REVIEW ON THA GREEN SYNTHESIS OF NANO PARTICLE USING PLANT EXTRACTS

[1] Ms. Kaveri A Bakhale ,[2] Mrs. Snehal Dhewale , [3]Mr. Dr.D.K.Vir .,

[4]Ms Gayatri S Bansod . , [5] Mr.Vishal S Barote

1(student), 2 (Associate Professor (Guide),3.Principal ,4 (student) ,5 (student) B

Pharmacy Final Year

,Shree Goraksha College of Pharmacy and Research centre, Khamgaon, Chhatrapati Sambhaji Nagar, Maharashtra, India 431151

1.Abstract :-

Green synthesis using plant extracts is a sustainable and eco-friendly method for producing nanoparticles, utilizing plant biomolecules to reduce metal ions and stabilize the resulting particles. This approach avoids toxic chemicals, is often conducted under mild conditions, and results in nanoparticles with various applications in medicine, environmental remediation, and energy storage. Common examples include the synthesis of silver, gold, and copper nanoparticles, where phytochemicals in the extract act as both reducing and capping agents.

methods that have unintended effects such As environmental pollution, large energy consumption, and potential health problems. In this review, current Developments in the green synthesis of nanoparticles of gold (Au NPs), silver (Ag NPs),Palladium (Pd NPs), copper (Cu NPs), and iron and its oxide (Fe NPs) were evaluated.Major findings reveal the complexity in geographical and seasonal distributions of Plants and their compositions that green synthesis is limited by time and place of Production as well as issues with low purity and poor yield. However, considering Current environmental problems and pollution associated with chemical synthesis, green Synthesis offers alternative development prospects and potential applications.© 2022 The Author(s). Published by Elsevier B.V

2.Keywords :-

Green synthesis; nanomaterials; plant; yeast; Green synthesis · Nanoparticles · Sustainability · Waste treatment · Dye degradation

3.Introduction:-

1. In recent years, nanotechnology has garnered significant attention due to its wide-ranging applications and potential for innovation. Nanomaterials are typically defined as materials with dimensions between 1 and 100 [1]. While size is the primary factor in classifying a substance as a nanomaterial, its shape and structure—referred to as morphology and geometry—also play critical roles in determining Nanotechnology has transformative potential across numerous sectors, including electronics, agriculture, and medicine (Figure 1). By incorporating nanoparticles, materials can be engineered with enhanced thermal, mechanical, and barrier properties [2].

The precise development of various nanoparticle shapes—such as spheres, rods, and quantum dots—expands their range of applications and opens up vast possibilities for future technological advancements [3].

2. Green synthesis presents several advantages over conventional chemical and physical methods. It is non-toxic (Devi et al., 2019), pollution-free (Alsammarraie et al., 2018), environmentally friendly, cost-effective (Kataria and Garg, 2018), and more sustainable (Nasrollahzadeh and Mohammad Sajadi, 2016). Despite these benefits, several challenges remain, particularly in the extraction of raw materials, extended reaction times, and inconsistencies in the quality of the final products. For instance, suitable raw materials are not always readily accessible (Turunc et al., 2017), the synthesis process can be time-consuming (Subramaniya la et al., 2015), and the resulting nanoparticles often exhibit uniform particle size, which may not meet all application requirements (Gao et al., 2016)

3. Nanostructures and nanotechnology represent a broad and interdisciplinary field of research and development that has experienced rapid global growth over the past few decades [1]. Recent evaluations of current innovations reveal increasing interest in this field, largely due to the unique physical and chemical properties exhibited by materials at the nanoscale. These include a high surface-to-volume ratio and enhanced surface reactivity compared to their bulk counterparts. Such properties make nanomaterials highly suitable for applications in catalysis, antibacterial and anticancer treatments, drug delivery systems, as well as mechanical and optical technologies [2]

4. Nanotechnology is a branch of science that focuses on the study and manipulation of materials at the nanoscale, typically ranging from 1 to 100 nanometers. It operates at the atomic and molecular level, offering significant advantages across various scientific fields such as dentistry, pharmaceuticals, and bioengineering [1] A green chemistry approach is crucial for the sustainable development of nanomaterials. This area of nanoscience should aim to produce nanoparticles (NPs) that are safe, environmentally friendly, and broadly accepted within the field of nanotechnology [2]. The choice of solvents and reducing agents used in the synthesis of nanoparticles has a significant impact on their morphology—including size, shape, and physicochemical properties. This morphology, in turn, affects the application and performance of the nanoparticles.

5. In recent years, nanotechnology has garnered significant attention across various scientific disciplines. This field involves the manipulation and application of materials at the nanoscale, typically between 1 and 100 nanometers [1]. While the defining feature of nanomaterials is their size, other factors such as morphology and geometry also play crucial roles in determining their physical and chemical properties. Nanomaterials are being utilized in a wide range of sectors, including electronics, agriculture, and medicine (Figure 1). Through nanotechnology, nanoparticles have transformed material design, leading to remarkable improvements in thermal stability, mechanical strength, and barrier performance [2]. The precise engineering of nanoparticle morphologies—such as spheres, rods, quantum dots, and other nanostructures—enables a broad spectrum of applications. This versatility opens up what could be considered limitless potential for technological innovation and advancement [3].

