OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

ANTIBACTERIAL ACTIVITY OF IRON NANOPARTICLES SYNTHESIZED FROM GREEN TEA LEAVES EXTRACT

Karthikeya Srinivasa Varma Gottimukkala[1], Aparna Silamkoti[2], Jaya Manasa Vedula[3]
Department of Biotechnology, Sreenidhi Institute of Science and Technology, Ghatkesar, Hyderabad, India[1 2 3]

Abstract: ***The research and development of Iron Nanoparticles has been increased in the recent years due to their incredible applications today. Physical and Chemical methods are used for synthesis of Nanoparticles, however due to their limitations, the focus of research has been shifted towards the development of clean and eco-friendly synthesis protocols of synthesizing them. We used an environmental friendly approach to synthesize the Iron Nanoparticles using the Green Tea Leaves Extract which acts as an reducing agent. It was observed that Camellia sinensis leaf extract can reduce Iron ions into Iron Nanoparticles at room temperature. The characterization of the synthesized Iron Nanoparticles was done using FTIR(Fourier Transform Infrared) analysis and SEM(Scanning Electron Microscope). The Antibacterial activity of the synthesized Iron Nanoparticles was investigated using well-diffusion method. The bacterial strains have shown good antibacterial activity.***

Keywords *— Iron Nanoparticles, Antibacterial activity, Camellia sinensis.*

----------∴∴∴----------

I INTRODUCTION

Nanotechnology can be defined as the manipulation of matter through certain chemical or physical processes to create materials in nano(10^{-9}) meters level (1-100 nanometers) with specific properties which can be used in various applications[1]. The advantage of Nanoparticles is the presence of large surface area to volume ratio[2]. Biosynthesis of Nanoparticles is an bottom up approach where the reaction is either reduction or oxidation [3]. The Green synthesis provides advancement over chemical and physical methods as it is environmental friendly, cost effective, easily scaled up for large scale synthesis and the method doesn't requires the use of high pressure, toxic chemicals and high temperature [4].

In the last decades, the treatment involved in infections caused by bacteria has become more complicated due to the emergence of the resistance mechanisms which has resulted in life threatening infections. This led to the search of alternate materials which can be used as antibacterial agents[5]. In the area of antibacterial agents, metal nanoparticles are of particular interest as they could be synthesized with highly potential active sites and with high surface area[6].

Nanoparticles have expressed significant advances owing to wide range of applications in the field of bio-medical[7], sensors[8], catalysts[9], electronics[10], photocatalysis[11], etc. The Iron Nanoparticles are found to be having distinctive magnetic properties and superior biocompatibility. In this study, The Iron Nanoparticles were synthesized using Green Tea Leaves extract and the antibacterial activity was studied against human pathogen such as Escherichia coli which can cause various diseases such as anemia, urinary tract infections, diarrhea etc, although most of the E.coli strains are harmless.

II MATERIALS AND METHODS

The Camellia sinensis leaves (Green Tea) was obtained from a commercial vendor – Lipton green tea. The Metal Precursors used in this experiment was Anhydrous Ferric Chloride from Hi Media. Throughout the synthesis or solution preparation, De-ionised water was used.

1. Preparation of Green Tea Leaves Extract (Reducing Agent)

The extract of the tea was prepared by taking 25gm of tea in 500ml of de-ionised water. The solution was heated at 80 Celsius in water bath to get the extract. The extract was cooled,

collected and filtered. The filtered solution was collected and stored in a clean beaker.

2. Synthesis of Iron Nanoparticles

The synthesis of Iron Nanoparticles was done by adding 0.01 M Ferric Chloride and the Green Tea leaves Extract in 1:1 proportion in a clean sterilized flask. The resulting solution from the addition of Ferric Chloride and Extract was black in color. The change of color was immediate. The solution was centrifuged was the supernatant was discarded. The pellet was washed twice again and centrifuged again to remove any impurities.

Figure 1: Black pellets sedimented during centrifugation showing the synthesis of Iron nanoparticles

3. Antibacterial Studies

The Bacterial strains of Escherichia coli were grown in Luria-Bertani(LB) at 37 Celsius with continous shaking at 250 rpm for 24 hours. 50µl of the bacterial culture was spread on LB agar plates with the help of Sterile L glass rod. Wells were developed on each plate using sterile steel borer of 10mm diameter and 50µl of the Iron nanoparticles suspension was loaded into the wells. The plates were incubated for 24 hours at 37 Celsius and the diameter of the inhibition zones was recorded in mm. The experiment was repeated thrice and the average values were calculated for antibacterial activity.

III DISCUSSION

Reduction Mechanism of Green Tea

The Camellia sinensis(Green Tea) has polyphenols which are responsible for the reduction of salt precursors to Nanoparticles. The polyphenols consists of Flavanoids and Catechins.The Epigallocatechin Gallate (EGCG) which is a an active catechin, takes part in reduction process because of its standard potential of 0.58 V that can reduce the Fe^{3+} to Fe^{0} as the Standard potential of the iron is -0.036 V. The reduction mechanism takes place in two steps, first when precursor is added it first forms a complex by breaking the –OH bond and forming a partial bond with a metal ion. Secondly, there is a breakage of the partial bond and the transfer of electrons to reduce the metal ions to nanoparticles, and thus itself get oxidize to ortho-quinone.

