INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

Synthesis and characterization of zinc oxide nanoparticles using aqueous extract of Banana Peel (Musa acuminata L.)

R. Ananthalakshmi [1]*, S. R. Xavier Rajarathinam[2], A. Lavanya[1], A. Mohammed Sadiq[3] and A. C. Gomathi[1]

[1]Department of Biochemistry, Sacred Heart College (Autonomous),Tirupattur,TamilNadu, India.
[2]Department of Chemistry, Sacred Heart College (Autonomous), Tirupattur , Tamil Nadu, India.
[3]Department of Biochemistry, Adhiparasakthi College of Arts and Science, Kalavai, TamilNadu, India.

ABSTRACT

The synthesis of metal nanoparticles in eco friendly way is gaining attention. Green synthesis of nanoparticles utilizes organisms and plants. Nanoparticles produced by plants are more stable and more varied in shape and size in comparison with those produced by organisms. The zinc oxide nano particles have wide applications in agriculture, pharmaceutical, medicine, cosmetics and so on. The present study investigated a simple recyclable approach for synthesis and characterization of zinc oxide (ZnO) nano particle by green synthesis method. Zinc oxide nano particles are synthesized using banana peel extract. The synthesized ZnO nanoparticles have been characterized by UV –Vis absorption spectroscopy, Fourier transform infrared spectroscopy (FT-IR) and Scanning electron microscopy (SEM). Also, the study includes the antimicrobial activity of the synthesized zinc oxide nanoparticles against Gram positive bacteria, Staphylococcus aureus.

KEY WORDS: Antibacterial activity, Banana peel , Nanoparticles, SEM , FTIR and UV- Vis Spectroscopy.

1. INTRODUCTION

Green synthesis of nano particle is an innovative branch of nanotechnology; it depends on plant source and the organic compound in the crude leaf extract. Many research works has been carried out concerned with green synthesis of nano particles [1].

The zinc oxide nano particle is an interesting semi conductor, Synthesis of zinc oxide nano particle done by using raw materials as chemical compounds zinc nitrate, zinc sulfate or zinc acetate. The chemicals are at the moment still imported in to Indonesia with a very expensive price. A potential source of raw materials containing high zinc is galvanized industrial waste in the form of zinc dross. It contains zinc up to 90 % -98 %.Nano particle used for dye contaminants from many other industries like fabric, printing, manufacturing, etc, show a vital role in damaging the environment.

Banana peels is an common wastage of day today life. Banana peels act as a great shoe polish, just rub it around your shoe and then buff it with a white cloth. It is used for Teeth Whitener, pain

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

reliever, Heals Bites by Bugs, Heals Psoriasis. It contains many nutritional values. They are act as rich source of soluble and insoluble fiber. They can fight against cholesterol, boost in our mood, antioxidant, protects eye and to prevent anemia by stimulating the production of hemoglobin in the blood. Its role to regulate blood pressure has been associated with the high content of potassium. Banana peel can cure heart burns stress, strokes, ulcers and many other ailments. The peels have been reported to be useful in making banana charcoal, an alternative source of cooking [2] liniment for reducing the acuteness of the arthritis, aches and pains.

In this study, we report the first time a novel, rapid cost effective and environmentally biosynthesis of Zinc oxide nano particle using *Musa acuminate L.* Peel extract. The structure of the synthesized product was investigated by the standard characterization and determined their antibacterial activity.

2. MATERIALS AND METHODS

2.1 COLLECTION OF PLANT SAMPLE

The peel of *Musa acuminata* used in this study was collected form Govindhapuram village, Tirupattur, Vellore district.

Figure 1: Banana (Musa acuminata) Tree

Figure 2: Peel of Musa acuminate

2.2 PREPARATION OF AQUEOUS BANANA (*Musa acuminata*) PEEL EXTRACT

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

After collection of *Musa acuminate* (banana) peel were separated and washed several times with distilled water to remove the dust particle and then shade dried to remove the residual moisture. The extract used for the reduction of zinc ions (Zn^{2+}) to Zinc oxide nano particles (ZnO) was prepared by placing 50 g of dried fine peel powder along with 1 liter of sterile distilled water and then boiled for 20 minutes at 60 °C. Cooled to room temperature and filtered using filter paper. The extract was stored in the refrigerator for further experiments.

