International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

Green Synthesis of Zinc Oxide Nanoparticles by using Hibiscus rosa-sinensis

R.Sharmila Devi[Ȧ*] and R. Gayathri[Ȧ]

[Ȧ]Department of Chemistry, Karpagam University, Coimbatore, Tamilnadu, India.

Accepted 10 July 2014, Available online 01 Aug 2014, **Vol.4, No.4 (Aug 2014)**

Abstract

The present study focus on green chemistry in the synthesis of Zinc Oxide nanoparticles by Zinc nitrate and utilizing the bio components of leaves extract of Hibiscus rosa-sinensis. The Zinc Oxide nanoparticles are known to be one of the multifunctional inorganic nanoparticles and Zinc Oxide crystallites have been synthesized by simple and ecofriendly method. There is a growing attention to biosynthesis the metal nanoparticles using organisms. Among these organisms ,plants seem to be the best candidate and they are suitable for large scale biosynthesis of nanoparticles.Nanoparticles produced by plants are more stable, and the rate of synthesis is faster than that in the case of other organisms.The particle size and morphology of the synthesized nanoparticles is characterized by using Scanning Electron Microscope(SEM), and X-ray Diffraction(XRD).

Keywords: *Zinc oxide nanoparticles, Hibiscus rosa-sinensis, Green synthesis, X-ray Diffraction, Scanning Electron Microscope.*

1. Introduction

Nanotechnology is emerging as a rapidly growing field with its application in science and technology for the purpose of manufacturing new materials at the nano scale level (MA. Albrecht et al, 2006). Recent advance in the field of nanotechnology, particularly the ability to prepare highly ordered nanoparticles of any size and shape, have led to the development of new biocidal agents. Nano-materials are called "a wonder of modern medicine". (Sangeetha gunalan et al, 2012). Nanotechnology is a multidisciplinary scientific field undergoing explosive development. nanometer-sized particles offer novel structural, optical and electronic properties that are not attainable with individual molecules or bulk solids(AnithaSiromani and Kiruba Daniel 2011). The characters of metal and metal oxide nanoparticles have been of great interest due to their distinctive feature such as catalytic activity, optical, magnetic and electrical properties (GarimaSinghal et al, 2010). Nanoparticles interaction with biological materials and established a series of nanoparticle / biological interfaces that depend on colloidal forces as well as dynamic biophysicochemical interactions. These interactions lead to the formation of new nanomaterial with control size shape,surface chemistry, roughness and surface coatings (Nel et al 2009). The use of plants for the synthesis of nanoparticlesis novel and provides a cost-effective and environmentally friendly alternative to chemical and physical synthesis. In addition, the use of plants can be easily scaled up for large-scale synthesis without the use of toxic chemicals or the need for high pressures, energy and temperatures. (Bhainsa KC etal 2006). Nanoparticles present a higher surface area to volume ratio with decrease in size, distribution and morphology of the particles (AklM.Awwad 1 et al,2012).

Zinc oxide (ZnO) is considered to be a technologically prodigious material having a wide spectrum of applications such as that of a semiconductor (Eg = 3.37 eV), magnetic material, electroluminescent material, piezoelectric sensor and actuator, naanostructure varistor, field emission displaying material, thermoelectric material, gas sensor, constituent of cosmetics etc(K Prasad et al, 2009). Often chemical synthesis methods like sol-gel process, micelle, chemical precipitation, hydrothermal method, pyrolysis, chemical vapour deposition etc. lead to the presence of some toxic chemical species adsorbed on the surface that may have adverse effect in medical applications. Some reactions require high temperature and / or high pressure for initiating the reaction, while some reactions require inert atmosphere protection, and /toxic matters such as H_2S, toxic templeate and stabilizer, and metallic precursors (Manish Hudlikar et al, 2010). In nanoparticles synthesis chemicals used are toxic and lead to non-ecofriendly by products (Garimasinghal et al, 2010). Use of biological organisms such as micro organisms, plant extract or plant biomass could be an alternative to chemical and physical methods for the production an eco-friendly manner on of nanoparticles(Bhattacharaya D etal). Several biological systems including bacteria, fungi and yeast have been used in synthesis of nanoparticles (G.Alagumuthu et al, 2012). Synthesis of nanoparicles using microorganism involves elaborate process of maintaining cell cultures, intracellular

