ASSESSMENT OF GREEN SYNTHESIS OF SILVER NANOPARTICLES BY GARLIC AND POTATO PEEL EXTRACT

UNDER SUPERVISION OF
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CERTIFICATE

I, hereby declare that the work presented here in this report entitled "**ASSESSMENT OF GREEN SYNTHESIS OF SILVER NANOPARTICLES BY GARLIC AND POTATO PEEL EXTRACT**" in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Biotechnology submitted in the department of Biotechnology and Bioinformatics, Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out under the supervision of Dr. Abhishek Chaudhary (Assistant Professor in the Department of Biotechnology and Bioinformatics). The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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SUPERVISOR'S CERTIFICATE

This is to certify that the work titled "Synthesis of silver nanoparticles via green synthesis by potato and garlic peels "by Kiara Tickoo and Kriti Ahuja during the end semester in June 2022 in fulfilment for the award of degree of Bachelors of Technology in Biotechnology of Jaypee University of Information Technology ,Solan has been carried out under my supervision .

Signature of Supervisor

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Date :

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TABLE OF FIGURES

1. THE LYCURGUS CUP……. 10
2. CLASSIFICATION OF NANOPARTICLE…….. 12
3. TYPES OF CARBON BASED NANOMATERIAL……. 14
4. SCHEMATIC VIEW OF MECHANICAL PROPERTIES AND THEIR APPLICATION……... 18
5. FLOWCHART ON CLASSIFICATION OF SYNTHESIS OF METALLIC NPs……..... 22
6. APPLICATION OF NANOPARTICLES IN DIFFERENT FIELD……... 27
7. ADVANTAGES OF GREEN SYNTHESIS ……... 30
8. GARLIC PEEL EXTRACT……. 32
9. MAGNETIC STIRRING OF GARLIC PEEL SOLUTION…. 32
10. POTATO PEEL EXTRACT……. 33
11. MAGNETIC STIRRING OF POTATO PEEL SOLUTION…. 34
12. SILVER NITRATE WITH POTATO EXTRACT FOR ANALYSIS…… 35
13. SPECTRUM OF Ag NANOPARTICLES SYNTHESIZED BY GARLIC PEEL EXTRACT……..... 36
14. SPECTRUM OF Ag NANOPARTICLES SYNTHESIZED BY POTATO PEEL EXTRACT……. 36
15. SPECTRUM OF Ag NANOPARTICLES SYNTHESIZED BY GARLIC PEEL EXTRACT AT LEAST PH 7……..... 37
16. SPECTRUM OF Ag NANOPARTICLES SYNTHESIZED BY POTATO PEEL EXTRACT AT LEAST PH 7……. 37

TABLE OF CONTENTS

Chapter -1 Introduction

- Abstract…… 7
- Introduction…….. 8
- Thesis work……... 9

Chapter -2 Literature of review

- History…… 11
- Introduction…… 11
- Classification…….. 16
- Characterisation……..... 19
- Synthesis……..... 21
- Toxicity ……..... 26
- Application…… 26

Chapter-3 Material and methods

- Generation of Ag nanoparticles by garlic peel…… 30
    - Preparation of garlic peel extract
    - Organic combination of AG nanoparticle
    - UV spectroscopy analysis
- Generation of Ag nanoparticles by potato peel…….. 33
    - Preparation of potato peel extract
    - Biosynthesis and optimisation of Ag nanoparticles
    - Portrayal of Ag nanoparticle

ABSTRACT

Nanotechnology is a broad phrase that encompasses a wide range of scientific and technological fields. It can be defined as working with little objects in its most fundamental form. The investigation, planning, and implementation of the project define the exploration area, modification, fabrication, and control of materials or devices through physical or electronic means chemical methods with precision of one billionth of a metre It refers to nanoscale technology that has real-world applications world. Nanomaterials have unique physical and chemical characteristics. utilised for socially beneficial uses. [1] The usage of nanotechnology technology on a nano scale It has the capacity to transform our lives perspectives and expectations, and provide us the power to solve problems, global problems.

They can be divided into various classes based on their characteristics and shapes.or sizes. Because of their large surface area and nanoscale size, they have unique physical and chemical properties. Their optical qualities are affected by their size, which results in variable colours due to absorption in the visible area. Their distinctive size, shape, and structure influence their reactivity, toughness, and other qualities.

Nanobiotechnology refers to the ways that nanotechnology is used to create devices to study biological systems. It is creation of functional materials, devices and systems through the understanding and control of matter at dimension in the nano meter scale length where properties of matter are observed and used for broad range of applications.

Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors: information technology, energy, environmental science, medicine, homeland security, food safety, and transportation, among many others. Today nanotechnology harnesses current progress in chemistry, physics, materials science, and biotechnology to create novel materials that have unique properties because their structures are determined on the nano-meter scale. With the these desirable properties we were able to synthesize silver nanoparticles by means of green synthesis using garlic and potato peel extracts.

CHAPTER 1 – INTRODUCTION

Nanoparticles are the particles mostly In range of 1-100nm and are usually made from carbon , metal oxides, organic matter or metals. They are further divides into three parts : Organic nanoparticles which are made up of proteins , carbohydrates etc . The second category is Inorganic nanoparticles which have the central core of the particle made of inorganic material. The third category is Carbon nanoparticles which are made from carbon and includes Carbon nanotubes and Fullerenes . Nanoparticles can be zero dimensional in which length, breadth and height are fixed for e.g. nanodots; it can be one dimensional that exhibits only one parameter for e.g. Graphene; it can also be two dimensions in which length and breadth are defined for e.g. carbon nanotubes; or it can be three dimensional in which length, breadth and height are defined for e.g. gold nanoparticles . These particles are of different size, shape and structure like they can be spherical ,conical, rectangular, triangular etc. Some of these particles are crystalline that Is they have a defined structure or they can be amorphous that means they can be also structure less. The synthesis of these nanoparticles can be done by bottom up method and top down method. Green synthesis is also a method of synthesizing nanoparticles by natural extracts or methods. Green synthesis is the best preferred method of synthesis as it is environmental friendly, cost effective, no requirement of extreme conditions. Nanoparticles generated by green synthesis are better than nanoparticles by conventional methods as this is a single step procedure with lower energy usage. Also these particles have their applications in many fields like medicine electronics military etc. Nanotechnology and Nanoparticles are the key for sustainable development for future.So the current thesis is about how we synthesized silver nanoparticles from potato and garlic peel extract. We choose garlic and potato peels as they possess various antioxidants and antibacterial properties. [8]

THESIS WORK

Green synthesis of silver nanoparticles by garlic peel and potato peel extract

Our aim was to synthesize silver nanoparticles by green methods rather than conventional methods and then optimize the reaction parameters. In this effortless and minimal expense garlic clove remove based silver nanoparticles was integrated and its expansive range of remedial movement including anti-biofilm, anti-parasitic and hostile to bosom disease action was assessed. Genrally AgNPs showed great optical property, profoundly translucent nature, round shape and consistently scattered with size estimating somewhere in the range of 10 and 50 nm. Further silver nanoparticles were synthesized by potato peel extract Green combination of nanoparticles utilizing plant separate has been proposed as a practical, ecological cordial and a solid option in contrast to compound and actual techniques for the development of nanoparticles. The current thesis centers around the green union of silver nanoparticles (AgNPs) utilizing vegetable strip concentrates of potato and garlic peels. This strip separates goes about as a decreasing and balancing out for the development of silver nanoparticles. The fluid strip concentrates of these vegetables are added independently to 1 mM silver nitrate arrangement and the development of silver nanoparticles is principally identified by the difference in variety from dreary to ruddy brown. The decrease of Ag + Ag 0 is affirmed by UV-Visible range.

