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A REVIEW ON GREEN SYNTHESIS OF METAL AND METAL OXIDE NANOPARTICLES

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ABSTRACT

Nanotechnology has become a promising and emerging field of research in creating and modifying nanomaterials for different applications. During the last few decades, several metal and metal oxide nanoparticles were synthesized and their applications were investigated in various fields of science and technology including biomedical, environmental, energy and agricultural practices. Moreover, metal oxide NPs have been synthesized by physical, chemical and biological method. The synthesizing physical and chemical method is expensive and toxic. Recently, biological synthesis of metal and metal oxide nanoparticles using plants, algae, and microbes as a source of precursor material has emerged as a green and safe method. Metal and Metal oxide nanoparticles are used in numerous fields. This review explores the biosynthesis of metal and metal oxide nanoparticles and their applications.

Keywords: Nanotechnology, methods, synthesis, metal and metal oxide nanoparticles

Introduction

Nanotechnology is being blowing up field of science and technology. Biotechnonology is considered to be the subset of nanotechnology. Nanotechnology is being blowing up field of science and technology. In earlier period , the fine structure of materials were unable to identify but in recent decades, with the development of microscopes the scientist were able to capture the fine structure of particles . The demonstration titled “ The scale of things ” which was created by the U.S. Department of energy , involves to give the comparison of various objects , that used to visualize the nanoparticle is how small.The American Physicist and Nobel Prize Leureate Richard Feynman coined the concept of nanotechnology in 1959. He had spoken about the applications of nanotechnology at the Califorina Institute of Technology . In 21st century the depth of nanotechnology started to spread over the world. Its includes other areas such as Micro-Manufacturing, Molecular, biology and organic chemistry.

Approches for nanomaterials synthesis

There are two approaches are used for nanomaterial synthesis they are, Top -Down approach, Bottom – Up approach,

Top-Down approach

It is referred as physical method, the bulk material is reduced into nano- sized particles or small dimension by applying external forces.The

growth process is remains very slow and hence this method is not suitable for large scale method

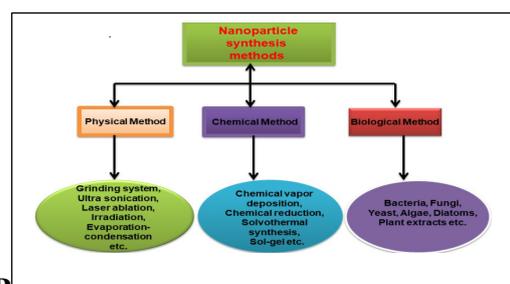
Bottom-Up approach

It is referred as Chemical method, Bottom-Up approach which means the collection and combination of atoms and molecules to build complex structure. It is a techniques, the starting material is gaseous state or liquid state .

Methods for synthesizing nanoparticles

There are three methods have been used for synthesis nanomaterials.

- Physical method
- Chemical method
- Biological method



Physical method

Physical method depend on the instruments during the process of synthesis of nanomaterials. This requires temperature greater than 350⁰C.

Chemical method

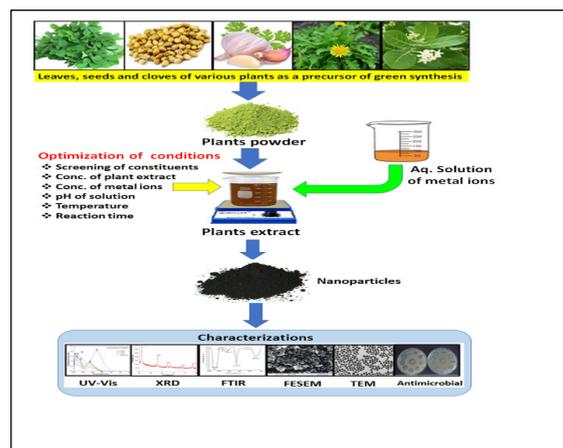
Nanoparticles which can synthesis by using chemicals as a reducing agent. This method is less expensive and can be carried out under temperature lower than 350⁰C..

