IJPSR (2019), Volume 10, Issue 5 (Research Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 02 September 2018; received in revised form, 22 November 2018; accepted, 24 November 2018; published 01 May 2019

UTILIZATION OF MAIZE EXTRACT FOR THE SYNTHESIS AND CHARACTERIZATION OF GOLD NANOPARTICLES AT ROOM TEMPERATURE

Ravi Jon [*1], Prabhakara Rao Dasari [2], Vipul Singh [1] and D. P. Jayapandian [1]

Department of Physics [1], Department of Chemistry [2], Faculty of Science, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj - 211007, Uttar Pradesh, India.

Keywords:

Green synthesis, Maize extract, Gold nanoparticles, Optimization

Correspondence to Author:
Ravi Jon

Assistant Professor,
Department of Physics,
Faculty of Science, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj - 211007, Uttar Pradesh, India.

E-mail: ravi.john@shiats.edu.in

ABSTRACT: In present work, the gold nanoparticles have been prepared through green synthesis using maize extract at room temperature, the maize extract was used as reducing and stabilizing agents for AuNPs (gold nanoparticles), synthesized gold nanoparticles were confirmed by the color change of the aqueous solution, and the PH of the solution was 7.8, after the confirmation, green gold nanoparticles were characterized through various techniques like UV-Visible spectroscopy, FT-IR (Fourier Transform Infrared Spectroscopy), SEM (Scanning Electron Microscopy), TEM (Transmission Electron Microscopy) and EDAX (Energy Dispersive X-ray analysis). UV-Visible spectroscopy was used to determine the green gold nanoparticles, the absorbance peak was observed at 540 nm with the spherical sized gold nanoparticles, and green gold nanoparticles were also confirmed by TEM, and average particle size of gold nanoparticles was observed 30 nm. FT-IR results represent the various phenolic compounds like alkaloids and flavonoids in aqueous solution. The size, shape and other properties were confirmed through Scanning Electron Microscopy and EDAX analysis. Green synthesis of the gold nanoparticles at room temperature is the innovative process for the various biomedical applications in the field of biomedical science and engineering because of the non-toxic property of the green gold nanoparticles.

INTRODUCTION: Nanotechnology and nano-science is the most prominent area in the scientific research, in the past few years green synthesis of the metal nanoparticles becoming more popular in the field of nanoscience and nanotechnology because it is less expensive and eco-friendly technique [1-3]. The various methods for the preparation of the gold nanoparticles have been proposed such as fruit extract, plant extract, seed extract, leaf extract, multivitamins, and microorganism has been used as reducing and capping agents.

QUICK RESPONSE CODE	DOI: 10.13040/IJPSR.0975-8232.10(5).2397-02
	The article can be accessed online on www.ijpsr.com
DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.10(5).2397-02	

The most important application of the gold nanoparticles is in the field of biomedical, nanomedicine, Drug delivery and detection of the tumor and cancer because of their unique optical and thermal properties [4-7].

But nowadays some other toxic chemicals have been used as reducing and stabilizing agents the nanoparticles which were produced through these chemicals are highly toxic and not safe for human applications, these reagents are not suitable for living organism and also not safe for the environment, proper handling and precautions are required when using these reducing agents, some microorganisms are also reported for the synthesis of nanoparticles [8]. Various plants, fruits and seed extract have been used for the green synthesis of gold nanoparticles such as, leaf extracts of neem [9], *Aloe-vera* [10], *Terminalia arjuna* bark [11], Tamarind leaf [12], *Coleus aromatics* were used for the synthesis of nanoparticles [13], *Cibotium barometz* root extract was used for the synthesis of silver and gold nanoparticles [14], stem of *Periploca aphylla* plant extract was used for the synthesis and characterization of gold nanoparticles [15], *Acer pentapomicum* leaves extract was used for the synthesis of gold nanoparticles [16]. Stability of green gold nanoparticles through heating and other techniques was analyzed. Gold nanoparticles show antibacterial activities [17-18]. Some authors mention the synthesis of silver and gold nanoparticles through macro and microalgae [19]. Gold nanoparticles can be used for anticancer drug release [20]. Green combination using plants, fruits and seed extract of nanoparticles could be benefited over the chemically and biological methods for the production of green gold nanoparticles; green synthesis can also be applied for the large-scale production of the green gold nanoparticles. In this present research work, we synthesized and characterized green gold nanoparticles using maize extract.