OBJECTIVE

1. Green synthesis of silver nanoparticles by potato and garlic peel extract.
2. Optimization of reaction parameters

CHAPTER 2 LITERATURE OF REVIEW

HISTORY

Nanoparticles have been used by humans in fourth century that demonstrated one of the most interesting examples of nanotechnology in the ancient world. The Lycurgus cup which is from the British Museum collection represents one of the excellent achievements in ancient glass industry. That is the oldest and famous example of dichroic glass. Dichroic glass is a glass which describes two different types of glass that changes colour in certain lighting conditions. That means that the Cup has two different colors: first is that the glass appears green in direct light, and then red-purple when light is shining through the glass. Further the scientists made the analysis of these cups under transmission electron microscopy and explained regarding dichroism, dichroism is referred to the phenomenon of two colours. This dichroism is caused due to the nanoparticles that have diameter ranging from 50-100nm. [8] This process was then followed by X ray analysis that resulted these nanoparticles are of silver and gold in the ratio of 7:3 respectively with an extra 105 of copper with it . The gold nanoparticles showed red color as result of light absorption (~520 nm). The red-purple color was formed due to the absorption by the bigger particles whereas the green color was connected to the light scattering by colloidal dispersions of silver nanoparticles with a size less than 40 nm. The Lycurgus cup is known as the oldest synthetic nanomaterials. [9]

Fig.1 THE LYCURGUS CUP [9]

INTRODUCTION

Nanoparticles are the particles mostly In range of 1-100nm and are usually made from carbon , metal oxides, organic matter or metals. They are further divides into three parts : Organic nanoparticles which are made up of proteins , carbohydrates etc . The second category is Inorganic nanoparticles which have the central core of the particle made of inorganic material. The third category is Carbon nanoparticles which are made from carbon and includes Carbon nanotubes and Fullerenes. Nanoparticles can be zero dimensional in which length, breadth and height are fixed for e.g. nanodots ; it can be one dimensional that exhibits only one parameter for e.g. Graphene; it can also be two dimensions in which length and breadth are defined for e.g. carbon nanotubes; or it can be three dimensional in which length, breadth and height are defined for e.g. gold nanoparticles . [2] These particles are of different size, shape and structure like they can be spherical, conical, rectangular, triangular etc. Some of these particles are crystalline that Is they have a defined structure or they can be amorphous that means they can be also structure less. The synthesis of these nano particles can be done by bottom up method and top down method. Also these particles have their applications in many fields like medicine electronics, military etc. Nanotechnology and Nanoparticles are the key for sustainable development for future. Nanoparticle combination are typically completed by different physical and compound strategies like laser removal, pyrolysis, lithography, substance fume statement, sol-gel procedure also, electro statement which are extravagant and perilous. The utilization of poisonous synthetic compounds and non-polar solvents for the combination of nanoparticles limits their applications in clinical fields. Consequently, the biosynthesis of clean, bio-viable, non-poisonous and eco accommodating nanoparticles created from both extracellularly and intracellularly merits. [8]

CLASSIFICATION

They are classified into three parts :-

1) Organic nanoparticles
2) Inorganic nanoparticles
3) Carbon based nanoparticles

1) ORGANIC NANOPARTICLES

These are the nanoparticles of two or more dimensions of size ranging between 1-100nm. They are mostly made up of organic matter. The main groups of organic nanoparticles are Dedrimers , ploymers, liposomes and micelles. There are different types of organic particles like starch nanoparticles, fluroscent nanoparticle, water soluble nanoparticles etc . The particles which come under this category have properties like they are biodegrable, non toxic and an unique property that is they are sensitive to thermal and nanoparticulate radiation which make these particles suitable for drug delivery and other medical uses They have low melting temperature and lesser thermal stability than metal nanoparticles.[9] Organic particles can deliver molecules by conjugation on the surface or in the core also by any physical encapsulation which makes these particles useful for the delivery of molecules and more for drug delivery and biomedical applications. [8]

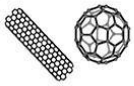
	Particle type	Composition/Structure	Properties	Applications
	Polymer	e.g., PLGA, glycerol, chitosan, DNA; monomers, copolymers, hydrogels	Some biodegradable	Drug delivery; passive release (diffusion), controlled release (triggered)
	Dendrimer	PAMAM, etc.	Low polydispersity, cargo, biocompatible	Drug delivery
	Lipid	Liposomes, micelles	Can carry hydrophobic cargo, biocompatible, typically 50–500 nm	Drug delivery
	Quantum dots	CdSe, CuInSe, CdTe, etc.	Broad excitation, no photobleaching, tunable emission, typically 5–100 nm	Optical imaging
	Gold	Spheres, rods, or shells	Biocompatibility, typically 5–100 nm	Hyperthermia therapy, drug delivery
	Silica	Spheres, shells, mesoporous	Biocompatibility	Contrast agents, drug delivery (encapsulation)
	Magnetic	Iron oxide or cobalt-based; spheres, aggregates in dextran or silica	Superparamagnetic, ferromagnetic (small remanence to minimize aggregation), superferromagnetic (~10 nm), paramagnetic	Contrast agents (MRI), hyperthermia therapy
	Carbon-based	Carbon nanotubes, buckyballs, graphene	Biocompatible	Drug delivery

Fig2. CLASSIFICATION OF NANOPARTICLES [8]

2) INORGANIC NANOPARTICLES

The inorganic nanoparticles are further divided into two parts which are metal like silver, gold and metal oxides like titanium oxides. They are not made from carbon. They have properties like non toxic, hydrophilic, highly stable and also biocompatible also they possess electrical , optical and magnetic properties that differ them from bulk counterparts.They are composed of polymer, lipid , metal, semiconductor. The subparts of inorganic nanoparticles are as follows: [15]

Metal Inorganic Nanoparticles

These nanoparticles are synthesized from metals within the quality size of 1-100nm either by constructive(by clustering the particles together) or destructive methods (by breaking the clusters of particles). For e.g. cobalt, copper, gold, iron . silica,lead etc . They provide antimicrobial prevention by generating membrane damge to proteins and DNA. Whenever there is a decrease of the size of nano particles :-

- There is an increase in the ratio of surface atoms to interior atoms
- There is an increase in the percentage of surface atoms
- The Average coordination number of nanoparticles decreases

Due to well - known localized plasmon resonance (LSPR) i.e (collective oscillations of electron at interface of the metal structure which are produced through collision of a metal and an incident light of specific wavelength) these nanoparticles have unique optoelectrical properties [15]

- **Metal oxide Inorganic nanoparticles**

These nanoparticles are produced to improve the properties of metallic nano-particles . For e.g. iron oxide nanoparticles their enzymatic activity works as nano-enzymes in detecting biomolecules like glucose , etc . Also they have high surface area to volume ratio and as a result lots of functional groups are obtained on the surface of nanoparticles. They provide increased efficeny and reactivity of metallic nanoparticles. They ha.ve applications in catalysis, energy conversion,rectifiers , anteenas etc. [2]

3) CARBON BASED NANAOPARTICLES

They are purely made up of carbon. These particles have properties like heat conductivity, electrical conductivity, and mechanical properties. As they are made up of pure carbon so have features like good conductivity, high stability, environmental friendly, low toxic. Carbon based nanoparticles have strong anistropic thermal conductivity that allows its usage in computing electronics where tempratire could raise upto 100 degree celscius of uncooled chips. They have applications in drug delivery, energy storage, bio-imaging etc. They are further divided into 5 subparts:- [8]

- Fullerenes
- Graphene
- Carbon nanotubes(CNT)
- Carbon nano fiber (CNF)
- Carbon black

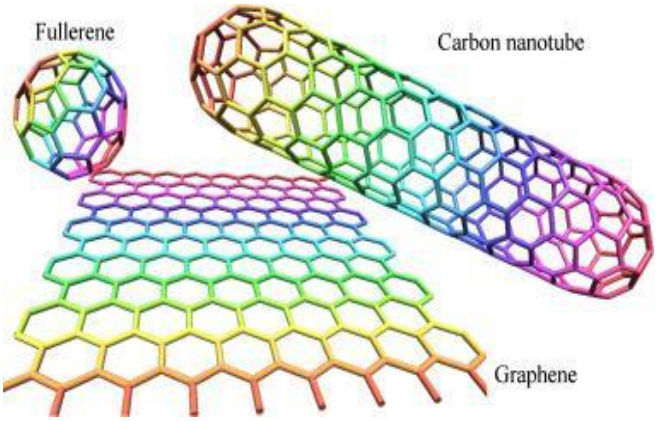


Fig 3. TYPES OF CARBON BASED NANOMATERIALS [15]