Biological method

Biological synthesis of nanoparticles is also called as Green method . It is similar to the chemical synthesis but in this case we do not use any Chemical reagents , we use microbial enzymes or plant phytochemicals. This method synthesized the nanoparticles from biological extract likes micro-organisms or plants .

GREEN SYNTHESIS

Green synthesis is a biological method of synthesizing nanoparticles from plant extract, micro-organism and enzymes .The advantage of synthesis of nanoparticles by plant extract is that it reduces the risk of further contamination by decreasing the reaction time and maintain the cell culture. It decreasing toxic residue into the environment. Large scale - up producing is possible in this method. Contamination is very low in this method.The biosynthesis of nanoparticles at very mild pH, pressure and do not require any toxic substance[4]. To synthesizing metal and metal oxide nanoparticles by biological method using plants and its by products which includes leaves, stems, flowers, fruits and roots etc. Plant extract prepared from selected part of the plant which is act as a reducing agent. Based on the nanoparticle preparation required metal ion source is added into the reducing agent. To follow certain conditions, colour change is obtained, this indicate the formation of metal and metal oxide nanoparticles.



TYPES OF METALLIC NANOPARTICLES

Green synthesis play a prominent role in the synthesis of metal and metal oxide nanoparticles, such as cesium oxide nanoparticles, CuO NPs ,Ag NPs, ZnO NPs etc

Silver nanoparticles

The synthesis of silver nanoparticles from green method, the main requirements is silver metal ions and a reducing agent .By using reducing agents, the shape of the nanoparticles may changed [1]. Silver nanoparticles can be delineate that the synthesise of particles using numerous microbe mediated and plant mediated methods[7].Silver nanoparticles can be extracted from many medicinal plants like mango peel [7], Grewia optiva [10], Cavendish banana peel [12], Banana raja peel [1], leaf extract of Hibiscus Rosa Sinensis [16], Red Apple [20], Ocimum Leaf Extract etc. Ag NPs is used to treat skin problems as skin cream and ointment for burns and open wounds. The *fresh mango* peel extract

is filtered twice. The resultant filter is act as a reducing agent. The metal ion of silver nitrate is added into the reducing agent. The mango peel extract is added into the silver nitrate . This colour change indicate the presence of silver nanoparticles

Copper oxide nanoparticle (CuO)

Synthesis of copper nanoparticles is eco-friendly Copper oxide nanoparticles is an P-type semiconductor. It have different morphological structure. Copper oxide nanoparticles are used as gas sensor , solar cells , lithium ion batteries [2].Copper oxide can be extracted from many plants like Catha edulis[4],Aleo Vera [5],Bougainvillea leaves [6],catharanthus Roseus leaf Extract [2] etc.It have the highest microbial activities compare to other metal oxide.It possess the properties include antibacterial activities[5]. The leaf of *Ocimum Basilicum* is dried and remove all moisture from leaf . The leaf were boiled in distilled water for 10 min after it becomes cooled to room temperature. The leaf extract is stored in refrigerator .The aqueous Copper Sulphate dehydrate is mixed with leaf extract of Ocimum Basilicum.The colour change were appeared. This conform the formation of copper oxide nanoparticles.

Zinc oxide nanoparticles (ZnO)

Zinc oxide is a semiconducting n-Type metal oxide. It act as absorbant such as NO₂, CO₂,CO , and NH₃ .Zinc oxide nanoparticles

possess high binding energy as well as large bandwidth and good transparency at room temperature It synthesized large scale in small interval of time. Zinc oxide oxide can be extracted from many medicinal plants like Banana peel extract, Banana peel from the jackfruit banana [13], leaf from Hibiscus rosa - sinensis [7], Lycopersicon esculentum etc.