MATERIALS AND METHODS: The green synthesis of the gold nanoparticles was carried out from maize extract; Yellow corn granules were purchased from local market Prayagraj, and Gold(III) chloride was purchased from [Sigma-Aldrich, USA: 99.99%]. Mature Corn granules were dried in direct sunlight then washed thoroughly with double distilled water. The corn granules were ground into a fine powder then 100gm fine powder was mixed with 500 mL deionized water and boiled for 50 min and centrifuged at 5000 rpm and filtered through Whatman no. 1 filter paper. The maize extract solution was used after 2 h of preparation. The filtrate solution was used as reducing and stabilizing agents for the further experimental process.

Synthesis of Gold Nanoparticles: For the production of the green gold nanoparticles, 10 mL of seed extract solution was added to the 100 mL of Gold Chloride solution (0.001M) with continuous magnetic stirring without heating. The solution was kept for 90 min at room temperature. The color changes yellow to ruby red ensure the formation of green gold nanoparticles. The properties of the gold nanoparticles like physical, optical, magnetic depend upon the preparation process and reducing agents; the ruby red solution was further used for characterization of the green gold nanoparticles.

FIG. 1: VISUAL OBSERVATIONS (A) GOLD CHLORO-AURIC SOLUTIONS (B) MAIZE EXTRACT AND (C) GOLD NANOPARTICLES

RESULTS AND DISCUSSION: After the Formation of the gold nanoparticles, the complete reduction of Gold ions was observed that convert into AuNPs after 6 h of incubation at room temperature. The ionic reduction strength of Gold ions was conforming in the sample by visual observations. The sample was shown in **Fig. 1**, turned from yellow to red in 90 min.

The synthesized gold nanoparticles were more stable due to the rate of Gold ions conversion to AuNPs and reducing agent [21]. The color exhibited by colloidal metallic nanoparticles, the reason is the presence of coherent excitation of free electrons within the conduction band that led to in-phase oscillation (*i.e.*, surface Plasmon resonance) [22]. The bioactive compounds present in the extract, it might be provided reducing and stabilizing agents to metallic gold ions in solution to convert them into AuNPs. The color optical absorption spectrum of metal nanoparticles depends on the particle shape, size, and state of aggregation.

UV-Vis Spectroscopy Analysis: The UV-Visible spectroscopy is one of the essential techniques for authentication of formation and stability of AuNPs from an aqueous extract of Maize seed. The color changed sample was observed by UV-Vis spectroscopy analysis. In **Fig. 2**, metallic AuNPs were showed the well-defined strong absorption peak at 540 nm at room temperature. The formation of absorption peaks were observed from a lower energy state to a higher energy state.

The intensity of the color did not intensify after 24 h, confirming that reaction was completed within the 24 h [23]. The band intensity is a sign of smaller, spherical and circle shaped nanoparticles with some agglomeration. AuNPs have been reported to exhibit a dark purple color in an aqueous solution that is related to their intensity and size owing to its Surface Plasmon Resonance (SPR) [24-25].