2.3 SYNTHESIS OF ZINC OXIDE NANO PARTICLE

To synthesis the zinc oxide nanoparticle, 500 ml of *Musa acuminata* peel extract was taken in a clean conical flask. And 10 g of Zinc nitrate was added to the solution and mixed thoroughly and kept in shaker incubator for 2 hours at 150 rpm. After incubation that mixture was allowed to cool down to room temperature. And the solution was centrifuged for 15 minutes at 4000 rpm. After centrifugation supernatant was discarded and obtained pellet was separated and kept in hot air oven for seven hours at 80 °C. The resultant sample was collected and smashed in a mortar and pestle so as to get a finer nature for further characterization of zinc oxide nano particles and stored in air tight container [3].

2.4CHARACTERIZATION STUDIES OF ZINC OXIDE NANO PARTICLES

2.4.1 UV- VISIBLE SPECTRUM FOR SYNTHESIZED NANO PARTICLES

The sample was measured for its maximum absorbance using UV-Vis spectrophotometer. The optical property of ZnO nano particles was analyzed via ultraviolet and visible absorption spectroscopy (UV-Vis-Ais- Model 60 Bio) in the range of 200-600nm.

2.4.2 FTIR ANALYSIS FOR SYNTHESIZED NANO PARTICLES

The FTIR spectrum was taken in the mid-IR region of 400-4000 cm^{-1}. The spectrum was recorded using ATR (Attenuated Total Reflectance) technique. The dried sample was mixed with the KBr (1: 200) crystal, and the spectrum was recorded in the transmittance mode (RUDAR ELMER-Spectrum- 2).

2.4.3 SEM ANALYSIS FOR SYNTHESIZED NANO PARTICLES

Scanning electron microscope (SEM) analysis was done by using Hitach S 2500 SEM Machine. Thin film of the sample was prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid. The extra solution was removed using a blotting paper and then the film on the SEM grid was allowed to dry putting it under a mercury lamp for 5 minutes.

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

2.4.4ANTIBACTERIAL ASSAY

Many systematic methods have been adopted to evaluate the antibacterial activity of ZnO nano particles. One of the most used the well diffusion method. Presently, *Staphylococcus aureus* (gram-positive) is mainly chosen as model bacteria to evaluate the antibacterial activity of ZnO nano particles.

2.4.4.1 INOCULUM PREPARATION

Twenty four hour old culture of selected bacterial broth prepared by inoculating a loop full of mother culture in to the tubes containing 5 ml of broth (nutrient agar) which were incubated at appropriate time and temperatures (37 °C for 24 hours).

2.4.4.2 PREPARATION OF TEST SOLUTION

The test solution was prepared with known weight of sample dissolved in 5% dimethyl Sulphoxide (DMSO) corresponding to 10, 20 and 30 µl/ ml.

2.4.4.3 DETERMINATION OF ANTIBACTERIAL ACTIVITY

The Agar well diffusion method was followed for antibacterial activity. The muller hinton agar was prepared, poured on petriplates and allowed to solidify. After solidification, 0.1 ml of standardized microbial inoculums suspension was poured and uniformly spread. The excess inoculums was drained and the plates were allowed to dry for 5 minutes. After drying, samples were placed on the surface of the plates with sterile pipette. Biosynthesized sample (10 µl, 20 µl, 30 µl, and 40 µl/ ml) were used and the DMSO (5 %) was used as a blind control. Finally the inoculated plates were incubated at 37 °C for 24 hours .The zone of inhibition was observed and measured in millimeters. This experiment was repeated for four times.