- **FULLERENES**

They are made up of 60 carbon atoms and have an approximate size of 1nm . It is in the shape of sphere,ellipsoids or tubes. There are many types of fullerenes like buckyball clusters, megatubes, nano onions etc. It doesn't possess superaromoticity that means atoms held in the hexagonal ring don't localize over the whole molecules. They are soluble in many solvents such as toluene.These particles areheld by sp2 hybridized. Also, they have wide availability because of its small size and biologically feasible.[8] A spherical structure is formed with 28-1500carbon atoms having a diameter (for single layer) upto 8.2nm (for multi layer) upto 36nm. Fullerenes currently is having

good market in cosmetics and sports good industry. It has a great significance in antiageing cream because it is is made up of 60 carbon atoms which means it has high electron affinity so absorbs many free radicals promoting antiageing. These carbon particles are not self imflammable. [9]

- **GRAPHENE**

  It is a 2D allotrope of carbon one atom thick bounded together in a hexagonal honeycomb lattice. The thickness of graphene sheet is about 1nm . It is the strongest material with no crystal boundaries. It is 200 times stronger than steel and also flexible can be folded . Graphene is a very thin nanomaterial and chemically inert. Intrinsic Graphene is a zero gap semiconductor. It is transparent, non toxic and has better electrical and thermal conductivity due to availability of free pi electrons. Graphene can be seen by three techniques which are transmission electron microscopy, electron microscopy and optical microscope. Graphene are available in different forms like nanostripes, graphene oxide, etc. It is used in ethanol distillation , desalination, solar cells, coolant additive,etc [2]

CARBON NANOTUBES(CNT)

This is a cylindrical molecule which consists of rolled up sheets of single layer of graphene. There are three types of CNTs armchair carbon nanotubes, zig –zag carbon nanotubes and chiral carbon nanotubes. The diameter of single wall CNTs is less than 1nm and of multi walled could be upto 100nm. [15]

These tubes are sp2 hybridized. Their ends can be of half fullerene molecules .They are synthesized by three methods such as laser ablation, arc discharge method and chemical vapour deposition method. Carbon nanotubes are highly chemically stable. They are used in energy srorage, device modelling , automobile parts etc. They are strongest , flexible and have good thermal conductivity. They are used catalytic reactions as catalysts or catalysts support. [9]

- **CARBON NANOFIBRE(CNF)**

  They are prepared in large quantities either in powdered form or in form catalytic entities. These are cylindrical nanostructures which are made from graphene layered arranged in the form of stacks, cups or plates.These

graphene sheets could be thinner than a strand of human hair. The nanofiber gets more strength when twisted together . The difference between CNT and CNF is that in CNTs graphene layers are wrapped in a hollow cylinder whereas in CNFs they are stacked as cones, plates or cups. They have properties like high electrical and thermal conductivity also has high elastic modulus and tensile strength. They are used in the field of nanocomposites, energy devices, tissue engineering etc.

- **CARBON BLACK**

  The carbon black is made up of carbon of amorphous material and has a spherical structure. It is synthesized because of the incomplete combustion of heavy petroleum products.It is produced by four methods which are lamp black process, channel black process, furnance black process and thermal black process.The diameter of carbon black lies between 20-70nm . The interaction between particles is so high that they can can aggregrate together and form a cluster upto 500nm. Functionalities of carbon black are reinforcement, pigmentation, electrical conductivity, catalyst support etc. It has its application in rubber, plastics, inks , paints and many more.

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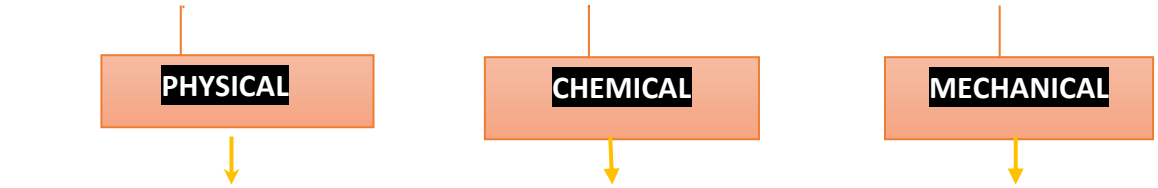
8. PROPERTIES



PHYSICAL	CHEMICAL	MECHANICAL
1)Size,shape, surface area	1) Structural formula	1) Hardness
2) Size distribution	2) Surface chemistry	2) Elastic Modulus
3) Surface morphology	3) Hydrophilicity	3) Adhesion
4) Solubility	4) Phase Identity	4) Friction
5) Crystallinity,defects structure	5) Compostion of nanomaterial	5) Capillary forces

[15]

PHYSICAL PROPERTIES

The physical properties of nanoparticles include its size, shape(like rods, cones etc.) , surface area , size distribution, surface morphology,solubility, structure including crystallinity and defect structure. Having high surface area to volume ratio makes its use as a catalyst. Because of its small size it helps in medicine field by easily entering in biological tissues. [2]

CHEMICAL PROPERTIES

Chemical properties of nanoparticles includes its structural or molecular formula, its composition including degree of purity, phase identity, surface chemistry including composition ; charge; tension; reactive sites, hydrophilicity. All the chemical processes occur on the surface of the nanoparticles. Nanoparticles interact differently with each other on the basis of repulsive or attractive forces between them , either they can remain free and interacted. [15]

OPTICAL PROPERTIES

Optical properties of nanomaterial like absorption, transmission, reflection, and light emission are very dynamic and they may be different from properties which are showed by the same bulk material. There is a wide range of optical effects which could be used to produce a wide variety of applications by introducing little manipulation in its shape, size, and surface functionality. The manipulation could be gained by different sources, depending upon the composition, size, and orientation .The optical property of nanomaterial is an important property in various ways. They have the ability of confining nanomaterials electrical properties to produce quantum effect with usually variations in shape, size, or could have effect on the color which they produce. For example, sphere gold nanoparticles of about 25-nm diameter looks green while those nanoparticles within the range of 100 nm appear orange. In the same vein sphere gold nanoparticles of 100-nm diameter appears with orange colour whereas same size of sphere silver nanoparticles appears yellow. The color which is observed in nanoparticle is the function of surface plasmon resonance effect that occurs when the outer electron band of nanomaterial with light wavelengths resonate[10]

MECHANICAL PROPERTIES

The mechanical properties of nanoparticles increases with a decrease in size ; because smaller the size lesser is the probability of imperfection. There is an improvement in the strength of the particle as the particle size decreases. Hardness and yield strength of the particle increases with the decrease in the particle size. This property basically helps us in telling the hardness and elastic

modulus of nanoparticles. It also explains adhesion and friction between particles and movement between the nanoparticles. Its applications includes lubrications and coating of nanoparticles Nanoparticles have outstanding mechanical properties due to the volume, surface and quantum effects of nanoparticles. When nanoparticles are added to a common material then these nanoparticles will strain the grain to a certain extent further forming an intragranular structure and also improving the grain boundary and promoting the mechanical properties of materials For example, adding 3 wt/% nanosilicon oxide to concrete may improve its compressive strength, bending strength, and splitting tensile strength [3]

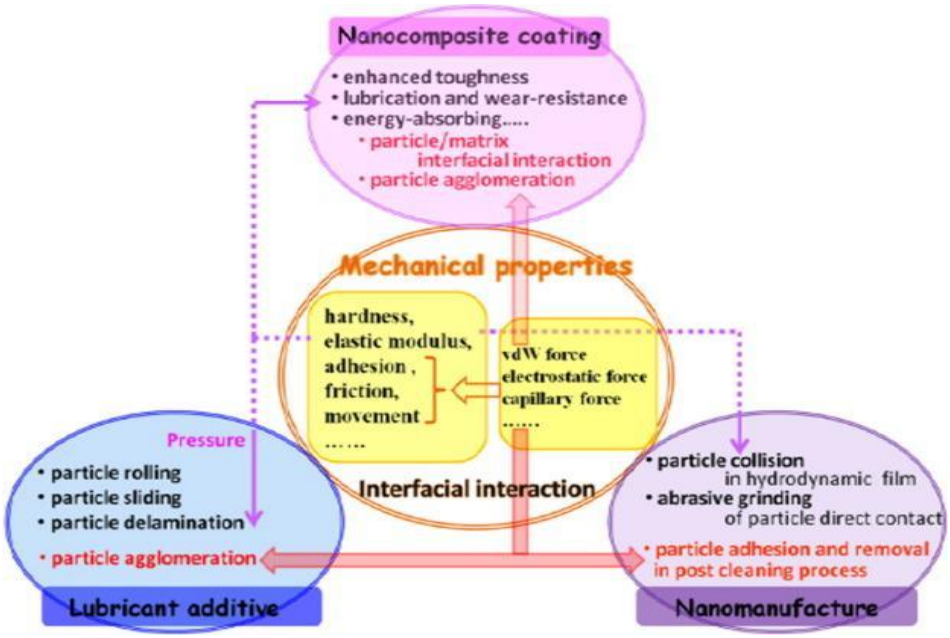


Fig.4 SCHEMATIC VIEW OF THE MECHANICAL PROPERTIES AND THEIR APPLICATIONS [15]