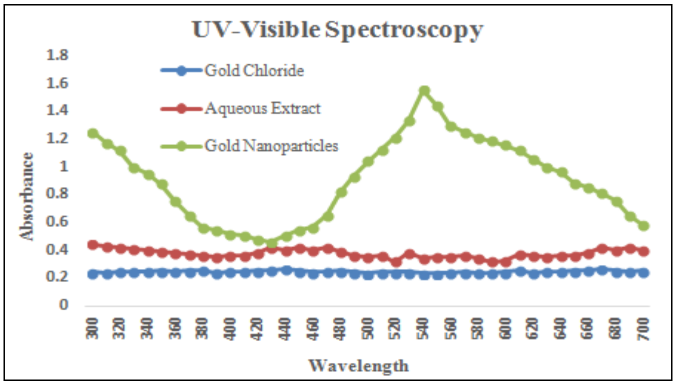

FIG. 2: UV-VIS. SPECTRA OF GOLD CHLORIDE (BLUE), AQUEOUS EXTRACT (RED), GOLD NANOPARTICLES (GREEN)

FT-IR Analysis: The FT-IR analysis is an important tool to identify the functional groups and relation between the metal nanoparticles and biomolecules present in the AuNPs of Maize seed extract. FT-IR to predict the role of the reducing and stabilizing capacity of the seed extract for the synthesis of AuNPs. The FT-IR analysis showed that the identified biomolecules are responsible for capping and stabilizing agents for gold nanoparticles. The gold nanoparticles showed the different peaks at 3852.51 cm^{-1}, 3838.28 cm^{-1}, 3749.59 cm^{-1}, 3674.51 cm^{-1}, 3648.52 cm^{-1}, 3566.20 cm^{-1}, 1733.13 cm^{-1}, 1716.29 cm^{-1}, 1698.04 cm^{-1}, 1557.82 cm^{-1}, 1541.24 cm^{-1}, 1507.54 cm^{-1}, 1456.90 cm^{-1}, 566.95 cm^{-1}, 542.21 cm^{-1} and 525.27 cm^{-1}.

The 566-525 cm^{-1} bands at 564 cm^{-1} may be assigned to alkyl halide groups, which are shifted to 526 cm^{-1} in the case of AuNPs [22]. These functional groups played an effective role in the green synthesis of gold nanoparticles. **Fig. 3** shows the main functional groups in nanoparticles at 3749.59 cm^{-1}as Stretching vibrations of the primary and secondary amines [26], 3600 - 3200 cm^{-1} as O-H stretching of intermolecular hydrogen bond [27]. These vibrations correspond to the hydroxyl functional group in alcohols and phenolic compounds [28-29] and at 1650 cm^{-1} amino acids containing NH_2 groups, amide I band [30-31].

The observational peaks were observed at 1557-1507 cm^{-1} which shows that the characteristic of N-O asymmetric stretching vibrations of nitro compounds [32-33].

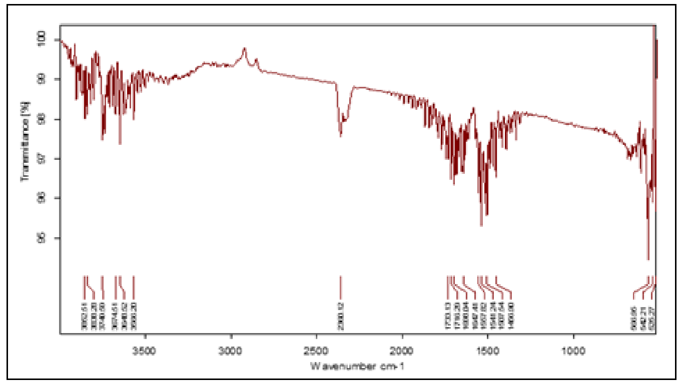

FIG. 3: FT-IR SPECTRUM FOR GOLD NANOPARTICLES

Transmission Electron Microscopy: In **Fig. 4**, the morphology size and shape of AuNPs Maize seeds were observed by TEM. The presence of absorption bands is a consequence of the existence of surface Plasmon in nanoparticles contained in the colloid [34]. The TEM image of Maize seed AuNPs showed the non-uniform size as 30 nm in circular shapes. These green gold nanoparticles were more stable than other nanoparticles prepared through chemical method. These nanoparticles were well dispersed at 150000 magnification range at HV-200.0Kv [35].

