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A Review On Green Synthesis And Characterization Of Nanoparticles

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Abstract-
Nanoparticles are structures that possess unique properties with high surface area-to-volume ratio. Their small size, up to 100 nm, and potential for surface modifications have enabled their use in a wide range of applications. Additionally, the materials used in the synthesis of NPs are primary determinants of their application. Based on the chosen material, NPs are generally classified into three categories: organic, inorganic, and carbon-based. These categories include a variety of materials, such as proteins, polymers, metal ions, lipids and derivatives, magnetic minerals, and so on. Each material possesses unique attributes that influence the activity and application of the NPs. Consequently, certain NPs are typically used in particular areas because they possess higher efficiency along with tenable toxicity. NPs were characterized using Powder X- ray diffraction (XRD), Ultraviolet–visible spectroscopy (UV–Vis), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive Spectroscopy (EDS), Fourier Transform Infrared spectroscopy (FTIR) and Dynamic light scattering (DLS) analysis. antidiabetic effect the term of alpha-glucosides inhibitors and alph-amylase inhibitors.
Keywords-Nanoparticles, Metal nanoparticles, Ant diabetic, Scanning electron microcopy, Emission electron Micrescopy, plant extract, alpha amylase Inhibitor

I. Introduction-

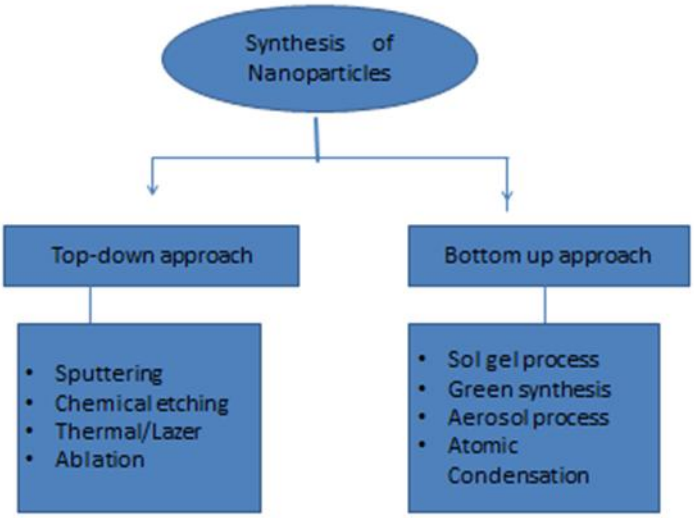
The field of nanotechnology has advanced exponentially in the last decade and many products containing nanoparticles are now used in various applications such as in food science, cosmetics and pharmaceuticals. Nanoparticles (NPs) are defined as particles with one dimension ranging between 1 and 100 nm. NPs exhibit different properties depending on their size and surface functionalities The small size and large surface area account for the extensive use of NPs in various areas such as cosmetics, electronics and both diagnostic and therapeutic medical applications. The exponential growth and increasing interest in nanotechnology have been enhanced by the ability to image nanomaterial's using techniques with atomic resolution capabilities such as scanning emission microscopy, scanning transmission electron microscopy and tandem electron microscopy . (Najahi-Missaoui et al., 2020)

The advantages of using nanoparticles as a drug delivery system include the following:

- Particle size and surface characteristics of nanoparticles can be easily manipulated to achieve both passive and active drug targeting after parenteral administration(Hall et al., 2007)
- They control and sustain release of the drug during the transportation and at the site of localization, altering organ distribution of the drug and subsequent clearance of the drug so as to achieve increase in drug therapeutic efficacy and reduction in side effects.
- Controlled release and particle degradation characteristics can be readily modulated by the choice of matrix constituents. Drug loading is relatively high and drugs can be incorporated into the systems without any chemical reaction; this is an important factor for preserving the drug activity.
- Site-specific targeting can be achieved by attaching targeting ligands to surface of particles or use of magnetic guidance.
- The system can be used for various routes of administration including oral, nasal, parenteral, intra-ocular etc.
- In spite of these advantages, nanoparticles do have limitations; i.e., their small size and large surface area can lead to particle-particle aggregation, making physical handling of nanoparticles difficult in liquid and dry forms. In addition, small particles size and large surface area readily result in limited drug loading and burst release. These practical problems have to be overcome before nanoparticles can be used clinically or made commercially available.

