International Journal of Molecular Biology & Biochemistry.
Volume 2, Number 1 (2014), pp. 33-40

http://www.irphouse.com

Extracellular Rapid Biosynthesis of Gold Nanoparticles Using Various Green Extracts of Plants

Kamala Priya M. R. and Priya. R. Iyer

P G and Research Department of Biotechnology
Womens Christian College, College Road, Chennai- 600006
E-mail: brajuraj@yahoo. com

ABSTRACT

In this current study, we have made attempts to standardize a green chemistry approach of gold nanoparticles synthesis and we have successfully come out with an effective, economic, feasible and cost efficient route of gold nanoparticles synthesis. 8 different plant samples were tried out for the process, that resulted in the synthesis of 8 types of nanoparticles. The reduction of gold chloride into gold nanoparticles was indicated by the color produced during the reaction. The formation of pink / wine red / cherry red color indicated the complete synthesis of gold nanoparticles. Depending upon the intensity of the color produced, the nanoparticles can be further quantified. The time required for the complete reduction of gold chloride into gold nanoparticles depended upon the type of the extract used. The duration for the synthesis was at the minimum for *Camellia sinensis (green tea)*extract that yielded nanoparticles in less than 30 seconds and the maximum duration required was recorded to be 24 hours in case of other plant extracts like *Coriandrum sativum*, *Mentha arvensis*, *Phyllanthus amarus*, *Artabotrys hexapetalus* and *Mimusops elengi* and for *Syzygium aromaticum* and *Camellia sinensis (black tea)extract*, the reduction was complete in 1 hour.

INTRODUCTION

The integration of nanoparticles with biological molecules has lead to the development of diagnostic devices, contrast agents, and important tools in cancel therapy. Nanobiotechnology describes an application of biological systems for the production of new functional material such as nanoparticles. Biosynthetic methods can employe either microorganism cells or plant extract for nanoparticles production. Biosynthesis of nanoparticles is an exciting recent addition to the large repertoire of nanoparticles synthesis methods and now, nanoparticle have entered a commercial exploration period. Currently, there are many gold nanoparticles industrial uses that resulted in a boost in its demand and production. Recent advancement in technology has introduced gold nanoparticles into the medical field. As studies of gold nanoparticles improve, several gold nanoparticles medical applications have been developed to help prevent the onset of infection and promote faster wound healing. The targeted drug delivery is one recent gold nanoparticles medical application in study.

MATERIALS AND METHODS

Preparation of the stock solution of chloraauric acid:

Chloroauric acid (HAuCl4) has been purchased from Lobal Chemie, and used as such without any further purification. 0. 339g of chloroauric acid was dissolved in 1 litre (1000 ml) of distilled water to attain a concentration of 10^{-3} M. This stock solution was further used for the synthesis of the nanoparticles with the required pH adjustments.

Preparation of the plant extracts for the synthesis:

About 8 samples were selected for the study. They were:

1. *Phyllanthus amarus*
2. *Syzygium aromaticum*
3. *Coriandrum sativum*
4. *Camellia sinensis (green tea)*
5. *Camellia sinensis (black tea)*
6. *Mentha arvensis*
7. *Mimusops elengi*
8. *Artabotrys hexapetalus*

***Coriandrum sativum* extract**

About 5 g of coriander leaves were weighed and washed under running water. The washed leaves were chopped into smaller pieces. 50 ml of distilled water was taken in a 200 ml Erlenmeyer conical flask and the chopped leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

***Camellia sinensis (green tea)*extract**

About 1. 5g of dried green tea leaves were weighed. 50 ml of distilled water was taken in a 200 ml Erlenmeyer conical flask and the leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

***Camellia sinensis (black tea)*extract**

About 1. 5g of black tea grains were weighed. 50 ml of distilled water was taken in a

200 ml Erlenmeyer conical flask and the leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