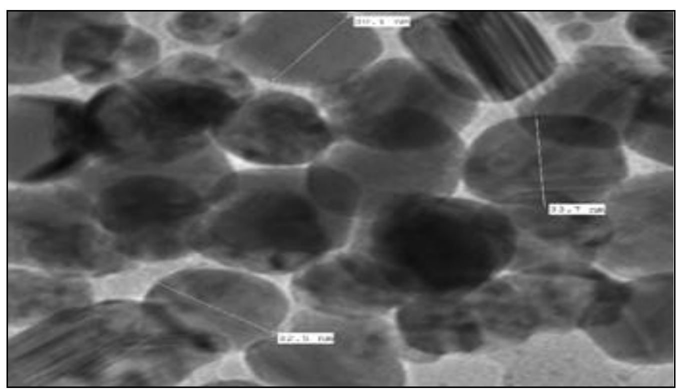

FIG. 4: TEM IMAGE OF GOLD NANOPARTICLES SYNTHESIZED FROM MAIZE EXTRACT

Scanning Electron Microscope: Scanning Electron Microscope (TESCAN Vega Model) was carried out to recognized morphology and size of nanoparticles by Maize seed in **Fig. 5**. The size of the synthesized AuNPs was observed as 30 nm by SEM analysis at 8000x magnification range. The larger gold nanoparticles may be due to the aggregation of the smallest one due to the SEM instrument. The observed nanoparticles were not dispersed effectively due to the colloidal solution and the formation of nano-clusters [36]. The image of SEM showed the circular, rod and spherical shape of NPs with a diameter range of 1 µm various gold NPs [37]. In this image, AuNPs shows variations in particle size, clusters, and microstructure because of aggregation and evaporation of solvent during the sample preparation.

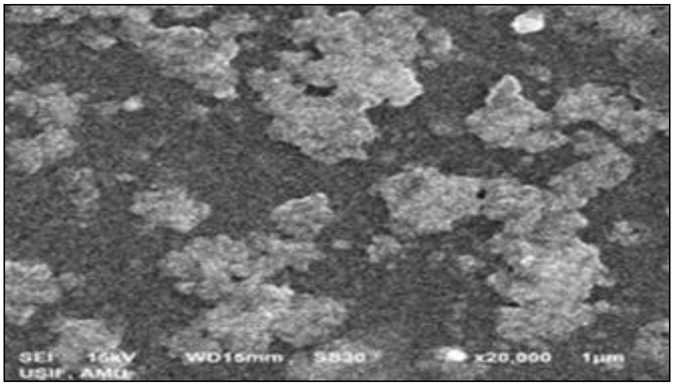

FIG. 5: SEM IMAGE OF GOLD NANOPARTICLES SYNTHESIZED FROM MAIZE EXTRACT

Energy Dispersive X-ray Analysis: The Energy Dispersive X-ray Analysis (EDAX) spectrum showed the presence of gold nanoparticles. The spectrum also shows the presence of C, O, and Al indicating the presence of phytochemicals. The EDAX analysis was observed for the AuNPs, and strong peaks of Maize seed extract was recorded. The metallic gold nanoparticle shows the typical optical absorption peak approximately at 1.8 to 2.9 keV.

In the presence of Maize seed extract, AuNPs showed broad signals and other signals were also present such as oxygen, sodium, potassium, and titanium due to a long signal. The EDAX revealed strong signals in the Gold region, three to five different areas for samples and thus confirmed the formation of gold nanoparticles.