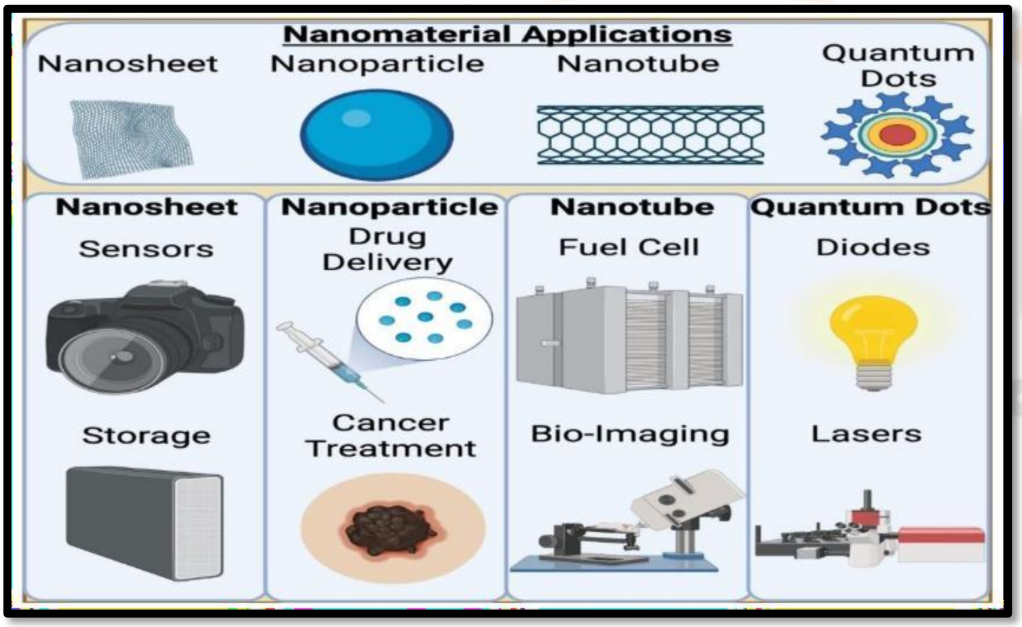

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Fig.no.1. Nanomaterial Applications

6. Nanomaterial synthesis can generally be divided into two primary approaches: traditional methods and green (eco-friendly) methods. Traditional synthesis techniques offer numerous advantages, including the ability to produce a wide range of nanoparticles with diverse applications. These methods often provide high scalability [9] and precise control over nanoparticle morphology [10–12], making them suitable for advanced applications such as battery conductivity, electronic devices [13–17], targeted disease therapies [18,19], and energy storage and conservation systems [20–2 0)However, despite their effectiveness, traditional synthesis methods come with significant environmental and health-related drawbacks. The frequent use of organic solvents in these processes presents serious neurobehavioral and reproductive risks during synthesis [23–25]. Moreover, the reliance on high-pressure and high- temperature conditions can contribute to hazardous working environments [26–28]. There is also growing concern regarding the emission of volatile vapors [29] and the excessive production of carbon dioxide, both of which significantly contribute to the greenhouse effect and broader environmental degradation.

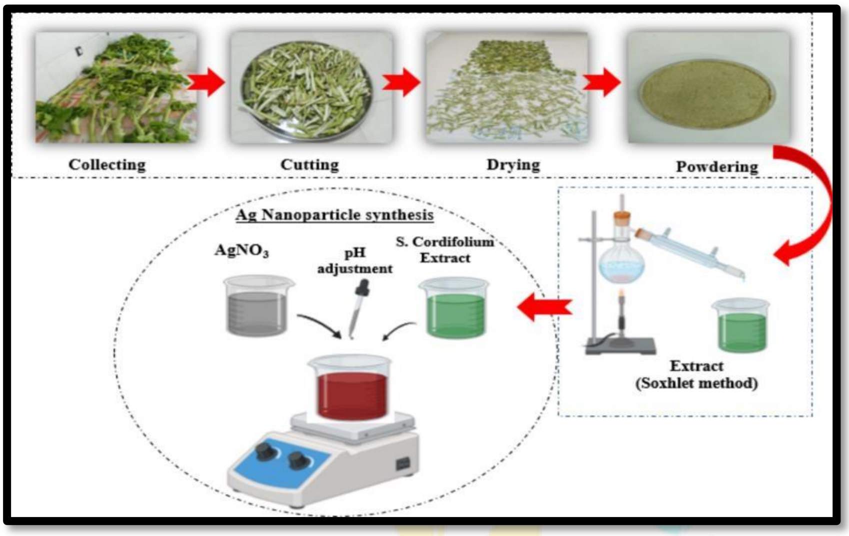

Fig.no.2. Green Synthesis Of Nanoparticles

1.Green Synthesis Of Nanoparticles

The three foremost conditions for the synthesis of nanoparticles are the selection of green or environment-friendly Solvent, a good reducing agent, and a harmless material for Stabilization. For the synthesis of nanoparticles, extensive Synthetic routes have been applied in which physical, chemical, and biosynthetic routes are very common. Generally, the Chemical methods used are too expensive and incorporate The uses of hazardous and toxic chemicals answerable for Various risks to the environment (Nath and Banerjee 2013). The biosynthetic route is a safe, biocompatible, environment-friendly green approach to synthesize nanoparticles Using plants and microorganisms for biomedical applications (Razavi et al. 2015). This synthesis can be carried out with Fungi, algae, bacteria, and plants, etc. Some parts of plants Such as leaves, fruits, roots, stem, seeds have been used for The synthesis of various nanoparticles due to the presence Of phytochemicals in its extract which acts like stabilization And reducing agent (Narayanan and Sakthivel ll 2011). For Nanoparticle synthesis, numerous biological and physicochemical pathways fall under two discrete classes: a bottomup and top-down approach, Fig. 1. Nanoparticles synthesis Via various biological and physicochemical approaches is Shown in Fig. 1

For synthesis of Ag NPs,1 mM solution of silver nitrate was prepared in an Erlenmeyer flask and 1–5 ml of plant extract was added separately to 10 ml of silver nitrate solution. This setup was incubated in a dark chamber to minimize photoactivation of silver nitrate at room temperature. Reduction of Agp to Ag0 was confirmed by the color change of solution from colorless to brown. Its formation was also confirmed by using UV–Visible spectroscopy.