*Corresponding author: **R.Sharmila Devi**

synthesis and multiple purification steps. In this regard using "green" methods in the synthesis of Zinc oxide nanoparticles has increasingly become a topic of interests as conventional chemical compounds/organic solvents as reducing agents (Cynthia Mason et al,2012)

The plant Hibiscus rosa-sinensis known colloquially as rose mallow Chinese hibiscus, China rose and shoe flower, is a species of flowering plant in the family Malvaceae, native to East asia. Hibiscus rosa-sinensis was named by Carolus Linnaeus. The latin term rosa-sinensis literally means "rose of China", though it is not closely related to the true roses. The flowers of Hibiscus rosa-sinensis are edible and are used in salads in the pacific Islands. The flower is additionally used in hair care as a preparation. It is also to shine shoes in certain parts of India. To the best of our knowledge, biological approach using leaf extract of Hibiscus rosa-sinensis has been used for the first time as a reducing material as well as surface stabilizing agent for the synthesis of ZnO nanoparticles. The structure, phase, and morphology of synthesized product were investigated by the standard characterization techniques.

2. Materials and Methods

Zinc nitrate ($ZnNO_3$) and glassware was purchased from Merck Chemical Reagent Co. Ltd. India. All glassware was washed with sterile distilled water and dried in an hot air oven before use. The procedure for the synthesis was referenced from literature (Gunalan Sangeethaa et al, 2012).

a. Preparation of the leaf extract

Hibiscus rosa-sinensis plant leaves were collected from the surroundings of Coimbatore. The leaves were washed several times with water to remove the dust particles and then dried light. The dried leaves were cutted and grinded for powder. The extract used for the reduction of zinc ions (Zn2+) to zinc nanoparticles (ZnO) was prepared by placing 5g of washed dried fine powdered leaves in 250 ml glass beaker along with 100ml of double distilled water. The mixture was then boiled for 60 minutes until the colour of the aqueous solution changes from watery to light yellow by using magnetic stirrer. The extract was cooled to room temperature and filtered using filter paper. The extract was stored in a refrigerator in order to be used for further experiments.

b. Preparation of zinc nanoparticles

For the synthesis of nanoparticle, 50ml of Hibiscus rosa-sinensis leaves extract was taken and boiled to 60-80 degree Celsius using a stirrer-heater. 5 grams of Zinc Nitrate was added to the solution as the temperatures reached 60 degree Celsius. This mixture is then boiled until it reduced to a deep yellow coloured paste. This paste was then collected in a ceramic crucible and heated in an air heated furnace at 400 degree Celsius for 2 hours. A light yellow coloured powder was obtained and this was carefully collected and packed for characterization purposes. The material was mashed in a mortar-pestle so as to get a finer nature for characterization.

3. Result and discussions

X-Ray Diffraction (XRD) Analysis

The powered sample was used by a Cu Kα - X Ray Diffractometer for confirming the presence of ZnO and analyse the structure. The peaks appeared at 2θ value ranging from 31.73°, 34.38°, 36.22°, 47.50°, 56.56°, 62.81°, 66.34°, 67.91°, 69.03° , 72.6° and 76.90° values corresponds to pure ZnO. The peaks of the graph are in good agreement with the literature report (Der Pharma Chemica, 2013, 5 (3):265-270). The location of the peaks was compared to literature values and the presence of zinc oxide particles was confirmed. The average size of the particles was calculated using Debye-Scherrer"s formula:

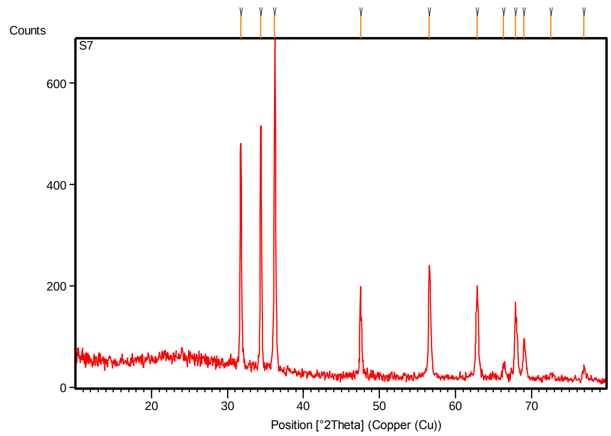

Fig. 1 XRD graph of ZnO nanoparticles

Scanning Electron Microscope (SEM) Analysis

The SEM analysis was used to determine the structure of the reaction products that were formed.