***Mentha arvensis* extract**

About 5 g of mint leaves were weighed and washed under running water. The washed leaves were chopped into smaller pieces. 50 ml of distilled water was taken in a 200 ml Erlenmeyer conical flask and the chopped leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

***Syzygium aromaticum* extract**

About 6 g (7-10) cloves were weighed. 50 ml of distilled water was taken in a 200 ml Erlenmeyer conical flask and the leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

***Artabotrys hexapetalus* leaves extract**

About 5 g of Artabotrys leaves were weighed and washed under running water. The washed leaves were chopped into smaller pieces. 50 ml of distilled water was taken in a 200 ml Erlenmeyer conical flask and the chopped leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

***Mimusops elengi* flowers extract**

About 5 g of Mimusops flowers were weighed and washed under running water. The washed flowers were further dried. 50 ml of distilled water was taken in a 200 ml Erlenmeyer conical flask and the dried leaves were added and kept on flame and boiled for 5 – 10 minutes. On cooling, the extract was collected through a filter and the collected extract was again filtered through a Whatman filter paper and the extract was stored at 4^0 and was used for further synthesis.

Synthesis of the gold nanoparticles:

To begin with, the pH of the chloroauric acid was checked and it was adjusted to alkaline ranging from pH 6. 5 to pH 8. 5. The amount of plant extract needed to reduce the chloroauric acid solution was in the ratio 1:10. For 10 ml of chloroauric acid about 1 ml of plant extract was added, which reduced the gold chloride into gold nanoparticles. The formation of wine red color indicated the synthesis of nanoparticles.

Rate of the synthesis of nanoparticles:

The time required for complete the reduction of nanoparticles depended upon the type of the extract used. The synthesis duration was at the minimum for green tea extract that yielded nanoparticles in less than 30 seconds and the maximum duration required was recorded to be 24 hours in case of other plant extracts like coriander, mint, P. amarus, manoranjitham and makizampo and for cloves and black tea extracts, the reduction was complete in 1 hour.

INTENSITY OF THE NANOPARTICLES PRODUCED:

The reduction of gold chloride into gold nanoparticles was indicated by the color produced during the reaction. The formation of pink / wine red / cherry red color indicated the complete synthesis of gold nanoparticles. Depending upon the intensity of the color produced, the nanoparticles can be further quantified.

RESULTS AND DISCUSSION

PREPARATION OF THE PLANT EXTRACTS FOR THE SYNTHESIS:

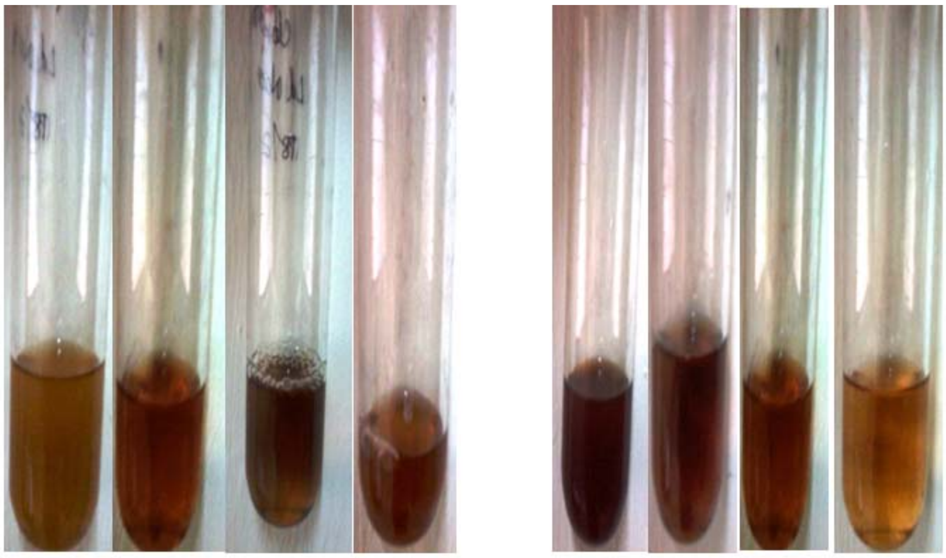
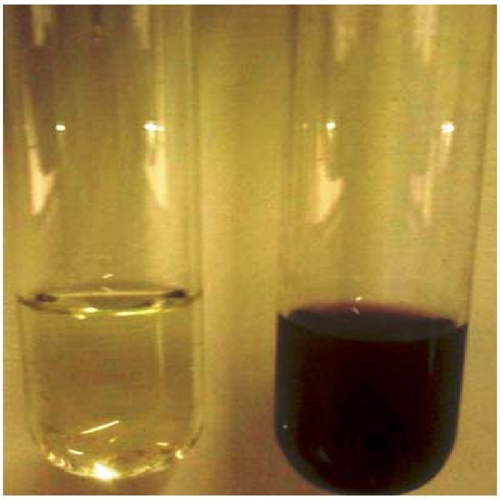