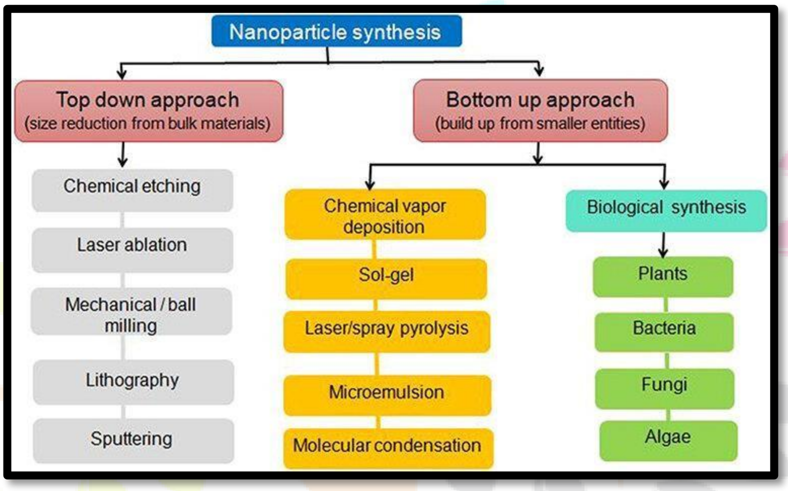

Fig.no.3. Nanoparticles synthesis

3.Resources for green synthesis

Of nanomaterials Microbial, fungal and algal-mediated synthesisTraditional physical and chemical methods are recognized For their high energy and time costs and the use of environmentally harmful chemicals. Chemical synthesis techniques Require a metal precursor, reducing agents, and a stabilizing Agent, with various processes suggested, such as reducing silver nitrate in the presence of a stabilizing and reducing Agent in an aqueous solution. Diferent reducing substances Like citrate, ascorbate, borohydride, hydrogen gas, surfactants, and ligands, or polymers such as polyvinylpyrrolidone and polyethylene glycol are stabilizing agents. Factors Like the starting concentration of the silver nitrate solution, The stabilizing agent's concentration, and the molar ratio of Silver nitrate to the reducing agent signifcantly infuence The sizeof the resulting nanoparticles (Gudikandula and charya Maringanti 2016). Therefore, chemical approaches Have limited advantages and lack environmentally friendly Synthesis techniques

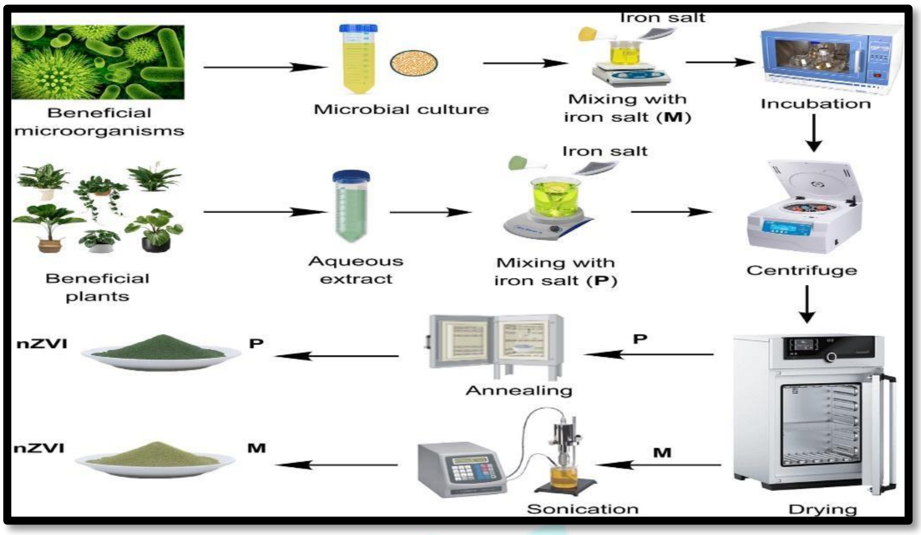

Fig.no.4. Green synthesis of Nanozerovalent

Green synthesis of Nanozerovalent iron using Microorganisms, i.e., M and Plants, i.e., P. Microbial culture Is mixed with iron salt and Incubated to produce nanoparticles. Aqueous plant extract Produces nanoparticles with Iron salt in situ. The obtained Nanoparticles are centrifuged to Get the solid nanoparticles from The suspension. The drying step And/or annealing is the fnal step To obtain the green synthesized Nanoparticles. nZVI refers to Nanozerovalent iron

5.Traditional Synthesis Methods

2.1. Sol-Gel Synthesis sol-Gel synthesis is a common method for the synthesis of nanomaterials. ThisRelatively simple method is straightforward and can be easily utilized for the synthesis of Nanomaterials using a variety of different metal oxides such as TiO_2, ZnO, SnO_2, WO_3, Fe_2O_3 as well as silica and Platinum [38–41]. This process usually progresses over a series Of five steps, beginning with hydrolysis of the precursors using either water or an organic solvent. Next, molecules that are adjacent to one another begin to form linkages as the process continues into the condensation step. The resulting “gel” is then aged and dried By supercritical drying, thermal drying, or freeze drying, with each producing slightly Different products. Finally, calcination is performed in order to drive off residues and dry Any remaining water [38].

Nanomaterials synthesized using Sol-Gel have wide-spread applications includeing drug delivery, wastewater treatment, construction materials, and a variety of sensors [41–48]. This method can be applied at an industrial level due in part to the limited Number of ingredients that are required to facilitate the final product [49,50]. Additionally, Sol-Gel synthesis can progress utilizing only one-pot which adds to its allure [44].As effective as the Sol-Gel synthesis method can be for the manufacturing of nanomaterials, it has several shortcomings regarding environmental and personal safety. Firstly, organic solvents that are typically used for the hydrolysis of the nanomaterial precursors Pose enormous health and environmental risks [23,24]. It has been shown that organic Solvents can affect a variety of different bodily systems, including neurobehavioral and Reproductive systems [23,25,51]. Although this method is effective and efficient, it poses significant risks that cannot be overlooked

6.Green production of nanoparticles

The techniques for obtaining nanoparticles using naturally occurring reagents such as vitamins, sugars, plant Extracts, biodegradable polymers, and microorganisms as reductants and capping agents could be considered Attractive for nanotechnology. These syntheses have led To the fabrication of limited number of inorganic Nanoparticles (mainly metal nanoparticles, although several metal oxides and salts are also reported). Among the reagents mentioned above, plant based materials Seem to be the best candidates and they are suitable for large-scale 'biosynthesis' of nanoparticles [29]. Plant Parts such as leaf, root, latex, seed, and stem are being used for metal nanoparticle synthesis. The key active Agent in some of these syntheses are believed to be polyphenols, present for example, in tea, wine and winery waste, red grape pomace. Greener synthesis of nanoparticles provides advancement over other methods as it is simple, cost-effective, and relatively reproducible and often results in more stable materials [30]. Microorganisms can also be utilized to produce nanoparticles but the Rate of synthesis is slow and only limited number of sizes And shapes are amenable compared to routes involving plant based materials. At present, fungi are gaining Worldwide popularity as nano-factories for the green Synthesis of nanoparticles [31]. Overall, biological materials provide an environmentally friendly or greener chemical method to produce invaluable materials because the biomaterial based routes eliminate the need To use harsh or toxic chemicals [32]. Mechanisms of these bioreductive transformations [33–35], as well as catalytic properties of materials obtained via these routes [36–39]Have been discussed in a series of reports.