MAGNETIC PROPERTIES

Magnetic Nanoparticles are nowadays of great curiosity and interest for researchers from an electric range of disciplines that includes heterogenous and homogenous catalysis, biomedicines, magnetic fluids, data storage and magnetic resonance imaging (MRI) also the environmental remediation such as water decontamination. Nanoparticles perform best when the size has less critical value ranging 10–20 nm . At this low scale of critical value the magnetic properties of NPs dominated effectively, which make these nanoparticle less expensive and can be used in different). The unequal electronic distribution in Nanomaterials

leads to magnetic property. These properties depend on the synthetic protocol and many synthetic methods like solvo thermal co precipitation micro-emulsion, thermal decomposition can be used for their preparation

CHARACTERIZATION

1) *SIZE AND SURFACE MORPHOLOGY*

In this property the size and surface morphology of nanoparticles is measured which is an important parameter and can be measured by the following techniques:-

A)Nano sight

This techniques helps in visualizing and measuring the size of nanoparticles and its accurate concentration. This technique uses nanoparticle tracking analysis to distinguish nanoparticles from 10nm to 2000nm.

B)Scanning electron microscopy

This instrument is used for the visualization of the surface morphology of organisms, cells and materials. Its resolution is about 1-2nm . It is basically for the determination of size , hsape and surface morphology [2]

C)Transmission electron microscopy

Its resolution is 0.1to 0.2nm . It is used for the determination of the internal structures and in the measurement of size related properties.
The particle shape can be determined by 2 techniques which are scanning electron microscopy and transmission electron microscopy [15]

2) *CRYSTALLINITY*

A) Xray Diffraction

This is a technique for study of nanoparticles which have a dimension ranging from 1-100nm. This technique is also used in determination of thickness of thin

films and the atomic arrangement like they are FCC, BCC or SCC. Also it helps in identifying an unknown particle or material[8]

B) Differential Scanning Calorimeter

This is a technique used for thermal characterization of solids and liquids. This helps in measuring polymorphism , degree of crystallinity, purity determination , decomposition and melting behaviour.

3)SPECIFIC SURFACE AREA

A) Burnaver Emmett teller (BET)

This is a gas adsorption technique which measures a specific surface area of nanoparticles including particle size , pore size distribution. It is also used for determination of porosity.

2) *SURFACE CHARGE*

The surface charge of colloidal particles in nanoparticles can be determined by measuring velocity of a particle in an electric field. Velocity can be determined using this technique. Zeta potential of nano particles is used for the analysis for the surface charge of the colloidal particles.

3) *SURFACE HYDROPHOBICITY*

This technique helps in the determination of biological and environmental providence of nanoparticles and their potential toxicity. The methods by which hydrophobicity can be determined are:-

- Hydrophobic interaction chromatography
- Bi plastic partitioning
- Adsorption of probes
- Contact angle measurements

SYNTHESIS OF NANOPARTICLES

There are two method for synthesis of nanoparticles:-

1) Bottom up method
2) Top down method

Bottom Up method

This method is a constructive method of synthesizing nanoparticles. In this approach there is a build up of material from the bottom like atom by atom or atom by molecule. The deposition of atom by atom leads to the formation of self assembly of atoms or molecules. This approach has some advantages likes nanoshells, ultrafine nanoparticles can be formed from this method; there can be control on deposition parameter ; also this is a cheaper approach. There are few disadvatages also of this approach like the large scale production is difficult; in this approach chemical purification is required. This approach is further subdivides into five categories:- [2]

a) Sol – gel method
b) Spinning
c) Chemical vapour deposition
d) Pyrolysis
e) Biosynthesis

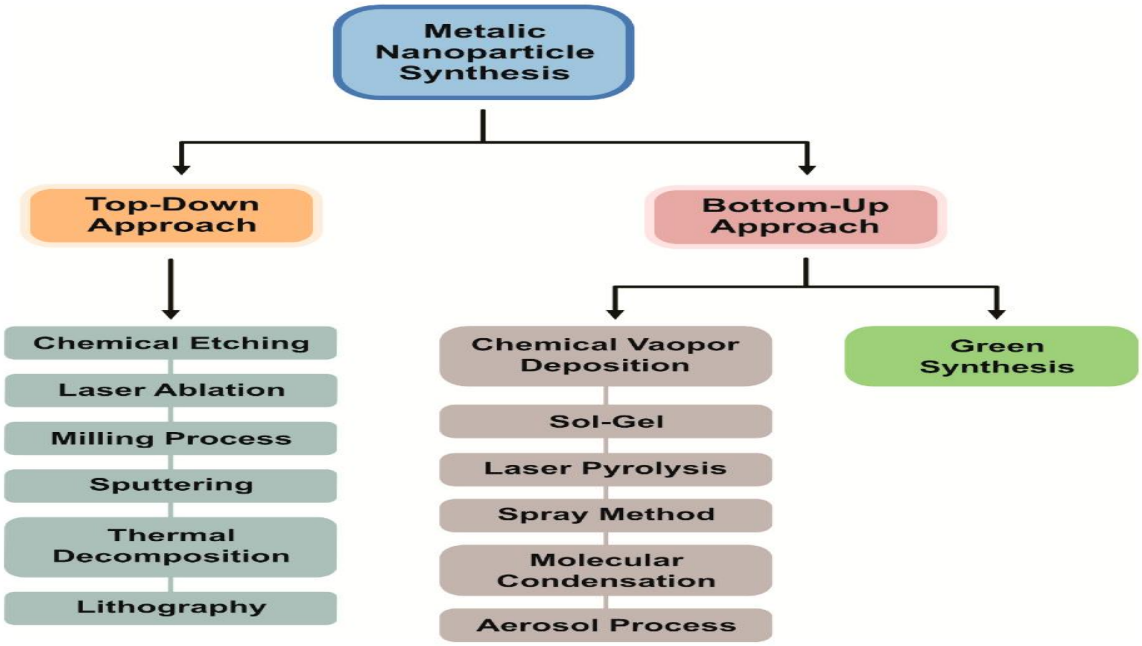


Fig5. FLOWCHART ON CLASSIFICATION OF SYNTHESIS OF METALLIC NPS [2]

Sol –Gel method

Sol means a colloidal solution of solids which are suspended in liquid phase whereas gel is a solid macromolecule dissolved in solvent. As it's the most simple method so is the most preferred approach in bottom up method. It is a wet chemical method which uses a chemical substance or a colloidal particle for the formation of the gel. Metal alkoxides and metal chlorides are precurssors. The formation of metal oxides involves connecting the metal centers with the oxide and hydroxide bridges and generating metal oxide or metal hydroxides polymer in the solution. After the process of drying is completed then the liquid phase is removed from the gel after which thermal treatment is applied for polycondensation. In this method metal oxides and chlorides are used as precurssors. This process is initiated by sedimentation then filtration after which centrifugation is done and at the last drying is done for removing the moisture. Advantages of this process are it is able to form uniform and small size powdered substances,helps in easy coating of films, can coat large and complex areas etc. This is a cheap and a low temperature technique which helps in control of product's chemical composition. [3]

Spinning

The synthesis of nanoparticles by this method is done by using spinning disc reactor . The spinning chamber consists of a rotating disc inside which the temperature is maintained. This chamber is filled with an inert gas so as to remove oxygen or to avoid any chemical reactions. The spinning disc is rotated at different speed where water and precursor are pumped inside the reactors. This rotation of disc causes spinning which further makes atoms or molecules to come in contact together and then precipitated out after that collected and finally dried. [2]

Chemical Vapour Deposition

This is a chemical process of synthesizing nanoparticles.In this method one or more volatile precurssors are involved then the subsrate is exposed to the precurssors which decompose on it and further forms a deposition. After this these precurssors are inserted into the CVD reactor then the molecules get adsorbed which react to different molecules to form crystals . This is a process through which high purity and high performance materials are produced. This is an approach used in semiconductor industry and to produce thin films. While doing this process water is exposed to one or more than one volatile precurssors which either react or decompose on substrate surface. The deposition is carried out in reactor at an average temperature that contains gas molecules . substrate temperature influences CVD process [8]. Advantages of this process over other are that this process produce highly pure, hard and strong nanoparticles but also this process has a disadvantages that it requires a special equipment.

