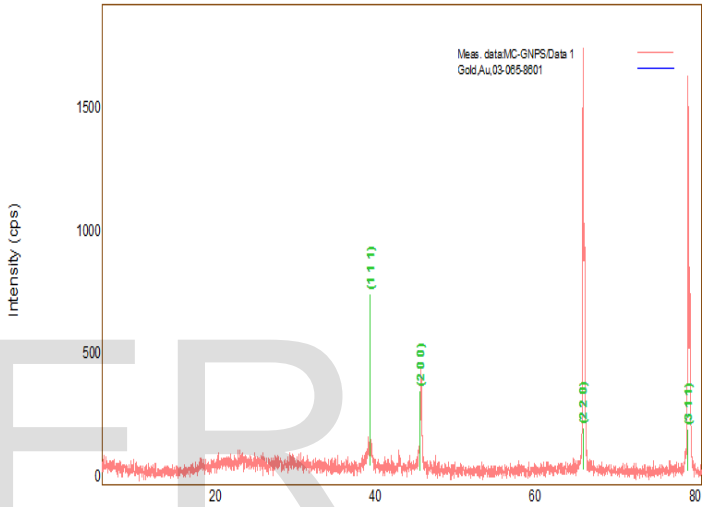
Fig. 4 EDAX of GNPs




Powder X-ray Diffraction Analysis

Powder XRD (copper anode) analysis of synthesized GNPs. Figure 5 exhibits diffraction peaks corresponding to (111), (200), (220) and (311) phases in the $2\theta$ range of 30º–90º. In the XRD pattern, diffraction peaks at angles of 38.29°, 44.81°, 65.113° and 78.251° could be assigned to face-centered cubic (fcc) metallic gold (111), (200), (220) and (311) facets of gold nanocrystals, respectively.

Fig. 5 XRD Pattern of GNPs




FTIR Analysis

FTIR Spectroscopy is routinely used for the identification of functional groups present in organic and inorganic materials. The FTIR spectrum of *M. charantia* extract is shown in the Figure 6. The presence of band at 3467.94 $cm^{-1}$ and 3434.01 $cm^{-1}$ are due to phenolic –OH stretching and –NH stretching respectively. The band at 1632.20 $cm^{-1}$ is due to C=O stretching and 1356.77 $cm^{-1}$ is assigned to C=N stretching. The band at 1015.61 $cm^{-1}$ is due to –CH in plane bending and 659.95 $cm^{-1}$ is due to the presence of aromatic ring [9].

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Fig. 6 FTIR spectrum of *M. charantia* leaf extract

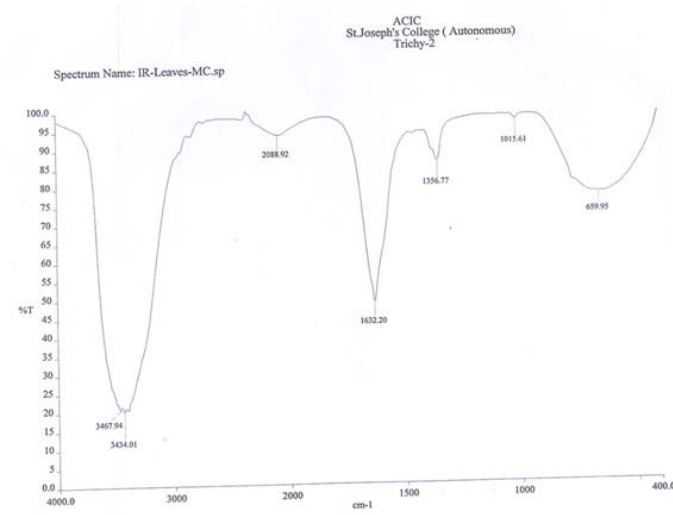
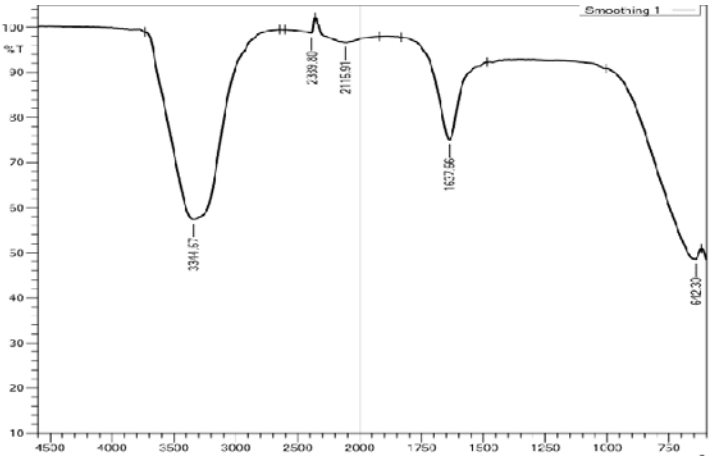