6.Plant extract

Many chemical methods are chosen for synthesizing NPs Because of their quick reaction time [16] and their capability To produce monodispersed NPs [17]. Methods such as chemical reduction [18], electrochemical reduction [19], photochemical reduction [20], and heat evaporation [21] have all Been employed for synthesis of NPs. Although all these methods are able to successfully produce the MNPs, theyhave few disadvantages such as the high price of the process And not being environment friendly since they make lots of pollution in the environment because of using toxic solvents And reducing agent [22]. Although chemical stabilizers are used more than plant extract, that materials are not safe foe The environment and for a human health condition. To avoid These drawbacks, green chemistry approaches have been Employed for production of NPs [23–25] which is simple, convenient, less energy- intensive, eco-friendly and minimize the usage of unsafe materials, and maximize the efficiency of the processPlant-based polyphenols are considered to be the largest Groups of natural antioxidants with extraordinary potential as drugs, nutraceuticals, and food additives [26]. The underlying principle in the green synthesis approaches is that the phytochemicals present in the plant parts serve the twin role of a Natural reductant besides being a nanoparticle stabilizer [27]. According to other reports [28], highly stabilized NPs may be Quickly synthesized from plant extracts rather than microbebased synthesis. Therefore, the plant extract could be an efficient approach for reducing NPs early material plus stabilized that

7. Plant extract

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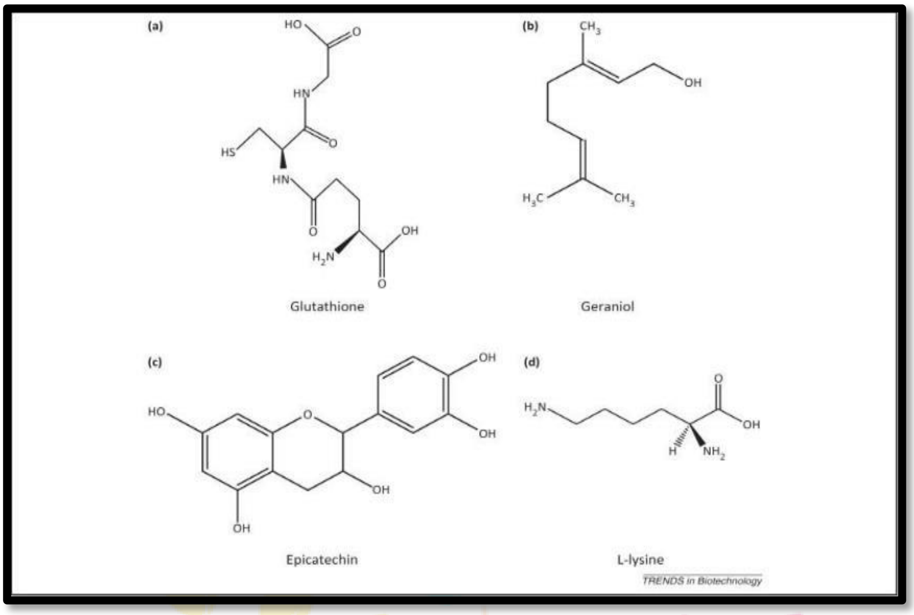

Fig.no.5 Chemical structures of some components of plant extracts.

The reactions have generally been carried out at Room temperature, although in some processes a heating was applied, mainly below 100 8C. For example, silver Nanoparticles have been synthesized (at room temperature And 60 8C) using Polyalthia longifolia leaf extract as a Reducing and capping agent along with D-sorbitol used To increase the stability of the nanoparticles [50]. The synthesized silver nanoparticles were more highly toxic To Gram-positive bacteria than Gram-negative bacteria. In Addition, silver nanoparticles have been synthesized using Sulfated polysaccharide isolated from marine red algae (Porphyra vietnamensis) [51]. The resulting silver nanoparticles showed surface plasmon resonance centered at 404 nm with average particle size measured to be 13 3 nm. The involvement of the sulfate moiety of the polysaccharide for reduction of silver nitrate was revealed Spectroscopically.

The resulting silver nanoparticles ranged in size from 3 to 20 nm. Leaf Extract of Morinda citrifolia L. High amounts of phenolic Compounds in the plant extract are likely to influence the Reduction process and stabilize nanoparticles preventing Agglomeration. Among many other plant extracts applied For reduction of Ag+ we note aqueous extracts of Moringa Oleifera [54] and Vitex negundo L. [55]

8. Types of nanoparticles

A wide variety of nanoparticles are synthesized by green Approach up to now and characterized by ultraviolet–visible spectroscopy, Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, photoluminescence analysis (PL), transmission electron microscopy (TEM), scanning Electron microscopy (SEM), energy dispersion analysis of X- ray (EDAX), X-ray difractometer (XRD), atomic force Microscopy (AFM), feld emission scanning electron microscopy (FE-SEM), thermal-gravimetric diferential thermal Analysis (TG-DTA), X-ray photoelectron microscopy (XPS), Attenuated total refection (ATR), dynamic light scattering (DLS) and UV–visible difuse refectance spectroscopy (UV-DRS).