Pyrolysis

This method of nanoparticle synthesis is used for large scale production of nanoparticles.It is used in formation of ultrafine powdered nanoparticles by heating the mixture of reactant vapour and inert gas under laser. In this the product is formed by laser inducing chemical reactions at meeting point of laser beam and vapour phase precursor. A vapour precursor is used which could be liquid or gas that is forced in through an opening at high pressure and then burned, the solid produced is classified to regain oxide particles from the by product gases. This approach results in the aggegrate clusters of nanoparticles rather than single nanoparticles. This is a simple, cost effective approach of synthesizing nanoparticles with high yield. [4]

Biosynthesis

This process of synthesizing nanoparticles is very eco-friendly or environment friendly . This method produces highly stable and well characterized nanoparticles. It eliminates the use of toxic chemicals and produce safer products with low consumption of energy. This method uses bacteria, plant extracts , use of waste, use of enzymes and microorganisms along with the precurssors to produce nanoparticles. These nanoparticles can be used in the biomedical field.Its advantages are that there is no need of high temperature; pressure or toxic chemical, reduced cost of micro organism isolation etc whereas the disadvantages are plants produces low yield of secreated protein which futher decreases the synthesis rate. Example:- bacteria of Au,Ag,Zn. [8]

TOP DOWN METHOD

This is a destructive method of synthesizing nanoparticles. It is used to destruct the agreggrate cluster of nanoparticles into small particles. This method is further divides into 5 other methods like:-

1) Mechanical miling
2) Nanolithography
3) Sputtering
4) Laser ablation
5) Thermal decomposition

Mechanical miling

This is a process in which suitable powder charge is place in high energy mill with the desired medium . The main aim of this process is to reduce the size of particles. Different types of elements are miled in an inert atmosphere . Plastic deformation which can lead to the change in the shape of the particle therefore this acts an influencing factor in this process. The limitation for this process is that its time consuming and require special precautions so as to prevent contamination from miling medium [45]

Lithography

This is a process of synthesizing nanomaterial in which etching , writing or printing is done so as to make material surface modify with structures in range of 1nm -100nm . this process can produce a single nanoparticle to an aggregrate cluster of nanoparticles with desired shape. The disadvantage of this method is that it has high cost maintenance and also need complex machinery.

Sputtering

This is a deposition method of depositing thin films . This mehod includes ejecting material from a target which is a source to a substrate. Target material can be alloy, ceramic or compound. Atoms from a source are ejected by high energy when bombarded with high energy nobles gases.The atoms that are ejected forms a thin layer film coating after condensing on substrate kept as an anode plate . It helps in producing non porus compact films. It is useful in depositing multilayer fims for mirror. It is further of three types DC SPUTTERING, Radio frequency sputtering and magnetnon sputtering.The advantages of this method are that no heat is required also this is performed under low vaccum. This is a high cost effective method.

Laser Ablation

In this method vapourization of material is effected by using laser beam pulses at high power. The set is done in a high vaccum system. In this process vapourization is affected by using pulses of laser beam lights having high power. These laser beam being powerful evaporates atoms from a solid source. Atoms collide with inert gas then are condensed on cooled substrate and then nanoparticles are formed from various solvents. No chemical agent is reqired in this method.Laser used as excimer in UV range because other wavlengths are usually reflected by surfaces of few metals. [8]

Thermal Deposition

This is an endothermic chemical deposition process which breaks the chemical compounds in a particular compound. The temperature at which this method synthesizes nanoparticles is referred to as decomposition temperature. The production of nanoparticles takes place by decomposing the metal at certain tempratures undergoing a chemical reaction. [15]

TOXICITY OF NANOPARTICLES

Having an outstanding industrial and medical applications, there are certain toxicities of nanoparticles and basic information is required regarding these toxic effects to encounter them properly. Nanoparticles could secretly enter the environment through water, soil, and air during different human activities. The application of nanoparticles for environmental treatment intentionally injects the engineered Nanoparticles into the soil or aquatic systems. As a result it has attracted increasing concern from all stakeholders. The advantages of magnetic nanoparticles like their small size, high reactivity and great capacity, could have become a potential lethal factors by inducing adverse cellular toxic and harmful effects which is unusual in micron-sized counter parts. Nanoparticles could enter organisms during ingestion or inhalation and then can translocate within the various oragns and tissues inside the body where the Nanoparticles could have the possibility to exert the reactivity having toxicology effects. [15] The toxicological effects of Nanoparticles on animal cells and plant cells to date are still limited. The uses of silver Nanoparticles in various consumer products have resulted them to their release to the aquatic environment and have become a source of dissolved silver and also exert toxic effects on aquatic organisms including bacteria, algae, fish etc .The respiratory system has an unique target for the potential toxicity of Nanoparticles because in addition to being the portal of entry for inhaled particles, it can also receive the entire cardiac output .Nanoparticles are used in biological applications on a large scale but still the rapid progress and early acceptance of nanobiotechnology the possibility for bad health effects due to lengthen exposure at various concentrations levels in human in the environment has not yet been formed. The environmental impact of Nanoparticles is more likely to increase in the future. One of the nanoparticles toxicity is the ability to gather near the protein concentration which depends on particles size, curvature, shape and surface characteristics charge, functionalized groups, and free energy. Because of this binding, some particles generate bad biological outcomes through protein [9]

APPLICATIONS

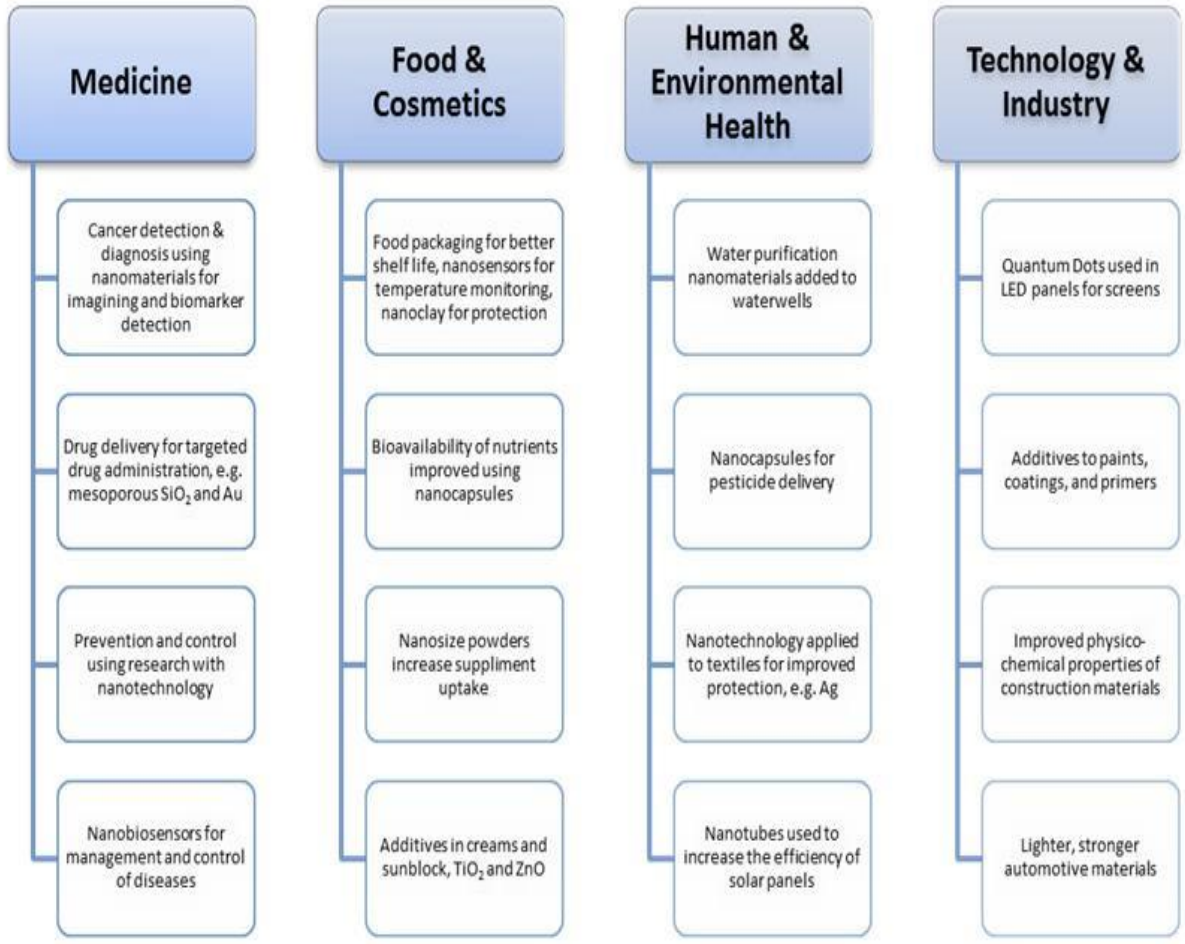


Fig.6 APPLICATION OF NANOPARTICLES IN DIFFERENT FIELDS [15]