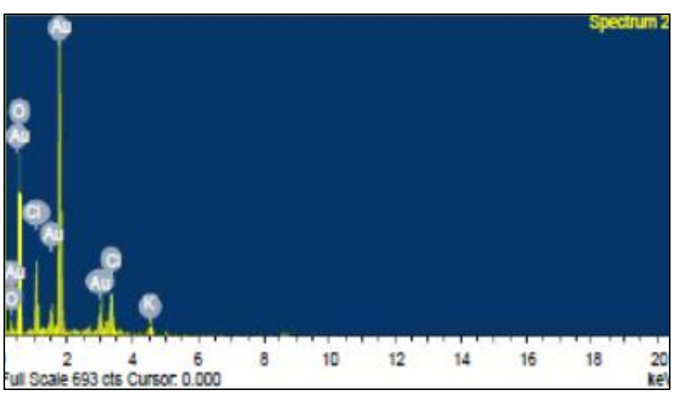

FIG. 6: EDAX SPECTRUM OF GOLD NANOPARTICLES

Fig. 6 shows the impurities also in AuNPs of Maize seed obtained by EDAX. It has been verified that the shape, size, solubility, surface area, dispersion factor and chemical composition of nanoparticles play an exceptional role in determining their biological responses respectively by EDAX [38].

CONCLUSION: Gold nanoparticles were prepared through green synthesis using Maize Extract. The color change indicates the AuNPs were formed due to the reduction in Au^+ ions. The gold nanoparticles which prepared were non-toxic and can be used in various biomedical applications. The shape of these gold nanoparticles was spherical and the size was 30 nm which was confirmed by scanning electron microscopy (SEM) and Transmission electron microscopy (TEM), reducing agents played an essential role for the formation of the size and shape of green gold nanoparticles.

FTIR results showed the chemical and molecular interactions which are used for green gold salt reduction. The present research work showed that the many natural plants, fruits, the leaf could be used for the synthesis of the green gold nanoparticles.

ACKNOWLEDGEMENT: We are thankful to the Aligarh Muslim University, Aligarh for their support in carrying out in this research work regarding SEM-EDAX, and TEM analysis. Thanks to Banaras Hindu University for their help of FT-IR spectrum analysis and also thanks to my advisor Prof. Dr. D. P. Jayapandian who helped me in this research work.

CONFLICT OF INTEREST: The authors declare that there is no conflict of interest.

REFERENCES:

1. Suman B, Eswari B, Divya BJ, Pallavi C, Venkataswamy M, Kemparaj K and Thyagaraju K: Effect of silver nanoparticles synthesized of *Trichodesma indicum* against naja naja (cobra) venom. Int J Pharm Sci Res 2018; 9(8): 3291-96. doi: 10.13040/IJPSR.0975-8232.9(8).3291-96.
2. Bhattacharya D and Rajinder G: Nanotechnology and potential of microorganisms. Crit Rev Biotechnol 2005; 25: 199-04.
3. Mohanpuria P, Rana NK and Yadav SK: Biosynthesis of nanoparticles: technological concepts and future applications. J Nanopart Res 2008; 10: 507-517.
4. Kreibig U and Vollmer M: Properties of Metal Clusters. New York: Springer. Optical Acta Part A, 2001; 74: 735-39.