The present review details the latest development of nanoparticulate drug delivery systems, surface modification issues, drug loading strategies, release control and potential applications of nanoparticles.(VJ Mohanraj et.al. 2007)

Method of preparation of Nanoparticles-



Synthesis of Nanoparticles-Products from nature or those derived from natural products, such as extracts of various plants or parts of plants, tea, coffee, banana, simple amino acids, as well as wine, table sugar and glucose, have been used as reductants and as capping agents during synthesis. Polyphenols found in plant material often play a key role in these processes. The techniques involved are simple, environmentally friendly, and generally one-pot processes. Tea extracts with high polyphenol content act as both chelating/reducing and capping agents for nanoparticles. We discuss the key materials used in the field: silver, gold, iron, metal alloys, oxides, and salts.Oxana Vet.al.(2013)

Bottom-up approach-Liquid phase methods are also numerous. It is within the liquid phase that all of self-assembly and synthesis occurs. Liquid phase methods are upscalable and low cost.Electrodeposition and electroless deposition are very simple ways to make nanomaterials (dots, clusters, colloids, rods, wires, thin films). Prabhu, S et.al.(2022)

Sol-gel method:- . **Dmitry Bokov et.al. (2021)**In this method, the molecular precursor (usually metal alkoxide) is dissolved in water or alcohol and converted to gel by heating and stirring by hydrolysis/alcoholysis. Since the gel obtained from the hydrolysis/alcoholysis process is wet or damp, it should be dried using appropriate methods depending on the desired properties and application of the gel. For example, if it is an alcoholic solution, the drying process is done by burning alcohol. After the drying stage, the produced gels are powdered and then calcined. The sol-gel method is a cost-effective method and due to the low reaction temperature there is good control over the chemical composition of the products. The sol-gel method can be used in the process of making ceramics as a molding material and can be used as an intermediate between thin films of metal oxides in various application

Table 1. Common precursors for the synthesis of metal oxides using sol-gel method and their functional groups

S.N.	Precursor
1	Tetraethoxysilane (TEOS)
2	Tetramethoxysilane (TMOS)
3	Dibutylphosphate
4	Titanium tetraisopropoxide
5	Vanadium $O(Am^t)_3$

Green Synthesis- The advantages of using plant and plant-derived materials for biosynthesis of metal nanoparticles have interested researchers to investigate mechanisms of metal ions uptake and bioreduction by plants, and to understand the possible mechanism of metal nanoparticle formation in plants.

Table- Green synthesis using plants

Plant Part	Scientific Name	Common Name	Antidiabetic and Other Biological Activities	Nanoprticles size	Modal	Referance
Leaf	*Flueggealeucopyrus*	Indian snowberry**,** white honey shrub	antibacterial, antioxidant, and antidiabetic	CuNPs	L	Pratibha et.al
leaves	of Barringtonia racemosa (B. racemosa). B. racemosa's	Powderpuff Tree	antibiotic and antifungal antidiabetic	(AgNPs	alpha amylase and alpha glucosidase	Shahnaz Majeed et.al.2024
fruits	Magnifera indica	Mango	Antidiabetic	mangiferin-loaded solid lipid nanoparticles (MG-SLNs)	Alpha (α) – Glucosidase inhibitory assay . Alpha (α) – Amylase inhibitory assay	Ahmed I. Foudah et.a.2024
leaf	*Capparis zeylanica*	Ceylon caper	antidiabetic and antimicrobial	titanium dioxide		M. Nilavukkarasi Et.al.2024
			Antimicrobial, diabetes mellitus	silver nanoparticles'		(2024)
leaf	Syzygiumcumini	Jamun	promising antidiabetic and wound-healing properties	AgNPs	glucose uptake and α-amylase inhibition assays	Santosh Malikarjun (2024)
	. Balanites aegyptiaca	Hingot	anti-diabetic	chitosan (CS) NPs	streptozotocin-induced diabetes in rats	Shimaa Aahmer et.al
leaf	M. charantia	bitter melon	diabetes mellitus	silver nitrate nanoparticle		Kalaiselvi Krishnamoorthy
Seed	*Azadirachta indica*	Neem	anti-diabeticanti-diabetic	AI-AgNPs	glucose adsorption assays , glucose uptake by yeast cells assays, and alpha-amylase inhibitory assays.	Gauhar Rehman et.al
Bulb	*Allium sativum*	Garlic	Diabetes	AgNPs from 10 to 30 nm	α-amylase and α-glucosidase	D.Jani e.al.
leaves	Elsholtziablanda	Mint	the antidiabetic	zinc oxide nanoparticles	α-amylase and α-glucosidase	Athisa Roselyn Maheo 2023
	Achillea maritima;	**Yarrow**	antioxidant; antibacterial; antifung	AgNP	alpha amylase and alpha glucosidase	BadiaaEssghaier et.a.2023
leaf	Butea monosperma	**Palash**	α- amylase inhibitory and anti-inflammatory	silver nanoparticles	α-amylase inhibition method	Akshay Patil,et.al.2023
Leaf	*Murrayakoenigii*	Curry Leaf Tree	diabetes mellitus, cancer, antioxidant, antimicrobial	ZnO NPs		Avinash Sharmaet.a.(2023)
leaf	*Tabernaemontana divaricate*	Crepe jasmine	Antibacterial Antidiabetic	CuO NPs	standard BSA denaturation and α-amylase inhibition technique.	Manonmani Raju
			the antibacterial, antifungal, and antioxidant	TiO_2 NPs	the α-amylase and α-Glucosidase enzyme activity	Wongchai An upong
Leaf	Gymnemasylvestre	gurmar	Diabetes mellitus	Zinc Oxide Nanoparticles	Streptozotocin	Sravani Gotteparthiet.al.
	Phragmantheraaustroarabica		antidiabetic activity	AgNP		Dina M. Khodeer