1. **Ag nanoparticles**

For the green synthesis of silver nanoparticles, the key requirements are silver metal ion solution and a reducing biological agent. The easiest and inexpensive method for silver nanoparticles production is silver ion's reduction and stabilization by a fusion of biomolecules such as polysaccharides, vitamins, amino acids,proteins, saponins, alkaloids, terpenes, and phenolics (Tolaymat et al. 2010). Silver nanoparticles can be extracted from many medicinal plants such as Saccharum ofcinarum (Chaudhari et al. 2012),

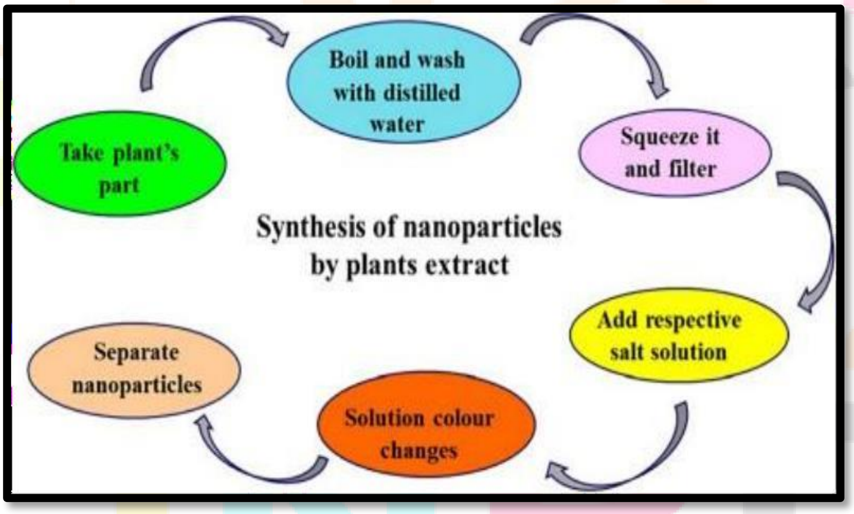

Fig.no.6. Environment-friendly and cheap route for the green synthesis of nanoparticles using plants extract.

2. **Au nanoparticles**

Gold nanoparticles have attracted considerable attention among all metallic nanoparticles due to their uniqueness in a high potential for use in medicine and biology feld (Jain et al. 2006), more biocompatible nature (Sperling et al. 2008), tunable surface plasmon resonance (Huang and ElSayed

2010), low toxicity (Jeong et al. 2011), strong scattering and absorption (El- Sayed et al. 2005), facile synthesis methods, easy surface functionalization (Ghosh et al. 2008), etc. In the mechanism of synthesis of gold nanoparticles, various chemical moieties in biogeniccomplexes treat as reducing agents and react with gold metal ion with the result of its reduction and preparation of nanoparticles, Fig. 5. Some studies revealed that in plants extract, some biomolecules like favonoids, phenols, protein, etc., act signifcantly in the reduction of metal ions and the topping of gold nanoparticles (Fig. 6)

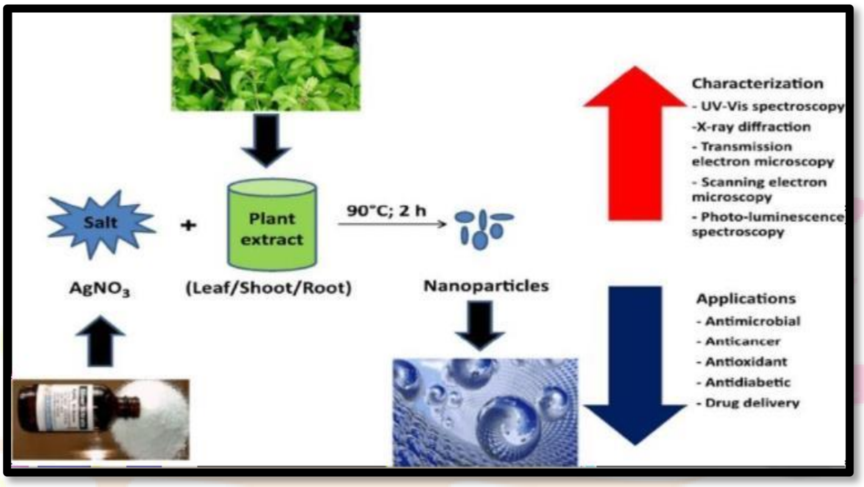

Fig.no.7.Green synthesis of silver Nanoparticles by plants

Plant	Size (nm)	Plant's part	Type of NPs Au	Type of NPs Ag	Reference
Alternanthera dentate	50–100	Leaves		*	[74]
Coleus forskohlii	silver (5–15) gold (5–18)	Root	*	*	[75]
Curculigo orchioides	15–18	Rhizome		*	[76]
Digitaria radicosa	90	Leaves		*	[77]
Dioscorea alata	10–20	Tuber		*	[78]
Diospyros paniculata	14–28	Root		*	[79]
Elephantopus scaber	11–100	Leaves		*	[80]
Emblica officinalis	10–70	Fruit		*	[81]
Abutilon indicum	1–20	Leafs	*		[82]
Butea monosperma	gold (10–100) silver (20–80)	Leafs	*	*	[83]
Carica papaya	15–28	Leaves	*		[84]
Gymnema sylvestre	72.8	Leaves	*		[85]
Hibiscus sabdariffa	10–60	Leaves	*		[86]
Hygrophila spinosa	50–80	Leaves	*		[87]
Ficus benghalensis	40	Bark		*	[88]
Ocimum sanctum	1–50, 10–300, 50–300, > 200	Leaves	*		[89]
Parkia roxburghii	5–25	leaves	*	*	[90]
Piper longum	20–200	Fruits	*		[91]
Podophyllum hexandrum L.	5–35	Leaves	*		[92]
Rhus chinensis	20–40	Galls	*		[93]
Stachys lavandulifolia Vahl	34–80	Aerial part	*		[94]

Table 1. Green synthesis of Au and Ag nanoparticles by different researchers using plant extracts.

9. Synthesis of nanoparticles

There are different physical and chemical methods for successfully synthesizing NPs (Figure 2(a)). One can categorize all These methods into two main approaches that can apply To any research in the field of nanoscale science: (1) theop-bottom and (2) the bottom-top approach (Figure 2(b,c)) Each of which has specific characterization and application.