Zinc oxide nanoparticles at lower concentrations destroy the deathly disease like cancer cells and it manage diabetics and cholesterol . The Banana peel was cut into small pieces and peels were added into pure water in the beaker.Then the peels is covered with aluminium foil sheet and heat into the constant temperature .This mixture was filtered and remove all impurities . The final filtered substance is act as reducing agent . The Zinc acetate dehydrate is mixed with accurate amount of reducing agent and boiled with double distilled method at constant temperature .The mixture change into pale yellow colour .

Iron oxide nanoparticles

FeO be mainly two structure they are magnetite and maghemite. Iron oxide nanoparticles act as antibacterial activity on different mycobacterial species. Iron oxide can be extracted from many medicinal plants like Hibiscus Rosa Sinensis [15] , Pomegranate seed extract , Spinach leaf and banana peel [8] ,Ficus Carica [9]etc. Different properties of Iron oxide nanoparticles includes photo catalytic activity , magnetic properties , antimicrobial activities , antioxidant activities etc .

Copper nanoparticles

Copper undergoes oxidation it give stable copper nanoparticles. copper can be extracted from many medicinal plants like Aleo vera ,Withania somnifera etc. Copper nanoparticles exhibit antibacterial properties, nematicidal properties, photo catalytic activity .good antimicrobial agent .It is mainly use as electronic devices and it have great conduction property. The roots of **Withania somnifera** root was extract is added with distilled water filtered with the help of Whatman No.1 filter paper .The aqueous extracts of Withania somnifera were mixed with the freshly prepared 0.2 M copper nitrate solution With a constant stirring, the solution was heated for 4 h until a colour change is occur . The colour is change from blue to sea green .This colour change showed the formation of copper nanoparticles.

Gold nanoparticles

It is an expensive metal .The biological synthesis of gold nanoparticles may some bacteria and algae are commonly used .the gold nanoparticles exhibit the properties likes antibacterial, anti fungal,anticancer and antioxidant .gold nanoparticles may synthesized from the plant extract like Aleo vera , Hibiscus rosa sinensis etc.

Titanium oxide nanoparticles

It contains great photocatalytic activity . it exhibits the properties like antimicrobial , antifungal and antibacterial activities .The

Titanium oxide nanoparticles is widely used in solar cells ,ultraviolet capacity like sun screen , cosmetics and bottle coatings .Titanium oxide nanoparticles are taken from the plant extracts like Aspergillus flavus , Azadirachta indica etc .

Iron oxide nanoparticles

FeO be mainly two structure they are magnetite and maghemite. Iron oxide nanoparticles act as antibacterial activity on different mycobacterial species. Iron oxide can be extracted from many medicinal plants like Hibiscus Rosa Sinensis [15] , Pomegranate seed extract , Spinach leaf and banana peel [8] ,Ficus Carica [9]etc. *Hibiscus rosa sinensis* plant flower Grained into the fine powder and boiled in distilled water . The solution of *Hibiscus rosa sinensis flower* extract was filtered with the help of Whatman No. 1 filter paper. This extract was store into the refrigerator .Iron chloride tetrahydrate was added into the reducing agent. The mixture was boiled continuously .The colour change were appeared . This conform the formation of Iron oxide nanoparticles.

Conclusions

In biological method, synthesis of nanoparticles by plant extracts that reduces the risk of further contamination by decreasing the reaction time and maintain the cell culture. No need expensive chemicals in green method so it is cost effective. Large scale - up producing is possible in this method. Contamination is very low in this method. The biosynthesis of nanoparticles at