leaves	Argyreia nervosa	**elephant creeper**	antibacterial, anti-inflammatory, antioxidant, and anti-diabetic activities	silver nanoparticles		Kalaiselvi Krishnamoorthy(2023)
Leaf	**Ficus palmate**	Wild figh	the antibacterial, antifungal, and antioxidant	**zinc oxide nanoparticles**		Avinash Sharma et.al(2022)
	Pterocarpus marsupium	Malabar kino	type 2 diabetes	silver nanoparticles	against streptozotocin and nicotinamide induced	J Bagyalakshmi2022
leaf	Murrayakoenigii and *Zingiber officinal*	Curry Leaf Tree	antidiabetic activit	Ag/CuO nanocomposites	α-amylase, α-glucosidase and glucose-6-phosphatase enzymes, and glucose uptake assay	Ag/CuO nanocomposites et.al(2022)
Leaf	Gymnemasylvetres	Gurmar	anti-dia betic	silver nanoparticles	inhibiting the enzymes α-amylaseThe	AjinnkyaB.Chavanet
	Brachychiton populneus	**Kurrajong**	the antioxidant, anti-inflammatory, antidiabetic, and cytotoxic activities	silver nanoparticles		**Muhammad Naveed**
	Physalis minima	Sunberry	anti-oxidant, anti-diabetic, and antibacterial	Gold nanoparticles		Velmurugan Sekar et.al.
			antibacterial, anti-diabetic, and anti-inflammatory	CuO-NPs	STZ-induced diabetic mice,	Shah Faisal et.al.
Leaf	Punica granatum	pomegranate	Antidiabetic	silver nanoparticles 35 to 60 nm	α-amylase and α-glucosidase	Rijuta G Saratalet.al
Hole plant	Cleome viscosa	Trickweed	an antibacterial, antioxidant and anti-diabetic age	silver nanoparticles		Suresh Yarrappagaari (2020)et.al
leaves and fruits	*Aegle marmelos*	bilwa or bael	*hypoglycemic/antidiabetic*	AgNO3	Blood Glucose levels in Diabetic rats	MRUNAL K. SHIRSAT1 2020
root	Curcumin,	Turmaric	anti-diabetic anti-diabetic	CS-ZnO-NC		Pratibha Chauhan 92019)
fruit		Ananas comosus	antioxidative, antidiabetic, and cytotoxic	AgNPs		Gitishree DasID2019
bulb	*Withaniacoagulans*	Panir kephool	Antidiabetic	chitosan nanoparticles		Kaarunya Sampathkumar et.al.2019
	Catathelasmaventricosum		antidiabetic activity	Selenium nanoparticles	STZ (streptozocin)-induced diabeticmice	Yuntao Liu (2018)
leaf	Calophyllumtomentosum	Bintangur	anti-bacterial, antioxidant, anti-diabetic, anti-inflammatory and anti-tyrosinase activity	AgNPs	a-Amylase inhibition assayHeat induced hemolytic assay of CtAgNPs	M. Govindappa(2018)
seed	*S. cumini*	Malbar plum	antidiabetic		*Candida albicans*-infected diabetic rats.	Paula e.t.a.(2017)
leaf	Pouteria sapota	Mamey Sapote	antidiabetic activity	silver nanoparticles	streptozotocin-induced ratsinhibition of alpha-amylase	Prabhu, S.et.al.2017