3. RESULT AND DISCUSSION

3.1 UV- VIS SPECTROSCOPY ANALYSIS

Optical properties of the prepared zinc oxide nano particles sample was revealed by UV-Vis spectrum at room temperature as shown in figure 3. It can be seen form the result that there was intensive absorption in the ultraviolet band of about 220-600 nm. The maximum absorption wavelength was seen at about 351 nm.

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

Similar result was reported in the Pyrus pyrifolia leaf extract-mediated bio reduction of Zinc oxide nano particles where they had absorbance of 376nm[4]. The difference in the absorption may be due to the difference in the reducing activity of our peel extract.

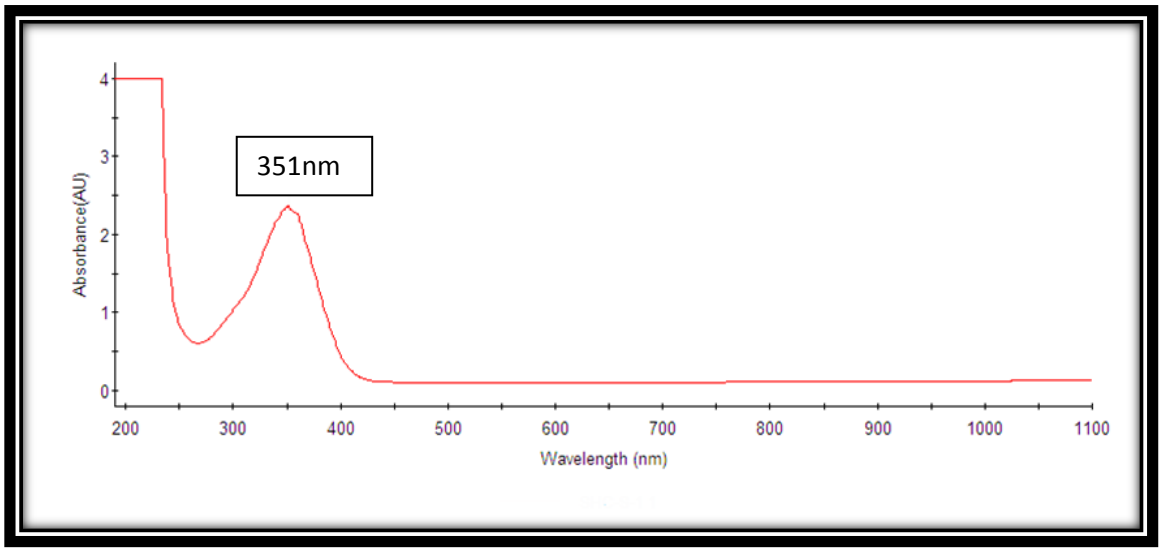

Figure 3: UV- Vis Spectra analysis

3.2 **FTIR ANALYSIS**

According to the Figure: 4, it is observed that the bands are at 3048.40 cm^{-1}, 2427.25 cm^{-1}, 1633.81 cm^{-1}, 1075.28 cm^{-1}, 769.68 cm^{-1} and 598.88 cm^{-1}. The FTIR spectrum of ZnO nano particles was recorded in the range of 400-4000 cm^{-1}. The peak in the region between 400 and 600cm^{-1} is allotted to ZnO region [5].