MEDICINES

The usage of nanoparticles in medicines could be termed as nanomedicines. It is a biological and medical application of nanoparticles. Nanoparticles are used in biosensors and many other medical instruments . The major use of nanoparticles in medical field is drug delivery. It provides many ways for drug delivery . Nanoparticles helps in delivery of the drug accurately at the target site in the body and then release the drug dousage then drug reaches inside the body by attaching itself to a nanosized carrier. Nanorobots are used in clearing the blockage of artery. Nanoparticles are also used in tissue engineering and organ implantation. [13]

ELECTRONICS

The electrodes used in electronic devices are made from nanowires which are derived from nanoparticles which enables flat panel display to be flexible . The devices which uses transistors are also made from nanoparticles which are assembled on glass or thin films. Fabrication of chips can also be done using nanowires. The integrated silicon nanophotonics components are used in the CMOS integrated circuits. This optical technique provides higher speed data transmission within integrated circuits than is possible with **electrical** signals

COMPUTERS

The silicon transistors are now replaced with carbon nanotubes. Carbon nanotube is hollow cylindrical structure with a diameter of 3- 30nm and consists of pure carbon .[13] Nnanorods is an impending technology in the display techniques due to less electricity consumption . With the helps of nanoparticles size of microprocessors are reduced . The growing arrays of magnetic nanoparticles are known as nanodots . [15]

INDUSTRIAL

The most prominent application of nanoparticles is surface and coatings used in household in self cleaning or easy clean surface on ceramics or glasses . Nanoparticles have improved the smoothness and heat resistance of household eqipments. Nanoparticles have its use in many industries like food, chemical etc. For e.g. particles of nano ceramic helps in improving the heat resistance and smoothness of household equipments.

TEXTILES

The use of nanoparticles makes clothes water and stain repellent and make it wrinkle free also. Textiles with nanoparticles finishing can be washed less frequently and at low tempratures. Nanoparticles helps in building certain characterstics in textile like high tensile strength, durability , water repellency and like this. Nano whiskers help in making a fabric water and stain resistant . Nano nets helps in altering few properties of synthetic fibre for e.g. altering properties of polyster to make it feel like cotton or linen. Nano wrap helps in increasing the life of the fibre than a normal fibre. [13]

THIN FILMS

If TiO2 nanoparticles are deposited as a thin films then its refractive index and colour make it a magnificient reflective coating for the dielectric mirrors and it can also be used in producing decorative thin films . Some pigments of titanium dioxide nanoparticles are used in sparkly paints, plastics,cosmetics etc . These pigments are the man made pigments and their particles may have two or more layers of different oxides usually titanium oxide , iron oxide have a gliterring effect like crushed mica products would look. There is also a possibility of limited colour change in certain process which depends upon how and at which angle finished product will be illuminated and also the thickness of oxide layers in pigment particles of metal. One or more colours are appeared through reflection rest of the other tones appear because of the interference of translucent titanium dioxide layers [15]

CHAPTER 3 MATERIALS AND METHODS

GREEN SYNTHESIS OF SILVER NANOPARTICLES [27]

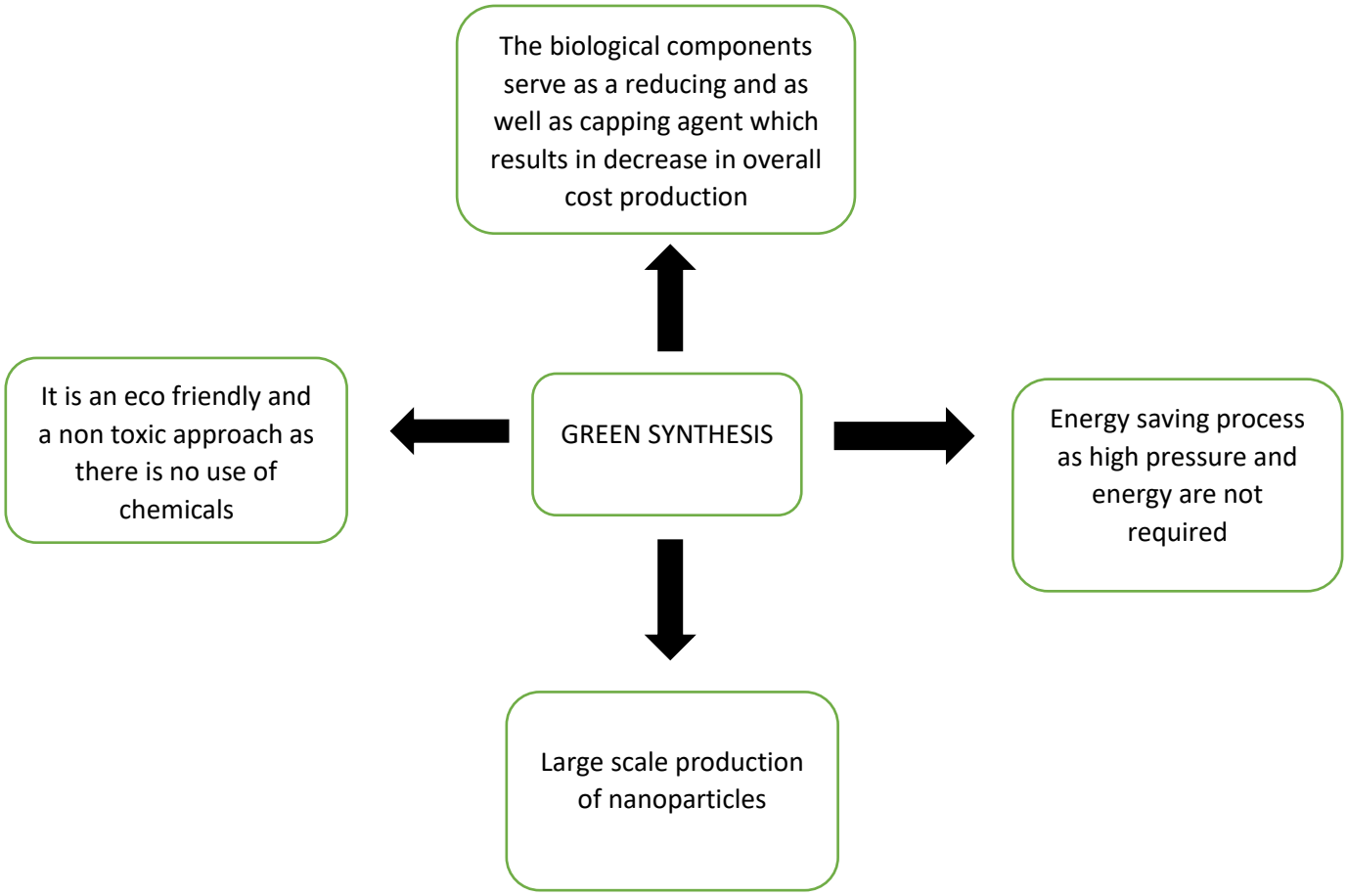


Fig.7 ADVANTAGES OF GREEN SYNTHESIS

Nowadays green synthesis is overlapping conventional methods of synthesis for production of silver nanoparticles because of its distinctive properties like non toxic, sustainable to the environment, less expensive, energy efficient , easy availability of extracts etc . This method of synthesis results in formation of stable and appropriate size nanoparticles . Green synthesis of silver nanoparticles is a process in which a precursor salt is combined with the biological extracts, then the metabolites present in these biological extracts can reduce and stabilize the mass metal in form of element , further following different mechanisms. The biological approach for the formation of nanoparticles has served as a simple and a feasible substitute to various physical and chemical methods The green

synthesis method depends on multiple reaction parameters like solvent , pressure, Ph conditions and temperature. The synthesis of nanoparticles is prefered by green methods as extracts used in the plants contain phytochemicals like flavonoids,caretonoids,phenolic acids,etc which covert these metal salts into metal nanoparticles. Green synthesis is better method as it helps in removing the unwanted by products that are harmful for the environment released during chemical methods and instead forming products which are sustainable and feasible for the environment. Green synthesis is further divided into two categories plants(leaves fruits,flower. Fruits) and microorganisms (bacteria,yeast,algae) Biological organisms can lower down the toxicity of metal and make them non toxic. Biologically nanoparticles are synthesized by bioreduction and biosorption.