5. El-Sayeed MA: Some Interesting Properties of S. Kulkarni, Biosynthesis of gold nanoparticles metal confined in time and nanometer space of by the tropical marine yeast *Yarrowia lipolytica* different shapes. Acc Chem Res., 2009; 34(4): 257. NCIM 3589. Mat Lett, 63: 1231-34.
6. Deyev S, Proshkina, G, Ryabova, A, Tavanti F, Menziani MC, Eidelshtein G, Avishai G and Kotlyar A: Synthesis, Characterization, and Selective Delivery of DARPin-Gold Nanoparticle Conjugates to Cancer Cells. Bioconj Chem 2017; 28: 2569-74.
7. Narayanan R and El-Sayed MA: J. Am. Chem. S.E. Mehaseb, The chemical composition of the Soc 2003; 125: 8340.
8. Malarkodi C and Annadurai G: A novel biological approach on extracellular synthesis and characterization of semiconductor zinc sulfide nanoparticles. Appl Nanosci 2013; 3(5): 385-389. doi:10.1007/s13204-012-0138-0
9. Shivshankar S, Rai A, Ahmad A and Sastry MJ: Colloid Interface Sci. 2004; 275: 496-502.
10. Prathap SC, Chaudhary M, Pasricha R, Ahmad A and Sastry M: Biotechnol Prog 2006; 22: 577-583.
11. Suganthy N, Sri Ramkumar V, Pugazhendhi A, Benelli G and Archunan G: Biogenic synthesis of gold nanoparticles from *Terminalia arjuna* bark extract: Assessment of safety aspects and neuroprotective potential *via* antioxidant, anticholinesterase, and anti-amyloidogenic effects. Environ. Sci. Pollut. Res 2018; 25(11): 10418-33.
12. Ankamwar B, Chaudhary M and Sastry, M: Metal-Organic and Nano-Metal Chemistry 2005; 35: 19-26.
13. Vanaja, M and Annadurai G: Coleus aromaticus leaf extract mediated synthesis of silver nanoparticles and its bactericidal activity. Applied Nanoscience 2012; 3. 10.1007/s13204-012-0121-9.
14. Wang D, Markus J, Wang C, Kim YJ, Mathiyalagan R, Aceituno VC, Ahn S and Yang DC: Green synthesis of gold and silver nanoparticles using aqueous extract of *Cibotium barometz* root. Artif. Cells Nanomed Biotechnol 2017; 45: 1548-1555.
15. Kaykhaii M, haghpazir N and Walisadeh J: Biosynthesis of gold nanoparticles using aqueous extract of stem of *Periploca aphylla* Plant. J Nanostruct, 2018; 8(2): 152-158. DOI: 10.22052/JNS.2018.02.005.
16. Khan S, Bhakt J and Syed F: Green synthesis of gold nanoparticles using *Acer pentapomicum* leaves extract its characterization, antibacterial, antifungal and antioxidant bioassay, Digest Journal of Nanomaterials and Biostructures 2018; 3(2): 579-89,
17. Parle M and Khanna D: I Jour of Res in Ayurveda & Pharmacy 2011; 2(1): 47-54.
18. Das RK, Gogoi N and Bora U: Green synthesis of gold nanoparticles using Nyctanthesarbortristis flower extract. Bioprocess Biosyst Engg 2011; 34: 615-19.
19. Hassaan MA and Hosny S: Green Synthesis of Ag and Au nanoparticles from micro and macro algae - review. International Journal of Atmospheric and Oceanic Sciences 2018; 2(1): 10-22.
20. Khutale GV and Casey A: Synthesis and characterization of a multifunctional gold-doxorubicin nanoparticle system for pH triggered intracellular anticancer drug release. Eur J Pharm Biopharm 2017; 119: 372-80.
21. Lakshmipathy R, Palakshi Reddy B, Sarada NC, Chidambaram K and Pasha SK: Watermelon rind-mediated green synthesis of noble palladium nanoparticles: catalytic application. ApplNanosci 2015; 5: 223-28.
22. Patra JK and Baek KH: Novel green synthesis of gold nanoparticles using *Citrullus lanatus* rind and investigation of proteasome inhibitory activity, antibacterial, and antioxidant potential. International Journal of Nanomedicine 2015; 10: 7253.
23. Liz LM and Tailoring M: Surface plasmons through the morphology and assembly of Metal Nanoparticles. Langmuir 2006; 22: 32.