leav	O. basilicum, Moringa oleifera leaf and flower		Antimicrobials, Diabetic, Cancer	Gold nanoparticle Gold nanoparticle	*α- amylase inhibition assay*	K.Anand et.al.2017
bark and wood	*Pterocarpus marsupium*	Indian kinotree	anti diabetic	silver nanoparticle s	*α- amylase inhibition assay*	J Bagyalakshm i(1017)
leaf	*Lonicera japonica*	Japanese honeysuckle	anti diabetic	silver nanoparticle s	*a-Amylase inhibition assaya-Glucosidase inhibition activity*	Kannan Balan (2016)
eaf	Gymnemasylvestre	gurmar	anti-diabetic	silver nanoparticle s	streptozotocin induced diabetic rats	Kalakotla Sha nker
leaf	Hibiscus subdariffa	Gudhal	anti-diabetic	Zinc oxide (ZnO) nanoparticle s	on streptozotocin (STZ) induced diabetic mice	Niranjan ballaet.al.(20 15)
			Antidiabetic	Zinc oxide and silver nanoparticle a	Streptozotocin-Induced Diabetic Rats	Ali Alkaladi et.al 2014
seeds	Trigonella foenumgraecum	fenugreek	antihyperglycemic, antidiabetic		streptozotocin (n-STZ) induced diabetes mellitus in rat,	Chetan p. (2012)

Characterization of nanoparticles- Nanoparticles are characterized by following method-

- UV spectrophotometry analysis confirmed the presence of metal with the maximum absorbance of 427 nm.
- FTIR analysis supported the existence of alcohols with the OH stretch and alkenes with the C–C stretch.
- The existence of metal NPs with an average hydrodynamic diameter of 36.58 nm was confirmed using dynamic light scattering (DLS).
- Energy dispersive X-ray spectroscopy (EDX) confirmed the presence of metal.
- spherical structure particles with the size distribution ranging from 10 to 17 nm with polydispersity, under transmission electron microscopy (TEM).
- Thermo gravimetric analysis (TGA) findings revealed that AgNPs maintain good thermal stability even at high temperatures.
- scanning electron microscope (SEM) was utilized to perform morphological and structural analysis. To evaluate the form and bonding arrangement of biosynthesized1

Table-Physicochemical properties with characterization of nanoparticles

S.N.	properties of nanoparticles	Characterization of nanoparticles	Refernces
1	Particle shape, size, and distribution	Dynamic light scattering Electron microscopy (scanning/transmission) Atomic force microscopy	B. Akbari et.al.(2011)
2	Particle roughness and topography	X-ray diffraction (XRD) , Electron diffraction (ED) , X-Ray Photoemission Spectroscopy (XPS) formerly known as ESCA–Electron Spectroscopy for Chemical Analysis	Christie M. Sayes 2009
3	Surface area and surface chemistries	Auger electron spectroscopy (AES), X-ray photoelectron spectroscopy (XPS), time-of-flight secondary-ion mass spectrometry (TOF-SIMS), low-energy ion scattering (LEIS), and scanning-probe microscopy (SPM), including scanning tunneling microscopy (STM) and atomic force microscopy (AFM)	**D. R. Baer et.al 2011** Anshida Mayeen et.al.2018
4	Stability, dispersion, swelling, agglomeration, and aggregation	Scanning electron microscopy (SEM) Environmental SEM (ESEM), Zeta potential	Ping-Chang Lin 2013
5	Purity	UV–VIS spectrophotometer	P. Senthil Kumar2019
6	Reactivity and hydrophobicity	Raman Spectroscopy, Fourier Transform Infrared Spectroscopy	Deena Titus et.al.2019
7	Chemical	UV–VIS spectrophotometer	Christie M. Sayes
8	Electrical	UV–VIS spectrophotometer, X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM)	AK Singh 2010
9	Optical	X-ray diffraction pattern (XRD) reveals single phase monoclinic structure. Scanning electron	Amrut. S. Lanje

		microscopy (SEM) showed the rectangular morphology of as prepared CuO nanoparticles. The transmission electron microscopy (TEM)	et.al.2010
10	Biological	In vitro cell viability In vivo Microbial colony viability	Ajeet Kumar , A. Jemec et.al.(2017)

Summary- Nanoparticles are synthesize different technique.Nanoparticles are used in treatment of various disease like antimicrobial, antioxidant, anti-inflammatory, anti diabetics and anticancer activity by using plants extract. These ate easily formation and characterization by using various analytical techniques.

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