Fig. 7 FTIR spectrum of gold nanoparticles




The phytochemicals present in the extract would simultaneously act as reducing, stabilizing and capping agents. The FTIR spectrum of *M. charantia* leaf extract shows a broad peak at 3432.40 $cm^{-1}$ (Figure 6) assigned to phenolic –OH which is shifted to 3329.14 $cm^{-1}$ (Figure 7) due to intermolecular hydrogen bonding. The band at 1631.94 $cm^{-1}$ assigned to carbonyl group (C=O) is shifted to 1637.56 $cm^{-1}$. Similarly, the peak at 659.050 $cm^{-1}$ assigned to aromatic ring is also shifted to 640.37 $cm^{-1}$. An analysis of the FTIR spectra of the extract and the synthesized GNPs revealed that the GNPs might be surrounded by molecules like polyphenols, alkaloids, reducing sugars, and flavonoids, which are commonly found in plant extracts. These chemical constituents present in the leaf extract are capable of converting chloro auric acid to gold nanoparticles due to their capping and reducing capacities. From these observations it is clear that the phytochemicals present in *M. charantia* leaf extract are responsible for reduction and stabilization by capping of GNPs

## CONCLUSION

- Green synthesis of GNPs was accomplished using methanolic extract of *M. charantia* leaf.
- The change in color from pale yellow to ruby red indicated the reduction of $Au^{3+}$ ions to $Au^{0}$. SPR bands of the colloids were centered at 535 nm.
- The colloid obtained by rapid reduction was found to consist of well-dispersed nearly spherical particles having size around 14.34 nm.
- Energy dispersive X-ray (EDAX) spectrometers confirmed the presence of elemental gold signal of GNPs.
- The nanoparticles are found to be highly crystalline as evidenced by the peaks in the XRD pattern corresponding to Bragg reflections from the (1 1 1), (2 0 0), (2 2 0) and (3 1 1) planes of the fcc structure.

References

1. Sharma KV, Yngard AR, Lin Y, Advances in Colloid and Interface Science (2009) 145 83–96.

2. Huang J, Li Q, Sun D, Lu Y, Su Y, Yang X, Wang H, Wang Y, Shao W, He N, Hong J, Chen C, .Nanotechnology (2007) 18: 105104-105115.

3. N. Ahmad, M.R. Hassan, H. Halder et al., *Bangladesh Med Res Council Bull* **25** (1999) 11–13

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4. R. Rathinamoorthy et al., *Int J Pharm Sci* **6**(2014) 932–938

5. D. Manikprabhu Lingappa, *Bioinorg Chem Appl* (2013)

6. S. Shiv Shankar, A. Rai, A. Ahmad, M. Sastry, *J Colloid Interface Sci* **275** (2004) 496–502

7. J.Y. Song, B.S. Kim, *Bioprocess Biosyst Eng* **32** (2009) 79–84

8. D.V. Leff, L. Brandt, J.R. Heath, *Langmuir* **12** (1996) 4723

9. R. Ashok kumar, M. Ramasamy, *Int J Curr Microbiol Appl Sci*3(1) (2014) 395–406

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