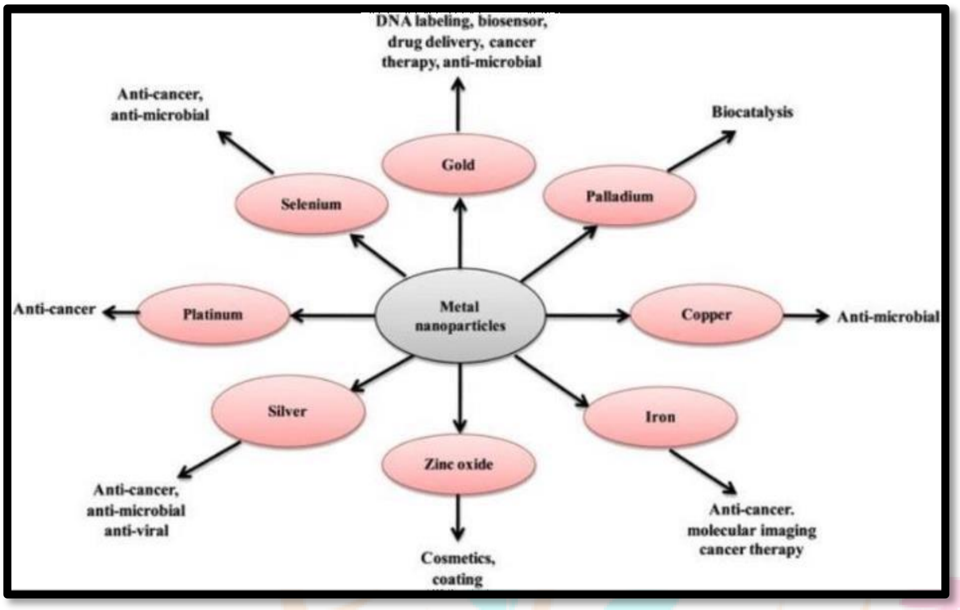

Fig.no. 8. Different types of metal nanoparticles

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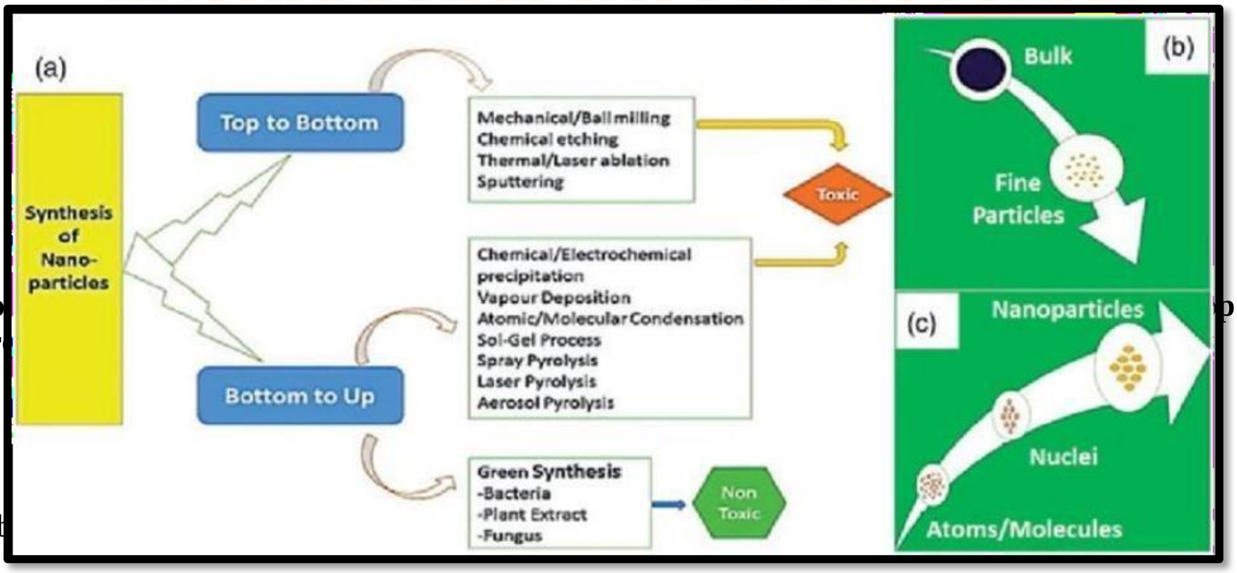

10. Top-b

In top-bottom approaches, the desired bulk of materials break down into the particles in the nanosized range (Figure 2(a)) [9] e.g. mechanical milling/alloying and sputtering [10,11] are examples of methods for reducing the size of the particles. This method can cause the surface imperfections in the product which causes serious restriction since the surface structure of a material plays a vital role in surface chemistry and physical properties of a material [8]

11. Bottom-top

In bottom-top approaches, the synthesis process start with In both top-bottom and bottom-top approaches, nanoparticles preparation is relying on utilizing chemical and physical methods which are quite expensive and more likely hazardous to the environment which involve use of toxic and dangerous chemicals that are responsible for various biological risks [8,9]. Since, plant-mediated NPs synthesis approach not only does not involve physical and chemical methods, also this method is environment-friendly, biocompatible, highly stable, therefore this method has attracted a substantial attention among researchers worldwide. i.e. co-precipitation, sol–gel, and atomic condensation [12–14] are examples of this approach.

12. Properties of nanoparticles

Physical properties of nanoparticles

Nanoparticles have different colors like yellow, gold and gray. The gold ones aremelting at much lower temperatures (~300°C for 2.5nm size) than the gold slabs (1064°C) [43].
Especially silver Nanoparticles have distinctive physico-chemical properties, including a high electrical and thermal conductivity, Surface-enhanced Raman scattering, catalytic activity and chemical stability, and non linear optical behavior [44].

Absorption of solar radiation in the photovoltaic cells is much higher in nanoparticles than it is in thin films of Continuous sheets of the bulk material – since the particles are smaller, they absorb greater amount of solar radiation.

13. Advantages

Nanopart The advantages of using nanoparticles for the drug delivery result from their two main basic properties. Second, the use of biodegradable materials for Nanoparticle preparation allows sustained drug release within the target site over the period of days or even weeks [45]. But not only for drugs are nanoparticles very important.