24. Skirtach, AG, Dejugnat, C, Braun, D, Susha, AS, Rogach, AL, Parak, WJ, Mohwald, H and Sukhorukov GB: The role of metal nanoparticles in the remote release of encapsulated. Nano Lett. Materials 2005; 5: 1371-77.
25. Xu W, Wang Y, Xu R, Liang S, Zhang G and Yin D: Synthesis and fluorescence spectrum analysis of CdS nanocrystals. J Mat Sci 2007; 42: 6942-45.
26. Prabhakara RD and Prashant A: Synthesis, characterization of silver nanoparticles using *Rosa damascena* hips extract and antibacterial, anti-cancer activities of the synthesized nanoparticles. International Journal of Pharmaceutical Sciences Review and Res 2017; 04: 13-19.
27. Prabhakara RD and Prashant A: Green synthesis, characterization and antimicrobial activity of silver nanoparticles using leaf extracts of *Carissa carandas*. Asian Journal of Chemistry 2017; 29(11): 2415-18.
28. Narayanan KB and Sakthivel N: Photosynthesis of gold nanoparticles using leaf extract of *Coleus amboinicus* Lour. Mater Charact 2010; 61: 1232-38.
29. Babu PJ, Sharma P, Kalita MC and Bora U: Green synthesis of biocompatible gold nanoparticles using *Fagopyrum esculentum* leaf extract. Front Mater Sci 2011; 5: 379-387.
30. Sau TK Fagopyrumesculentum Rogach AL: Nonspherical noble metal nanoparticles: colloid-chemical synthesis and morphology control. Adv Mater 2010; 22: 1781-04.
31. Prabhakara RD and Prashant A: Green Synthesis of Silver Nanoparticles: A Review. International Journal of Chemistry and Pharmaceutical Sciences 2016, 4(8): 445-56.
32. Rajeshkumar, S, Kannan, C and Annadurai, G: Synthesis and characterization of antimicrobial silver nanoparticles using marine brown seaweed *Padina tetrachromatic*. Drug Invention Today 2012; 4: 511-13.
33. Gnanajobitha, G, Vanaja, M, Paulkumar, K, Rajeshkumar, S, Malarkodi, C, Annadurai, G and Kannan, C: Green synthesis of silver nanoparticles using Milling toniahortensis and evaluation of their antimicrobial efficacy. International Journal of Nanomaterials and Biostructures 2013; 3(1): 21-25.
34. Alvarez RA, Cortez-Valadez M, Bueno LO, Hurtado RB, Rocha-Rocha O, Delgado-Beleño Y, Martinez-Nuñez CE, Serrano-Corrales LI, Arizpe-Chávez H and Flores-Acosta M: Vibrational properties of gold nanoparticles obtained by green synthesis. Physica E: Low-dimensional Systems and Nanostructures 2016; 84: 191-5.
35. Morel AL, Giraud S, Bialecki A, Moustaoui H, de La Chapelle ML and Spadavecchia J: Green extraction of endemic plants to synthesize gold nanoparticles for theranostic applications. Frontiers in Laboratory Medicine 2017; 1(3): 158-71.
36. Hamelian M, Hemmati S, Varmira K and Veisi H: Green synthesis, antibacterial, the antioxidant and cytotoxic effect of gold nanoparticles using *Pistacia atlantica* extract. Journal of the Taiwan Institute of Chemical Engineers 2018.
37. Siddiqi KS and Husen A: Recent advances in plant-mediated engineered gold nanoparticles and their application in a biological system. Journal of Trace Elements in Medicine and Biology 2017; 40: 10-23.

38. Zha J, Dong C, Wang X, Zhang X, Xiao X and Yang X: Green synthesis and characterization of monodispersed gold nanoparticles using *Ginkgo biloba* leaf extract. Optik-International Journal for Light and Electron Optics 2017; 144: 511-21.

How to cite this article:
Jon R, Dasari PR, Singh V and Jayapandian DP: Utilization of maize extract for the synthesis and characterization of gold nanoparticles at room temperature. Int J Pharm Sci & Res 2019; 10(5): 2397-02. doi: 10.13040/IJPSR.0975-8232.10(5).2397-02.