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

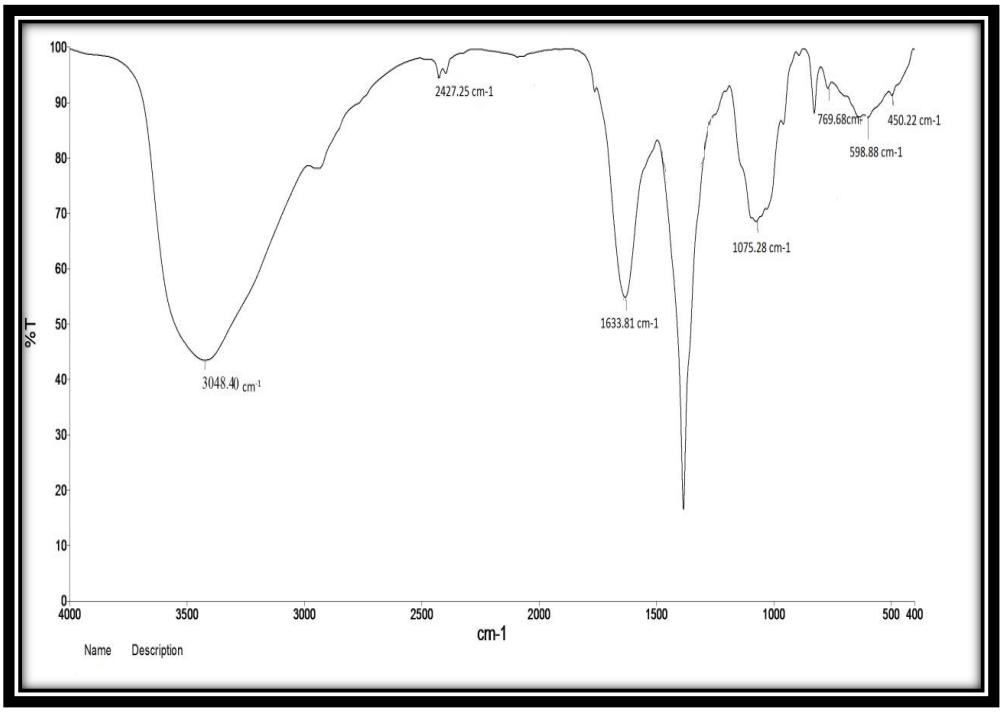

Figure 4: FTIR Analysis

The peak at 3048.40 cm^{-1}reveal that the presence of (O-H) bond, 2427.25 cm^{-1}corresponds to Amine (N-H), 1633.81 cm^{-1} peak observe Amide (C=O), 1075.28 cm^{-1}peak contain Ester(C-O), 769.68 cm^{-1}peak observe Alkyl Halide, 598.88 cm^{-1} peak observe Alkyl (C-Br). The band observed at 450 cm^{-1} from the FTIR spectra of *Musa auminata* L. peel extract is due to the functional group ZnO, as the peak in the region between 400 – 600 cm-1 was allotted to ZnO region[6]. So, the band located at 450 cm-1was observed due to the reduction and stabilization of metal group ZnO Gnanasangeetha and Thambavani [7] also got the ZnO FTIR band between 540 - 417cm-1. The narrow and strong diffraction peaks indicate the well crystalline nature of zinc oxide [8].

Functional group	**Type of vibration**	**Characteristic absorption(cm^{-1})**
Alcohol(O-H)	Stretch, H bond	3048.40 cm^{-1}
Amine(N-H)	Stretch, bending	2427.25 cm^{-1}
Amide(C=O)	Stretch	1633.81 cm^{-1}
Ester(C-O)	Stretch	1075.28 cm^{-1}

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

Alkyl Halide	Stretch	769.68 cm^{-1}
Alkyl(C-Br)	Stretch	598.88 cm^{-1}
Zinc oxide	Stretch	450 cm^{-1}

Table 1: FTIR

3.3 SEM (Scanning Electron Microscope) ANALYSIS

SEM studies were revealed to visualize the size and shape of zinc oxide nano particle as shown in Fig 5. The synthesized ZnO nano particles were agglomerated with a particle size range of 350nm at 1μm resolution. The obtained ZnO nano particles was appeared with that most of spherical in shape.