1) The form of metal nanoparticle that has to be synthesized and this is the most important criteria for selection.
2) The choice of the organism becomes limited if the organism develops resistance against a small number of metals . [28]
3) Metals like copper, silver, gold , titanium dioxide , pallidium, platinum, cadium are often synthesized into their nanoparticles by microbial resources such as algae, fungi, bacteria , yeast and viruses. [26]

GENERATION OF SILVER NANOARTICLES BY GARLIC PEEL EXTRACT

PREPARATION OF GARLIC PEEL EXTRACT

Garlics were collected from a vegetable wendor and peeled. Garlic peels were washed with clean sterile refined water and permitted to air dry for 60 minutes. The external covering of the garlic were physically stripped off. The garlic bulbils being isolated were washed and extricated in the accompanying manner: Exactly 200 g of garlic were mixed into fine powder and absorbed 100 mls of refined water for 24 h. The pulps got were left in a spotless, sterile glass compartment and shaken overwhelmingly to consider legitimate extraction and it was sifted utilizing a sterile muslin fabric after which the concentrate was gotten and put away at 4 °C until expected for the amalgamation of Ag-Nanoparticles.

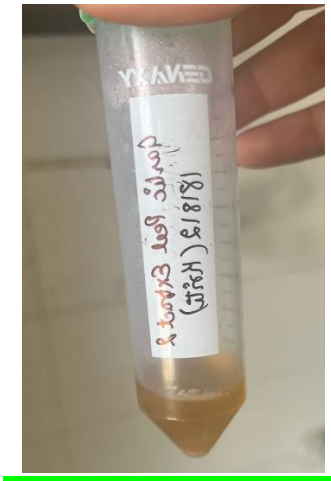


Fig.8 GARLIC PEEL EXTRACT

SYNTHESIS OF SILVER NANOPARTICLES

Silver nitrate was utilized as forerunner for blend of silver nanoparticles. 5 ml of 1 mM silver nitrate fluid arrangement was added to every 100 ml of clear plant remove. The cups were placed into shaker (150 rpm) at 30 °C and response was done for a time of 72 h. In this interaction garlic extricates go about as the lessening and balancing out specialists. Silver nanoparticles were gotten steadily by the disintegration and compound debasement of plant remove. The earthy colored colors arrangement demonstrate that the AgNPs were combined from the plant concentrates and they were centrifuged at 5000 rpm (Biorad centrifuge)for 10 min to get the pellet which is utilized for additional review.

Fig.9 MAGNETIC STIRRING OF GARLIC PEEL SOLUTION

UV VISIBLE SPECTROSCOPY ANALYSIS

The decrease of unadulterated Ag+ particles was checked by estimating the UV-Vis range of the response medium at 2 h in the wake of weakening a little aliquot of the example into refined water. UV-Vis spectra of these aliquots were observed as an element of season of response on UV-Vis spectrophotometer worked at a goal of 300-800nm. The tones change in the response blends (metal particle arrangement + garlic extricates were recorded through visual perception which showed the bioreduction of silver particles in fluid arrangement. UV-Vis ghastly investigation was finished utilizing UV-VIS spectrophotometer (Thermo scientific multiscan go)

GENERATION OF SILVER NANOPARTICLES BY POTATO PEEL EXTRACT

PREPARATION OF POTATO PEEL EXTRACT

Potato were collected from a vegetable wendor and peeled off. . The potato strips were washed multiple times under running water and then by Milli q water after which the peels were air dried for 3 days then were placed in incubator to remove the left over moisture in the peels and were stored at room temperature. Further dried peels were grinded into powder form and 100gm of powder was taken mixed with 200ml mili q water . The mixture was then left for mixing in the magnetic stirrer for 3 hours. The stirred mixture was filtered by filter paper and the extract was obtained.

Fig.10 POTATO PEEL EXTRACT

BIOSYNTHESIS AND OPTIMISATON OF AGNPS

- Synthesis mix was prepared by adding 1:1 $AgNO_3$ 4mM to the potato peel extract medium, as a substrate for AgNPs biosynthesis, the reaction mix was distributed in sterile screw-capped tubes and mixed well.
- $AgNO_3$ was prepared in shade to avoid photo-oxidation.
- The resultant solutions were incubated for 24 hrs at 37°C, and 150 rpm in a shaking incubator.
- After incubation, color change indicates nucleation and maturation of the AgNPs.
- The peel extract was centrifuged at 10000 rpm for 10 minutes, the supernatant was poured and the residue resuspended in deionized distilled water and centrifuged.
- This washing process was repeated three times to get rid of supernatant residual.
- The deposited nanoparticle's pellet in the tube, was desiccated in an oven at 40 °C.
- The dessicated AgNPs was in vials for subsequent analysis

Fig.11 MAGNETIC STIRRING OF POTATO PEEL SOLUTION

PORTRAYAL OF AgNPs

Morphological Examination- The adjustment of shade of the brooded combination was noticed furthermore, recorded which demonstrated the union of AgNPs.

UV-Vis Spectrometry Analysis-The AgNPs orchestrated after were exposed to optical estimations, which were done by utilizing an UVVis spectrophotometer and checking the spectra between 300-800 nm at the goal of 0.1 nm with the assistance of UV-Vis spectrophotometer.

Fig.12 SILVER NITRATE WITH POTATO EXTRACT FOR ANALYSIS

CHARACTERIZATION

Silver nanoparticles' UV–vis spectrum

Surface plasmon resonance (SPR), which occurs from collective oscillations of their conduction band electrons in response to electromagnetic waves, gives Ag NPs suspension a bright golden yellow . Due to the excitation mode of their surface plasmons, which is dependent on the size of nanoparticles, Ag NPs produce a distinct absorbance band in the UV area. Depending on the quantum size effects, these SPR bands red-shift or blue-shift. At ambient temperature, the optical absorption of green produced Ag NPs was determined with a double beam UV–vis spectrum in the wavelength range 300–800 nm

RESULTS

The primary examination of silver nanoparticle synthesis used UV–Vis spectrophotometric measurements. The mixture of plant extract and AgNPs has undergone a colour change. This combination shifts from transparent to yellowish-brown over time. For one week, the absorbance of the solution was studied. The syntheis of silver nanoparticles is shown by the gradual colour shift of AgNO3 solution from colourless to yellow to reddish brown. According to the spectral analysis, the nanoparticles were made but that
Yield was very less obtained.