Sl. No	Plant Species	Plant origin	nanoparticles	Plant part	Morphology/Size	Reference
1		Banana raja peel	silver nanoparticles	Peel	tetraheddron or triangle . 100 - 300nm	[1]
2		Catharanthus Roseus	copper oxide nanoparticles	Leaf	14 -56 nm	[2]
3		Brassica oleracea var . italic	Copper oxide nanoparticles	Leaf	26 nm	[3]
4		catha edulis	Copper oxide nanoparticles	Leaf	Globular	[4]
5		Aleo vera	Copper oxide nanoparticles	Leaf	20 nm	[5]
6		Bougainvillea	Copper oxide nanoparticles	Leaf	8-20 nm	[6]
7		Mango	Silver nanoparticles	Peel	162 nm	[7]
8		Spinacia oleracea and Musa acuminata	iron nanoparticles	Banana Peel , spinach leaf	from 20 to 50 nm	[8]
9		as carica	Iron oxide	Leaf	43 - 57 nm	[9]
10		ewia optiva	Silver	Leaf	30 to 65 nm	[10]
11		otropis antea	Silver	Leaf	40 to 50 nm	[11]

12		Clavendish Banana peel	Silver	Peel	23–30 nm	[12]
13		Clerodendron bungei	Copper oxide	Leaf	18-23nm	[13]
14		Hibiscus rosa sinensis	Silver	Leaf	-	[14]
15		Hibiscus rosa sinensis	Silver	Flower	5-40 nm	[15]
16		Withania somnifera	Copper	Root	-	[16]
17		Apple	Silver	Fruit		[17]
18		Lycopersicon esculentum	Zinc oxide	Fruit	50 and 90 nm	[18]
19		Ocimum Basilicum	Copper oxide	Leaf	Above 70 nm	[19]

very mild pH, pressure and do not require any toxic substance. The development of nanotechnology and their numerous applications make the green preparation of metal and metal oxide nanoparticles hopeful and abundant potential applications in different fields such as optical, electrical, magnetic, chemical industry, nonlinear optical devices, space industries, drug-gene delivery and medical field.

REFERENCE

1. Achmad Chafidz , Amira Rahmani Afandi , Bunga Mela Rosa , Jono Suhartono , Pratikno Hidayat , Harri Junaedi (2020) Production of silver nanoparticles via green method using banana raja peel extract as a reducing agent. *Communications in science and technology* 5(2) 112-118.
2. Nazarith Begum ,A.Esakkiraja ,S.Mohamed Asan ,M.Muthumari ,G.Venbu Raj(2019) Green synthesis of copper oxide nanoparticles using

- Catharanthus Roseus leaf extract and their antibacterial activity. *International Journal of Scientific Research in Multidisciplinary studies*, pp 21-27.
3. D. Renuga, J. Jeyasundari, A. S. Shakthi Athithan and Y. Brightson Arul Jacob (2020) Synthesis and characterization of copper oxide nanoparticles using Brassica oleracea var. *italica* For its antifungal application. *Mater. Res Express* 7.
 4. Worku Wubet Andualem, Fedlu Kedir Sabir, Endale Tsegaye Mohammed (2020), Synthesis of Copper Oxide Nanoparticles Using Plant Leaf Extract of *Catha edulis* and Its Antibacterial Activity. *Journal of nanotechnology*. Vol (2020)
 5. P. P. N. Vijay Kumar, U. Shameem, Pratap Kollu, R. L. Kalyani, S. V. N. Pammi (2015) Green Synthesis of Copper Oxide Nanoparticles Using Aloe vera Leaf Extract and Its Antibacterial Activity Against Fish Bacterial Pathogens. *BioNanoSci.* 015-017.
 6. Ahid M. Al-Faouri, Mahmoud H. Abu-Kharma and Akl M. Awwad (2021). Green synthesis of copper oxide nanoparticles using *Bougainvillea* leaves aqueous extract and antibacterial activity evaluation. *Chemistry International* 7(3) 155-162.
 7. Peter Sadel, Pavel Divis, Jaromir Porizka (2019) Green synthesis of silver nanoparticles using mango peel.
 8. Pankaj Kumar Tyagi, Samridhi Gupta, Shruti Tyagi, Manoj Kumar, R. Pandiselvam, Sevgi Durna Daştan, Javad Sharifi-Rad, Deepak Gola, and Arvind Arya (2021) Green Synthesis of Iron Nanoparticles from Spinach Leaf and Banana Peel Aqueous Extracts and Evaluation of Antibacterial Potential. *Journal of nanomaterials*. vol. (2021)
 9. Elvan ustun Sena Ceren Önbaş, Sakine Kubra Çelik, Melek Çol Ayvaz, Neslihan Şahin (2022) Green synthesis of iron oxide using ficus carius. *Biointerface Research in Applied Chemistry Vol. (12)*. 2108-2116
 10. Muhammad Iftikhar, Muhammad Zahoor, Sumaira Naz, Nausheen Nazir, Gaber El-Saber Batiha, Riaz Ullah, AHMED bari, Muhammad Hanif and Hafiz Majid Mahmood (2020). Green synthesis of silver nanoparticles using Grewia optiva leaf aqueous extract and isolated compounds as reducing agent and their biological activities. *Journal of Nanomaterials* vol (2020).
 11. Priyanka Subhash Joshi, Gowthami Ramesh, Jenitta Emima Packiyam and Shobha K Jayanna. (2017) Green synthesis and evaluation of silver nanoparticles using leaf extract from *Calotropis gigantea*
 12. T. Kokila, P. S, Ramesh, D, Geetha (2015) Biosynthesis of silver nanoparticles from Cavendish banana peel extract and its antibacterial.