Figure :

1. ***Phyllanthus amarus*** **extract**
2. ***Syzygium aromaticum*** **extract**
3. ***Coriandrum sativum*** **extract**
4. ***Camellia sinensis (green tea)*****extract**
5. ***Camellia sinensis (black tea)*****extract**
6. ***Mentha arvensis*** **extract**
7. ***Mimusops elengi*** **flowers extract**
8. ***Artabotrys hexapetalus*** **leaves extract**

The plant extracts were stored at 4°C and used for a period of 7 months. All the extracts were crystal clear in nature. Similar results have been reported by Sumit. S. Lal and P. L. Nayak (2012).

SYNTHESIS OF THE GOLD NANOPARTICLES



A B

A = Chloroauric acid

B = Gold nanoparticles after addition of plant extracts

The plant extracts were used for the synthesis of gold nanoparticles using chloroauric acid or gold chloride. The extracts acted as the reducing and stabilizing agent in the process of synthesis. The presence of phytochemicals like phenols, tannins and other plant compounds and components were responsible for the reduction, so the extracts were further analyzed and estimated for the various chemicals compounds present in them. Similar synthesis has been reported by Sumit. S. Lal and P. L. Nayak (2012).

RATE OF THE SYNTHESIS OF NANOPARTICLES:

Type of the plant extract	Duration of synthesis
Camellia sinensis (green tea)	**<30 secs**
Syzygium aromaticum, Camellia sinensis (black tea)	**30 – 60 mins**
Coriandrum sativum, Mimusops elengi, Artabotrys hexapetalus, Phyllanthus amarus	**≤24 hours**

The results of the nanoparticles synthesized were in varying colours depending upon the plant extracts used.

It was ranging from deep wine red to pale pink in colour. Similar results were illustrated by Sumit. S. Lal and P. L. Nayak (2012).

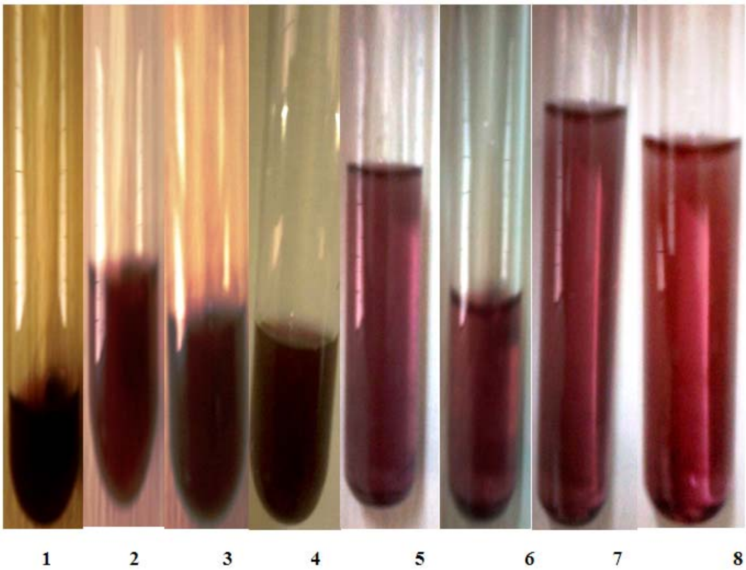


Figure:

1. ***Phyllanthus amarus* AuNP's**
2. ***Syzygium aromaticum* AuNP's**
3. ***Coriandrum sativum* AuNP's**
4. ***Camellia sinensis (green tea)* AuNP's**
5. ***Camellia sinensis (black tea)* AuNP's**
6. ***Mentha arvensis* AuNP's**
7. ***Mimusops elengi* AuNP's**
8. ***Artabotrys hexapetalus* AuNP's**

INTENSITY OF THE NANOPARTICLES PRODUCED:

The green tea extracts yielded the deepest wine red coloured nanoparticles of all the 8 extracts tested. The duration was as well rapid, which took place in less than 30 seconds. The synthesized nanoparticles were stable without aggregations of the particles. It has been stated that the intensity of the colour of the nanoparticles produced, is an indicative of the quantity of the nanoparticles present in the solution. This implies that the nanoparticles synthesized using green tea extract proves to be the most efficient source for the synthesis among the samples under study. Similar results were illustrated by Sumit. S. Lal and P. L. Nayak (2012).

Types of Nanoparticles from various extracts	Intensity of nanoparticles color produced
***Camellia sinensis (green tea)* AuNP's**	+++++
***Syzygium aromaticum* AuNP's**	+++++

***Camellia sinensis (black tea)*AuNP's**	+++++
***Coriandrum sativum* AuNP's**	++++
***Mimusops elengi* AuNP's**	+++
***Artabotrys hexapetalus* AuNP's**	+++
***Mentha arvensis* AuNP's**	+++
***Phyllanthus amarus* AuNP's**	+++

CONCLUSION

The increasing demand for the nanoparticles applications opens up new arenas in the process of its synthesis. We have dealt with a green synthesis in this study using various feasible, amply available and cost effective resources, the plant extracts. Among the 8 different extracts that were under the study, *Camellia sinensis (green tea)* yielded the rapidly synthesized gold nanoparticles. The synthesized gold nanoparticles were stable throughout the study which implies that the synthesized nanoparticles were highly stable. The least used plant samples for the synthesis have been exploited in the study including *Mimusops elengi*, *Artabotrys hexapetalus*, *Syzygium aromaticum, Coriandrum sativum*, *Camellia sinensis (black tea),* and the other plants *Mentha arvensis, Phyllanthus amarus* as well proved to be an effective reducing and stabilizing agents in the process of bioreduction of gold nanoparticles. Indeed, the gold nanoparticles have enormous potentialities, that makes them to be inevitable in almost all sectors, in the years to come.

SUMMARY

This integration of nanoparticles with biological molecules has lead to the development of diagnostic devices, contrast agents, and important tools in cancel therapy.

Nanobiotechnology describes an application of biological systems for the production of new functional material such as nanoparticles. Biosynthetic methods can employed either microorganism cells or plant extract for nanoparticles production. Biosynthesis of nanoparticles is an exciting recent addition to the large repertoire of nanoparticles synthesis methods and now, nanoparticle have entered a commercial exploration period.

Currently, there are many gold nanoparticles industrial uses that resulted in a boost in its demand and production. Recent advancement in technology has introduced gold nanoparticles into the medical field. As studies of gold nanoparticles improve, several gold nanoparticles medical applications have been developed to help prevent the onset of infection and promote faster wound healing. The targeted drug delivery is one recent gold nanoparticles medical application in study.