Nanotechnology can actually revolutionize a lot of Electronic products, procedures, and applications. The areas that benefit by the continued development of Nanotechnology when it comes to electronic products include nano diodes, nano transistors, OLED, plasma displays,
Quantum computers, and many more. Nanotechnology can also benefit the energy
sector Another Industry that can benefit from nanotechnology is the manufacturing sector that will need materials like aerogels, Nanotubes, nano particles, and other similar items to produce their products with. These materials are often more Durable, stronger and lighter than those that are not produced with the help of nanotechnology [46].

There are some more advantages of nanoparticles over their production and their drug delivery process. Due to their small Size Nanoparticles penetrate small capillary and are taken up by the cell which allows for efficient drug Accumulation at the target sites in the body. Using Nanoparticles in drug delivery give good control over size and Give good protection of the encapsulated drug. Retention of the drug at the active site has longer clearance time.

Nanoparticles increased the therapeutic efficiency as well as bioavailability. They reduced fed/fasted variability that Increased drug stability. Stable dosage forms of drug which are either unstable or have unacceptably low Bioavailability in non-nanoparticulate dosage form. While carrying drug with nanoparticles have no biotoxicity of the carrier. Nanoparticles are do not show any Problem in large scale production and sterilization but they only avoid organic solvent [45-47].

15. Disadvantages

Nanotechnology has raised the standard of living but at the same time, it has increased the Pollution, which includes water pollution, air pollution This kind of pollution is very dangerous for living organisms.

The disadvantages of nanoparticles are very poorly explored. So there are only a few more of them based on drugs delivery. producing Nanoparticles for drug delivering extensive use of polyvinyl alcohol as a detergent that create an issue on toxicity. Nanoparticles have only limited targeting abilities that's why discontinuation of therapy is not possible.

The disturbance of autonomic Imbalance by nanoparticles having direct effect on heart and vascular function. Nanoparticles show particle growth, Unpredictable gelation tendency, unexpected dynamic of polymeric transmitions and sometimes burst release [45]

16. Role of plants in green synthesis Of nanoparticles

In the biosynthesis of nanoparticles environmentally Accepted "green chemistry" concept has been applied for The development of clean and environment-friendly nanoparticles which involves bacteria, fungi, plants, actinomycetes, etc., which is said to be "green synthesis" (Pal et al. 2019). Biosynthesis of nanoparticles by using the above Organisms epitomizes a green substitute for the invention Of nanoparticles with innovative properties

Plants are known as chemical factories of nature Which are cost-efficient and need little maintenance. Plants have revealed outstanding potential in heavy metal Detoxifcation as well as accumulation by which environmental pollutants problem can be overcome because very Small traces of these heavy metals For nanoparticle synthesis, The part of the plant which has to b can d and boiled with distilled water. After sequence

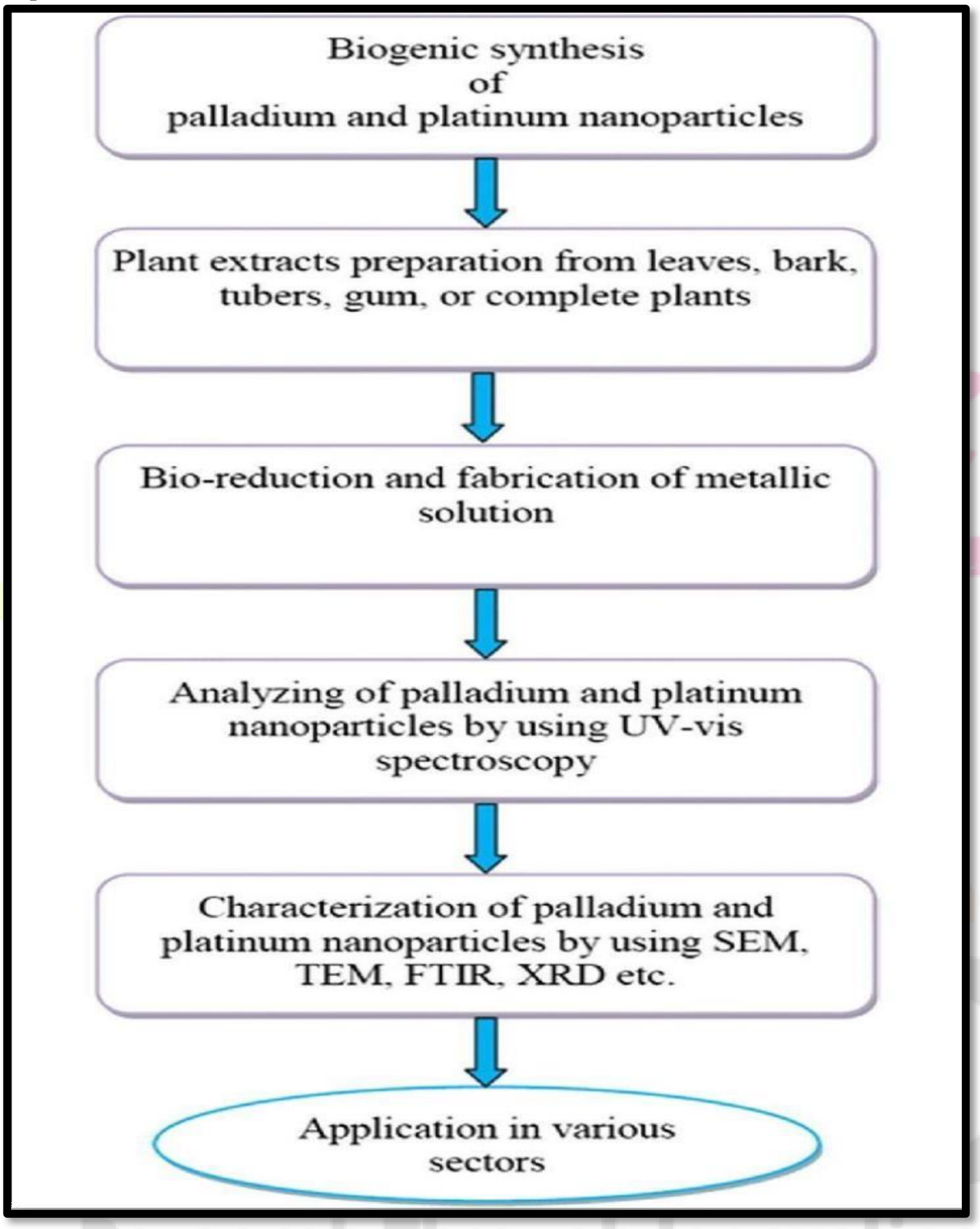

Fig.no.10.flowchart for synthetic route,characterization and applications of green synthesis