13. Fozia Amin,¹ Fozia,² Baharullah Khattak,¹ Amal Alotaibi,³ Muhammad Qasim,¹ Ijaz Ahmad,⁴ Riaz Ullah,⁵ Mohammed Bourhia,⁶ Anadil Gul,⁷ Saira Zahoor,⁸ and Rizwan Ahmad (2021) Green Synthesis of Copper Oxide Nanoparticles Using *Aerva javanica* Leaf Extract and Their Characterization and Investigation of *In Vitro* Antimicrobial Potential and Cytotoxic Activities. *Evidence –Based Complementary and Alternative Medicine* vol(2021)
14. Ambili Reveendran, Sanoj Varghese, K. Viswanathan (2016) Green synthesis of silver nanoparticles using Hibiscus Rosa Sinensis. *IOSR Journal of Applied Physics* 35-38
15. S. Surya, G. dinesh Kumar, Rahakumar (2019) Green Synthesis of silver Nanoparticles by using flower extract of Hibiscus rosa-sinensis and its antimicrobial activities. *International Journal of innovative Research in Science, Engineering and Technology* vol.5. 5242-5247.
16. J. Shanmugapriya, C. A. Reshma, V. Srinidhi, K. Harithpriya, K. M. Ramkumar, Dhamodharan Umpathy, Krishnamoorthy Gunasekaran, and R. Subashini (2022) Green Synthesis of Copper Nanoparticles Using *Withania somnifera* and Its Antioxidant and Antibacterial Activity. *Journal of nanomaterials* vol(2022).
17. Zainal Abidin Ali,¹ Rosiyah Yahya,² Shamala Devi Sekaran,³ and R. Puteh¹ (2015) Green Synthesis of Silver Nanoparticles Using Apple Extract and Its Antibacterial Properties. *Hindawi Publishing Corporation Advances in Materials Science and Engineering*. Vol(2016).
18. Prasanta Sutradhar & Mitali Saha (2016) Green synthesis of zinc oxide nanoparticles using tomato (*Lycopersicon esculentum*) extract and its photovoltaic application. *Journal of Experimental nanoscience*. vol(11), pp 314-327.
19. Melda Altikatoglu, Azade Attar, Fatih Erci, Corina Marilena, Ibrahim Isildak Green synthesis of copper oxide nanoparticles using ocimum Basilicum and their antibacterial activities. *Fresenius Environmental Bulletin* vol(26), pp 7832-7837.