All the above mentioned studies yielded reliable results in favor of the gold nanoparticles. This implies that the research on gold nanoparticles will be definitely fruitful to the people and betterment of the society.

REFERENCES

[1] Ahmad, A. ; Mukherjee, P. ; Senapati, S. ; Mandal, D. ; Khan, M. I. ; Kumar, R. ; Sastry, M. (2003). Extracellular biosynthesis of silver nanoparticles using the fungus Fusarium

[2] Amin, I., Zamaliah, M. M., Chin, W. F., (2004). Total antioxidant activity and phenolic content in selected vegetables, Food Chem. 582-586.

[3] Applied Surface Sci., 255, 577-580(2008 B). Synthesis of silver nanoparticles using microorganisms, Materials Science-Poland, 26, 2, 419-424

[4] Annamalai A, Sarah Thomas Babu, Niji Anna Jose, D. Sudha and Christina V. Lyza. 2011 Biosynthesis and Characterisatiion of Silver and Gold nanoparticles using aqueous leaf extracts of Phyllanthus amarus Schum. & Thonn. World applied sciences Journal 13 (8): 1833-1840

[5] Bar, H. ; Bhui, Kr. D. ; Sahoo, P. G. ; Sarkar, P. ; De, P. S. ; Misra, A. (2009). Green synthesis of silver nanoparticles using latex of Jatrapha curcas, Colloids Surfaces, A. Physicochem. Eng. Aspects, 339, 134-139

[6] Begum, A. N. ; Mondal, S. ; Basu, S. ; Laskar, A. R. ; Mandal, D. (2009). Biogenic synthesis of Au and Ag nanoparticles using aqueous solutions of Black Tea leaf extracts, Colloids bimetallic Au core-Ag shell nanoparticles using Neem (Azadirachta indica) leaf broth. J. Colloid Inter. Sci., 275, 496-502

[7] Cai, W., T. Gao, H. Hong and J. Sun, 2008. Application of gold nanoparticles in cancer nanotechnology. Nanotechnology, Science and Applications, 1: 17-32. Cancer Letters, 269, 57-66

[8] Chah, S., R. M. Hammond and N. R. Zare, 2005. Gold nanoparticles as a colorimetric sensor for protein conformational changes. Chem Biol., 12: 323-328.

[9] Chandra, P. S. ; Chaudhary, M. ; Pasricha, R. ; Ahmad, A. ; Sastry, M. (2006). Synthesis of gold nanotriangles and silver nanoparticles using Aloe vera plant extract, Biotechnology Prog., 22, 577-583

[10] Ghosh, P. ; Han, G. ; De, M. ; Kim, K. C. ; Rotello, M. V. (2008). Gold nanoparticles in delivery applications, Advanced Drug Delivery Reviews, 60, 1307-1315

[11] Harbone JB (1984). “Phytochemical Methods: A Guide Modern Technique Of Plants Analysis”. Pp 126 – 129

[12] Jha, K. A. ; Prasad, K. (2009). Biosynthesis of silver nanoparticles using Cycas leaf broth. Joy PP, Thomas J, Mathew S, Sharia B P. Medicinal Plants. Kerela Agriculture University, Aromatic & Medicinal Plant Research Station. 1998, 299-301.

[13] Sumit. S. Lal and P. L. Nayak 2012 Green Synthesis Of Gold Nanoparticles Using Various Extract Of Plants And Spices International Journal of Science Innovations and Discoveries, Volume 2, Issue 3, May-June 2012 sundried Cinnamomum camphora leaf, Nanotechnology, 18, 1-11

[14] Sunil Pandey, Goldie Oza, Ashmi Mewada and Madhuri Sharon. 2012 Green Synthesis of Highly Stable Gold Nanoparticles using Momordica charantia as Nano fabricator Scholars Research Library Archives of Applied Science Research, 2012, 4 (2):1135-1141 Surfaces B. Biointerfaces, 71, 113-118