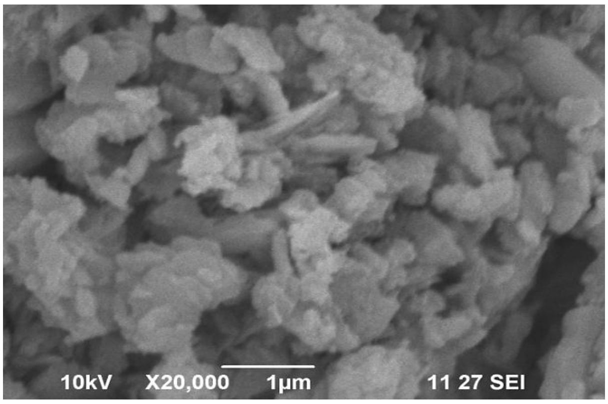

Fig. 2 SEM images of Zinc Oxide Nanoparticles

Thin films of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid, extra solution was removed using a blotting paper and then the film on the SEM grid were allowed to dry by putting it under a mercury lamp for 5 min . SEM image has showed individual zinc particles as well as a number of aggregates. The SEM image showed relatively spongy shape nanoparticle shown in Fig 2.

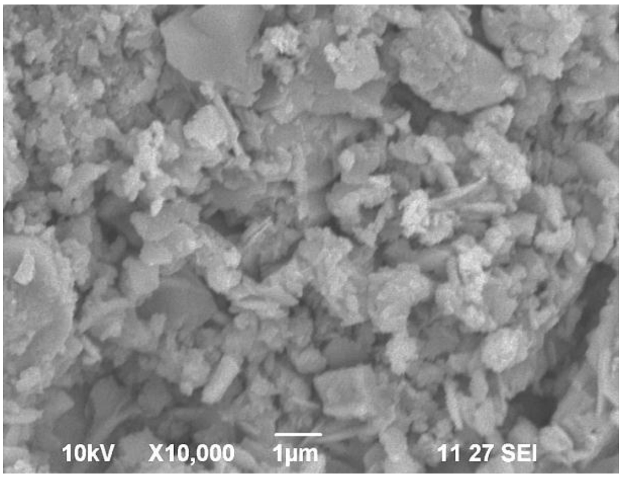

Fig. 3 SEM images of Zinc Oxide Nanoparticles

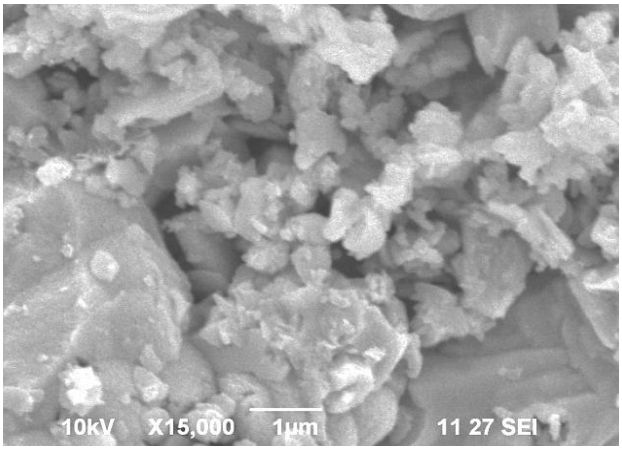

Fig. 4 SEM images of Zinc Oxide Nanoparticles.