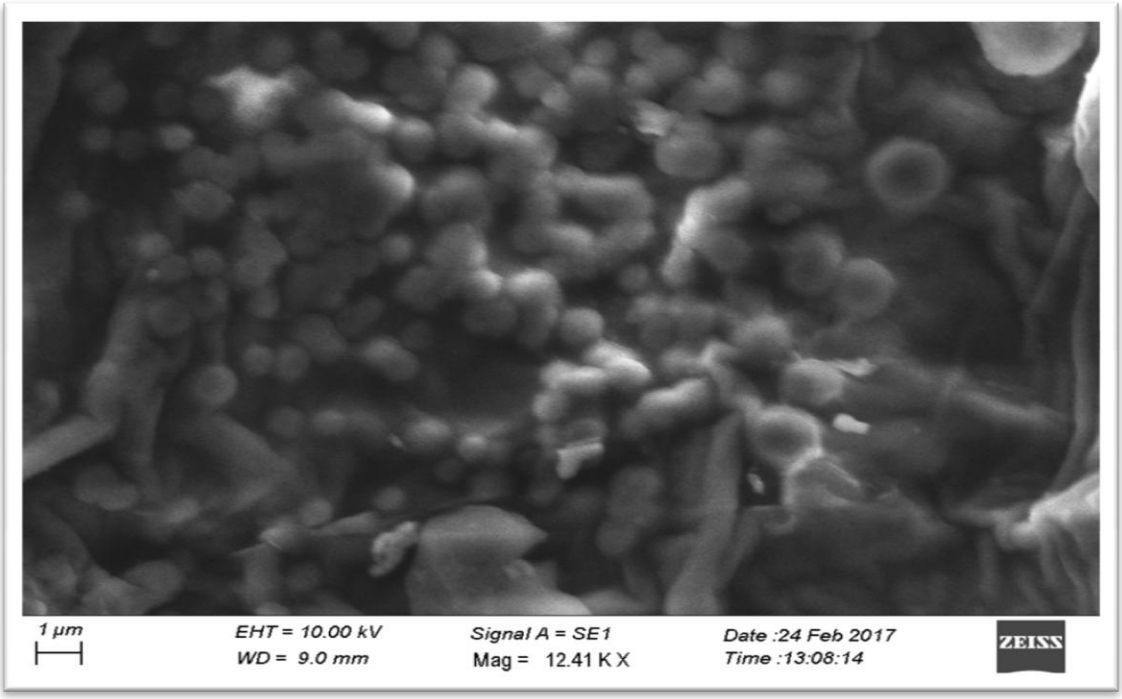

Figure 5: SEM analysis

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

Figure 6: Antibacterial activity

.

From the SEM images it was observed that the particles were well shaped. Most of the particles were hexagonal in shape. The average crystallite size was obtained by drawing histogram for the SEM image[9] .

3.4 ANTIBACTERIAL ACTIVITY

Antimicrobial activities against ophthalmic pathogens, generally, the nano particles bind with the thiol (-SH) groups of protein that destroy the cell wall. But in the case of resistance bacteria, the possible mechanism of activity is, the nano particles might inhibit the production of enzyme which

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

INTERNATIONAL JOURNAL OF BASIC AND APPLIED RESEARCH
www.pragatipublication.com
ISSN 2249-3352 (P) 2278-0505 (E)

involved in the drug deactivation process or the particles block the efflux pump pathway which involved drug elimination process[10].

Table 2: Antibacterial activity of biosynthesized zinc oxide nano particles

S.No	Bacteria	Zone of Inhibition (dm in mm)			Blind control (0.5 % DMSO)
		10 µl/ml	20 µl/ml	30µl/ml	20 µl
1.	*Staphylococcus aureus*	13mm	17mm	19mm	No zone

The results of antibacterial activity of synthesized zinc oxide nano particles were found highly toxic against human pathogenic bacteria. Zinc oxide nano particles exhibit anti bacterial activity against *Staphylococcus aureus* as it shows a clear inhibition zone at the concentration of 30µl/ml. The result confirmed that these particles which can be prepared in a easy, quick and cost effective manner are suitable for the formation of new types of antibacterial agents. The similar antibacterial activity was recorded by the ZnO nanoparticles prepared using Luffa acutangula peel extract[11].