Characterization

The morphology and size were verified by characterizing the samples by FTIR to study the functional groups and SEM for diameter of the nano particles.

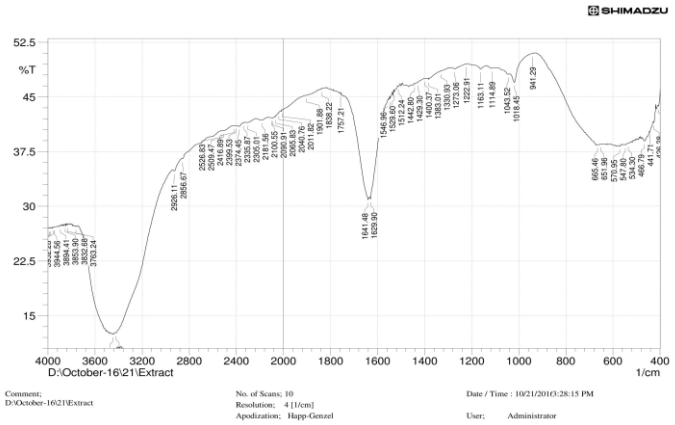

Figure 2: FTIR of Extract

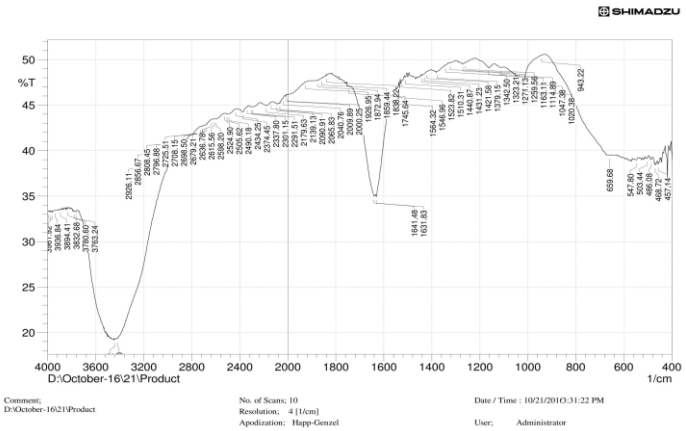

Figure 3: FTIR Product

FTIR analysis of synthesized Iron nanoparticles and Camellia Sinensis extract was done to analyse and evaluate the attached biomolecules to the Iron nanoparticles. The FTIR of extract showed vibrations stretching at 1640 cm^{-1} for C=C and 3449 cm^{-1} for O-H. The C-H and C-N adsorption bands were also observed at 2930 and 1379 cm^{-1}.

Comparing the FTIR of product i.e Iron nanoparticles, It showed wide stretch of O-H group at 3420 cm^{-1}, C=C at 1635 cm^{-1} , C-H at 2925 cm^{-1} , and C-O-C and C-N at 1025 and 1375 cm^{-1} which matches almost to the extract. The oxidized polyphenols on the synthesized Iron Nanoparticles were examined. It may be assumed that the polyphenols in the Camellia sinensis extract may function as reducing agent and capping agent.

SEM Images of Iron Nanoparticles

Average diameter of Iron Nanoparticles was found to be 128nm.