Conclusions

The biological production of metal nanoparticles is becoming a very important field in chemistry, biology, and materials science. Metal nanoparticles have been produced chemically and physically for a long time; however, their biological production has only been investigated very recently. The biological reduction of metals by plant extracts has been known since the early 1900s; however, the reduction products were not studied. The rapid biological synthesis of zinc nanoparticles using leaf extract of Hibiscus rosa-sinensis provides an environmental friendly, simple and efficient route for synthesis of nanoparticles. The use of plant extracts avoids the usage of harmful and toxic reducing and stabilizing agents. The synthesized nano crystallites of ZnO are in the range of 30-35 nm. Zinc nanoparticles can exist in ions only in the presence of strong oxidizing substances. The environmental conditions will affect the stability of nano particle. The synthesis of ZnO nano particles is still in its infancy and more research needs to be focused on the mechanism of nanoparticle formation which may lead to fine tuning of the process ultimately leading to the synthesis of nanoparticles with a strict control over the size and shape parameters.

References

MA Albrecht, CW Evan, CL Raston, (2006), Green chemistry and the health implications of nanoparticles. *Green chemistry*, Vol.3, No.8, pp.417-432.

Sangeetha Gunalan, Sivaraj Rajeswari, Rajendran Venckatesh (2012), Green synthesized ZnO nanoparticles against bacterial and fungal pathogens. *Progress in Natural science: Materials International*.2012;22(6): 693-700

Anitha Siromani and Kiruba Daniel Garima Singhal, RijuBhavesh, Kunalkasaraiya, AshishRajanan Sharma, Rajendra Pal Singh(2011), Biosythesis of silver nanoparticles using Ocimum sanctum (Tulsi) leaf extract and screening its antimicrobial activity, *Journal of Nanoparticle Research* , Vol.13,pp.2981-2988

Nel, A.E, Maidler L, Velegol D, Xia T, Hoek E. M.V, Somasundaram, P.L, Klaessig F, Castranova V, Thompson M. *Natural Material* ,2009, 8, 543

Bhainsa KC, D.Souza S.Extracellular biosynthesis of silver nanoparticles using the fungus Aspergillus fumigates. *Colloids surface B Biosurfaces*,-2006:47(2):160-164

Bhattacharya D and Rajinder G, Nanotechnology and potential of microorganisms. Crit Rev Biotechnology (2005) 25: 199-204.

Ponarulselvam, Pannerselvam, Murugan, Aarthi, Kalimuthu, Thangamani (2012), Synthesis of Silver nanoparticles using leaves of Catharanthus roseus Linn. G. Don and their antiplasmodial activities, *Asian pacific Journal of Tropical Biomedicine*, pp.574-58.

GarimasSinghal, RijuBhavesh, KunalKasariya, AshishRanjan Sharma, Rajendra Pal Singh (2011), Biosynthesis of silver nanoparticles using Octimum sanctum (Tulsi) leaf extract and screeming its antimicrobial activity, *Journal of nanoparticle Research,* Vol.13,pp.2981-2988.

Akl M. Awwadl, Nida M. Salem, Amany O, Abdeen (2012), Biosynthesis of Silver Nanoparticles using Oleaeuropaea Leaves Extract and its Antibacterial Activity, *Nanoscience and Nanotechnology*, Vol.2, No.6,pp. 164-170.

Manish Hudlikar, ShreeramJoglekar, Mayur Dhaygude and KisanKondam (2012), Latex-medicated synthesis of ZnS nanoparticles, *Journal of Nanoparticle, Research*, Vol.14, pp.865.

Cynthia Mason, Singaravelu Vivekanandha, ManjusriMisra, Amar Kumar Mohanty (2012), Switchgrass (Panicumvirgatum) Extract Medicated green Synthesis of Silver Nanoparticles, *World Journal of Nano Science and Engineering*, Vol.2,pp.47-52.Naheed Ahmad Seema Sharma (2012), Green Synthesis of Silver Nanoparticles using Extract of Ananas Comosus, *Green and Sustainable Chemistry*, Vol.2, pp.141-147.

G.Alagumuthu&R.Kirubha (2012), Green Synthesis of silver nanoparticles using Cissusquadrangularis plant extract their antibacterial activity University, *International Journal of Nanomaterials and Biostructures*, Vol.2,No.3,pp.30-33

Samira Bagheri, Chandrappa K. G. and Sharifah Bee Abd Hamid, Facile synthesis of nano-sized ZnO by direct precipitation method, *Der Pharma Chemica*, 2013,5(3):265-270.