CONCLUSION

The innovative nano particle synthesis system developed in this work applies to precipitation method to produce ZnO nano particles. Experimental result shows that the high frequency bio synthesis precipitation method developed in this research to undergo nano particle synthesis. As well as the, ZnO nano particles of pure quality can be directly produced.. The properties of the produced nano particle suspension have been identified by the UV-Vis spectroscopy, FTIR and SEM analysis and Antibacterial activity of peel aqueous extract showed hopeful antibacterial activity against bacterial human pathogens.

REFERENCE

1. Noorjahan, C.M., S. K. Jasmine Shahina, T. Deepika and Summera Rafiq. 2015. A biogenic approach for the synthesis and characterization of ZnO nanoparticles produced by *Tinospora cordifolia*. *International Journal of Pharmacy and Pharmaceutical Sciences,* 7(8): 5751 - 5753.

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED

ISSN 2249-3352 (P) 2278-0505 (E)

2. Chaitali Chakraborty, Arunima Mukherjee, Bornini Banerjee , Shubham Mukherjee and Kakali Bandyopadhyay.2017. Utilization of banana peel and pulp as a functional ingredient in product development: A Review. *Int. J. Engg. Res. & Sci. & Tech*, 6(1): 1-14
3. Vijaylaxmee Mishra, Richa Sharma, 2015 "Green Synthesis of Zinc Oxide Nano particles Using Fresh Peels Extract of *Punica granatum* and its Antimicrobial Activities*" International Journal of Pharma Research and Health Sciences*, 3(3): 694 – 699.
4. Parthiban C., and N. Sundaramurthy, 2015. "Biosynthesis, Characterization of ZnO Nano particles by Using *Pyrus Pyrifolia* Leaf Extract and Their Photocatalytic Activity*". International Journal of Innovative Research in Science, Engineering and Technology.* 4(10):340-350.
5. Yuvakkumar, R., J. Suresh, B. Saravanakumar, A. Joseph Nathanael, A. Sun Hong and V. Rajendran. 2015. Rambutan peels promoted biomimetic synthesis of bioinspired zinc oxide nanochains for biomedical applications. *SpectrochimicaActa Part A: Molecular and Biomolecular Spectroscopy*, 137: 250–258.
6. Supraja, N., T. N. V. K. V. Prasad, T.Giridhara Krishnaand E. David. 2015.Synthesis, characterization, and evaluation of the antimicrobial efficacy of *Boswellia ovalifoliolata* stem bark extract mediated zinc oxide nanoparticles. *Applied Nanoscience,* 204: 15-20.
7. Gnanasangeetha, D and S. D. Thambavani. 2014. Facile and eco-friendly method for the synthesis of zinc oxide nanoparticles using *Azadirachta* and *Emblica. International Journal of Pharmaceutical Sciences and Research,* 5 (7): 2866 - 2873.
8. Rajivgandhi, S., A. Dinesh Kumar, R. Sundareshwaran and V. Vineeth. 2015. Synthesis and Characterization of ZnO Nanoparticles, *International Journal of Innovative Research in Technology, Science and Engineering,* 1(5): 73-78.
9. Geetha. M.S., H. Nagabhushana H.N. Shivananjaiah, 2016. "Green mediated synthesis and characterization of ZnO nano particles using Euphorbia Jatropa latex as reducing agent". *Journal Of Science Advanced Materials And Devices,* 4(2): 301 - 310.
10. Manish Hudlikar, ShreeramJoglekar, Mayur Dhaygude and KisanKondam, 2012, Latex-medicated synthesis of ZnS nanoparticles, *Journal of Nanoparticle, Research*, Vol.14, pp.865.
11. Ananthalakshmi, R., Xavier Rathinam.S.R.,Muthukumari.M.,Gomathi.A.C and Mohammed Sadiq, 2017, Synthesis and characterization of zinc oxide nanoparticles using peel extract of *luffa acutangula* and its antibacterial activity against *staphylococcus aureus, Life Science Archieves*,3(1): 876-882.

Received: 5 November Revised: 13 November Accepted: 22 November
Index in Cosmos
Volume 7 Number 12
UGC APPROVED