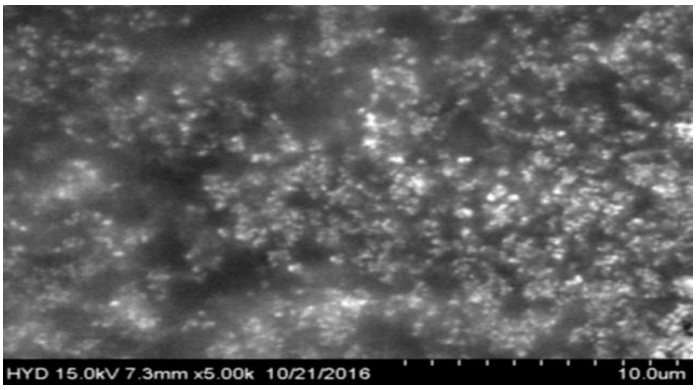

Figure 4:SEM of synthesized Iron Nanoparticles

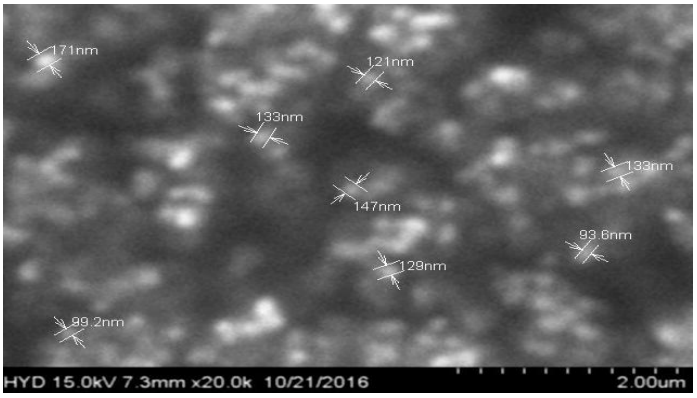

Figure 5: Zoomed image of Iron Nanoparticles

Antibacterial studies

The synthesized Iron Nanoparticles were found to be susceptible to the E.coli bacteria. The antibacterial studies were repeated thrice and the average value was of the Zone of Inhibition was found to be 8mm. The zone of Inhibition is shown in the figure.

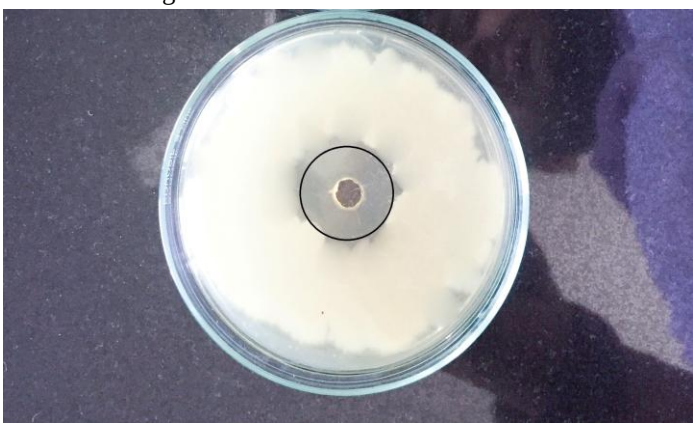

Figure 6:Zone of Inhibition caused by the Synthesized Iron Nanoparticles

IV RESULT

The Iron Nanoparticles were synthesized in an eco-friendly and easy way using Camellia sinensis leaves extract which acted as an reducing agent and the Antibacterial(E.coli) effect of the synthesized Iron Nanoparticles was successful.

V CONCLUSION

As a result of this study, Iron Nanoparticles were synthesized successfully in an easy and less time consuming way using Camellia sinensis leaves extract. The Polyphenols in Green Tea extract may possess the properties of reducing the ferric cations and also act as capping agents.It also shows that the synthesized Iron Nanoparticles from Green Tea Leaves Extract has an Antibacterial property.

ACKNOWLEDGEMENT

I acknowledge the assistance of Dr Biotechnology Department for helping me in completing the V Sesha Srinivas , Mrs Deveka Zamare, Harika reddy of Biotechnology Department for helping me in completing the project.I'm indebted to them for valuable comments and suggestions.

REFERENCES

[1] O V Salata, Applications of nanoparticles in biology and medicine, Journal of Nanobiotechnology, 2004.

[2] Vijayshree Sharma and Dr Jyothi Sharma, Electron microscopy study of green synthesized zero valent Iron nanoparticle, International Journal of Engineering Technology Science and Research, 2017.

[3] Naik, R.R.; Stringer, S.J.; Agarwal, G.; Jones, S.; Stone, M.O. Biomimetic synthesis and patterning of silver nanoparticles. Nat. Mater, 2002.

[4] Ahmad, A. and Sastry, M.A. Biological synthesis of triangular gold nanoprisms. Nat. Mater, 3, 2004.

[5] R. P. Allaker, "The use of nanoparticles to control oral biofilm formation," Journal of Dental Research, vol. 89, no. 11.

[6] Stoimenov, P.K., Klinger, R.L., Marchin, G.L., Klabunde, K.J.: Metal oxide nanoparticles as bactericidal agents. Langmuir 18(17), (2002)

[7] A. K. Gupta and M. Gupta, "Synthesis and surface engineering of iron oxide nanoparticles for biomedical applications," Biomaterials, vol. 26, 2005.

[8] K. Jagajjanani Rao and S. Paria, "Green synthesis of silver nanoparticles from aqueous Aegle marmelos leaf extract," Mater. Res. Bull., vol. 48, 2013.

[9] T. Shahwan, S. Abu Sirriah, M. Nairat, E. Boyaci, a. E. Eroğlu, T. B. Scott, and K. R. Hallam, "Green Synthesis of iron nanoparticles and their application as a Fenton-like catalyst for the degradation of aqueous cationic and anionic dyes," Chem. Eng. J., vol. 172, 2011.

[10] N. a Frey and M. Sun, ShouhengMaterials, "Magnetic Nanoparticle for Information Storage Applications," no. Richter, 2009.

[11] G.-Y. Zhang, Y. Feng, Y.-Y. Xu, D.-Z. Gao, and Y.-Q. Sun, "Controlled synthesis of mesoporous α-Fe2O3 nanorods and visible light photocatalytic property," Mater. Res. Bull., vol. 47, no. 3,