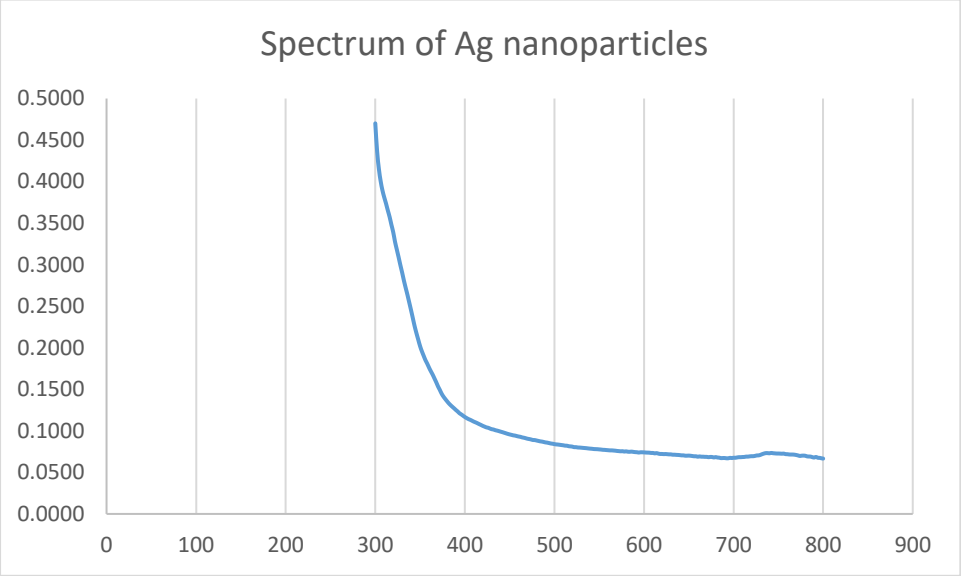


Fig.13 Spectrum of ag nanoparticles synthesized by garlic peel extract

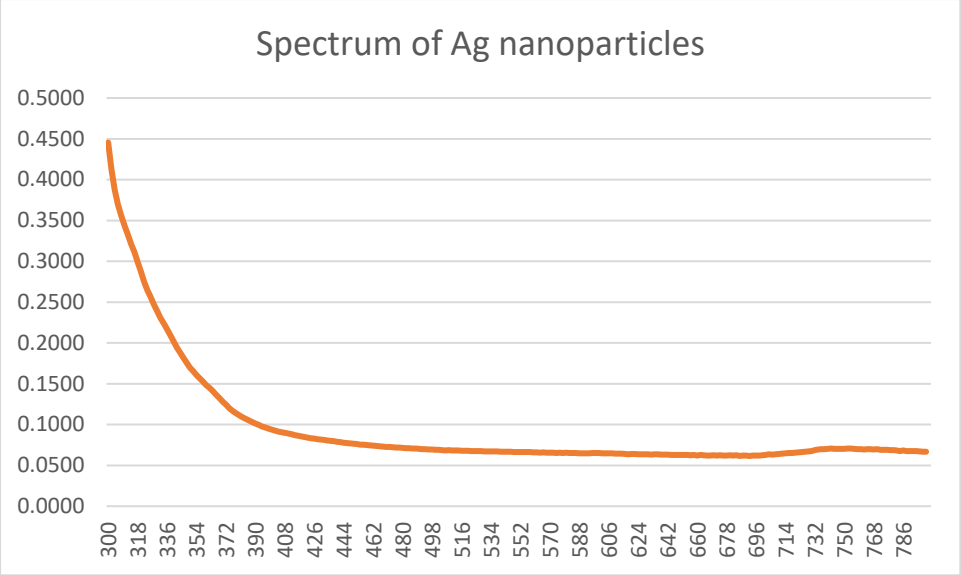


Fig.14 Spectrum of Ag nanoparticles synthesized by potato peel extract

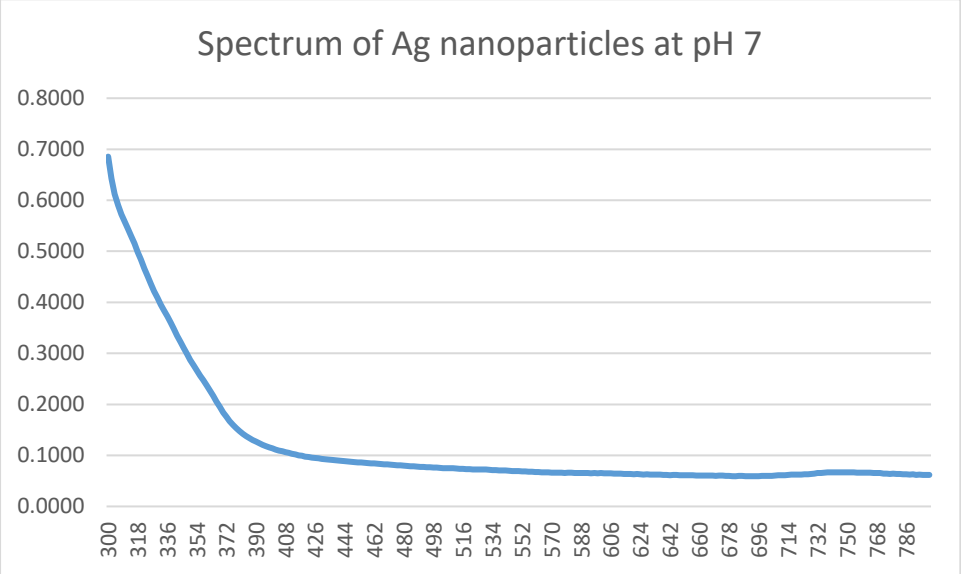


Fig.15 Spectrum of Ag nanoaparticles by garlic peel extract at Ph 7

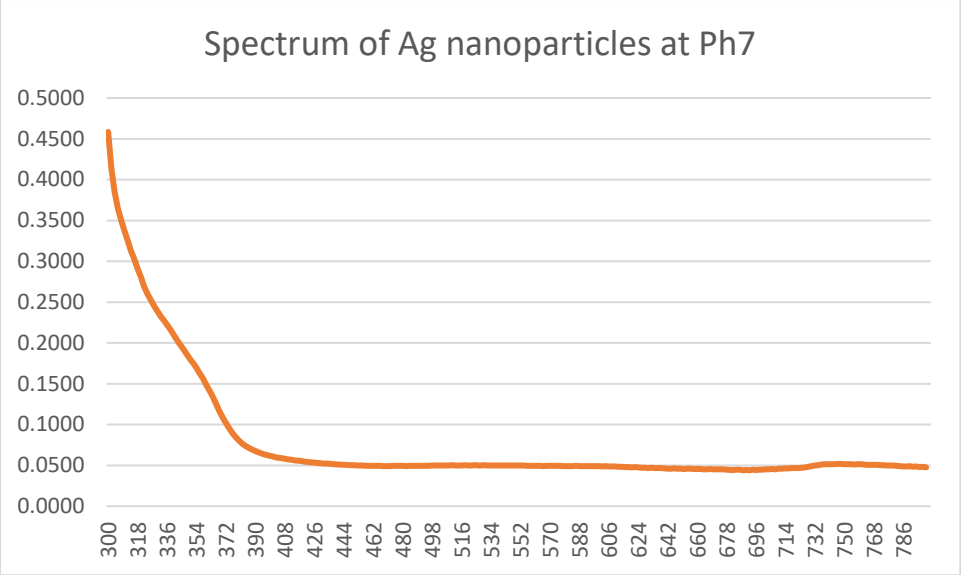


Fig.16 Spectrum of Ag nanoaparticles by potato peel extract at Ph 7

CONCLUSION

Nanotechnology has exploded in popularity during the last few decades. This report provides a comprehensive overview of NPs, their types, synthesis, characterizations, properties, and applications using various characterization techniques such as SEM and TEM, as well as a detailed introduction to green synthesis of silver nanoparticles using potato and garlic peel extract. NPs have a vast surface area due to their small size, making them appropriate for a variety of applications. If technology continues to grow, nanotechnology appears to be where the world is headed, and competition nearly guarantees that progress will continue. It will offer up a vast array of prospects for everyone. It is currently being tested for a variety of new applications in order to improve efficiency and performance. The use of environmentally friendly materials for the manufacture of NPs, such as plants or other living entities, has a variety of advantages in terms of eco-friendliness and compatibility for pharmaceutical and biomedical applications, as hazardous chemicals are not used in the methods. In addition, bioinspired NPs are more advantageous and outperform chemical and physical approaches. Green synthesis has shown considerable promise in the manufacture of AgNPs. As a result, this chapter ends with the hope that the unique properties of AgNPs can be put to good use for human benefit without causing any controversy about the product or process, lowering the cost so that it is affordable to all. Nanotechnology has a bright future because of its efficiency and environmental benefits. This study shows that nanoparticles stabilised with garlic and potato extracts could be great candidates for future biomedical research. Because of the low synthesis temperatures and time required, this synthesis

technique is a cost-effective and environmentally friendly alternative to standard protocols that may be easily scaled up for industry. We demonstrate that varying the amount of garlic-potato extract used during synthesis allows for some variation in nanoparticle size and size distribution. The silver nanoparticles made with garlic extract were found to be compatible with a variety of biological medium

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