Fltering, and adding respective solutions which nanoparticles we want to synthesize, solution color starts changing unveiled the formation of nanoparticles and we can Separate these,
Fig. 4 Literature suggested accumulation, detoxifcation, and Phytoremediation of toxic metals by some plants, such As Thlaspi caerulescens, Maytenus founieri, Arabidopsis Helleri, Sesbania drummondii, Acanthopanax sciadophylloides, Clethra barbinervis, and Brassica juncea.

The use Of these plants in heavy metal elimination from aqueous solutions has gained considerable attention due to its great Potential for the removal of pollutants and toxicity from Wastes in an eco-friendl method (Carolin et al. 2017). Many nanoparticles such as gold, silver, zinc oxide, iron Have been synthesized very easily by adopting a green Approach (Singh et al. 2018). The phytocompounds present In the plant extract such as polyols,
terpenoids, polyphenols are responsible for metallic ions bioreduction (Ovais Et al. 2018).

17. Application of nanoparticles

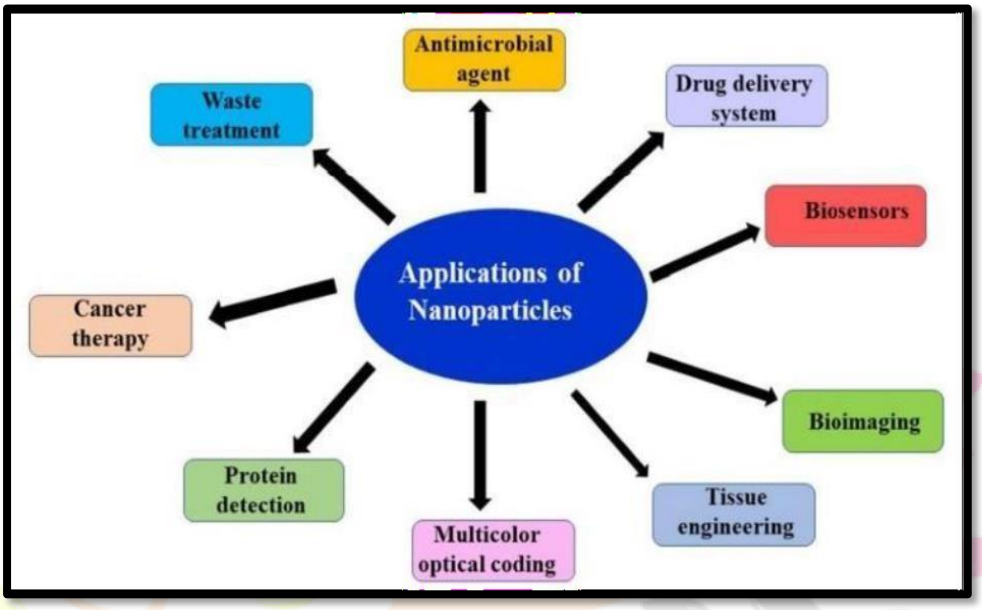

Fig.no.11. Applications of green Synthesized nanoparticles in Environmental and biomedical Felds

Blue absorbance value with time (Das and Velusamy 2014). Congo red and reactive yellow 179 dyes were Decolored by photocatalytic activity using gold nanoparticles Synthesized by using Eucommia ulmoides (Guo et al. 2015).Silver nanoparticles have drawn considerable attention From researchers and scientists due to their wide area of Applications like biolabeling, sensors, antimicrobial activity, Antibacterial activity, cell electrodes, integrated circuits, etc.

Due to showing antimicrobial activity, these are applicable In numerous felds such as medicine, health, packaging, animal husbandry, various industries, military, cosmetics, and Accessories. Against infectious organisms such as Staphylococcus Aureu, Vibria cholera, Bacillus subtilis, Syphillis Typhus, Pseudomonas aeruginosa, and Escherichia coli, These nanoparticles showed potential antimicrobial efects.the green synthesized $TiO2$ nanoparticles have.
$TiO2$ nanoparticles derived by Hibiscus rosa sinensis exhibited excellent antimicrobial activity against both Grampositive and Gram-negative strains of bacteria (Kumar et al. 2014). Similarly, $TiO2$ nanoparticles are widely applicable In the degradation of various pollutants such as nitroarene Compounds and toxic dyes.

18. Conclusion

This Technique gives us a simple and efficient way for the Synthesis of nanoparticles with tunable optical properties Governed by particle size. In conclusion, this Green chemistry approach toward the synthesis of AgNPsPossesses several advantages viz, easy process by which This may be scaled up, economic viability, etc. Applications Of such eco-friendly nanoparticles in bactericidal, wound Healing and other medical and electronic applications, Makes this method potentially stimulating for the largescale synthesis of other inorganic materials, like Nanomaterials. Toxicity studies of M. oleifera-mediated Synthesized AgNPs are also underway. During the last some decades, increasing demand for green Chemistry and nanotechnology pushes toward the adoption Of green synthetic routes for the synthesis of nanomaterials via plants, microorganisms, and others. Green synthesis of nanoparticles has been the area of focused research By researchers in the last years by adopting an eco-friendly Approach. Much research has been carried out on the plant Extract-mediated nanoparticles synthesis and their potential Applications in various felds due to their cost-efectiveness, Nontoxic route, easy availability, and environment-friendly Nature. Moreover, they have a wide area of applications Such as catalysis, medicine, water treatment, dye degradation, textile engineering, bioengineering sciences, sensors, Imaging, biotechnology, electronics, optics, and other biomedical felds.

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