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SYNTHESIS OF ZINC NANO PARTICLES USING NATURAL CAPPING AGENTS

D.SWETHA

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Under the guidance of

DR.S.BRITTO, M.Sc.,M.Phil.,Ph.D.,

Assistant professor,Department of Chemistry

PG AND RESEARCH DEPARTMENT OF CHEMISTRY

St.JOSEPH'S COLLEGE (AUTONOMOUS)

Abstract

Capping agents are of utmost importance as stabilizers that inhibit the over-growth of nanoparticles and prevent their aggregation/coagulation in colloidal synthesis. The capping ligands stabilize the interface where nanoparticles interact with their medium of preparation. Specific structural features of nanoparticles are attributed to capping on their surface. These stabilizing agents play a key role in altering the biological activities and environmental perspective. Stearic effects of capping agents adsorbed on the surface of nanoparticles are responsible for such changing physico-chemical and biological characteristics. Firstly, this novel review article introduces few frequently used capping agents in the fabrication of nanoparticles. Next, recent advancements in biomedicine and environmental remediation approaches of capped nanoparticles have been elaborated. Lastly, future directions of the huge impact of capping agents on the biological environment have been summarized.

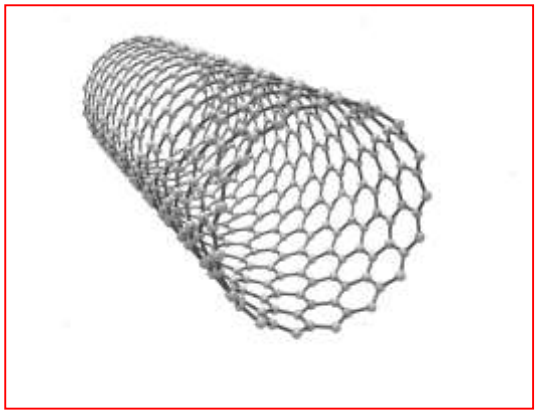
CHAPTER- I

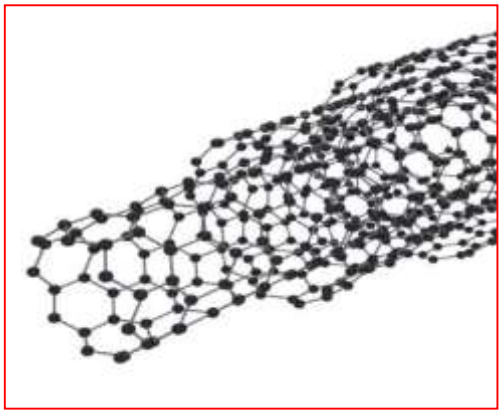
INTRODUCTION:

1.1 USE OF NANO PARTICLES

The particles of chemical compounds are referred to be nano particles. If their size is of 10^{-9} m inn length 1-100 nm in diameter. The synthesis of nano particles is an emerging field of chemistry, because of their wide use in matrial sciences. A variety of reports have been found in the literature. (Boverhof.2015) However a large scale of production of nano particles is much challengeable to the chemists. Main fields of nanotechnology application range from catalysis, Micro and nano –electronics(Semiconductors, single electron transistors), non- linear optic devices, photo-electrochemistry to biomedicine , diagnostics, foods and environment, chemical analysis and others . To the environment concern, chemists need to look the eco friendly methods to the large scale synthesis of nano particles.

In general, the nano –objects properties depend on chemical compostion , but also on size, shape, compostionn and their environment including their spatial distribution. Usually the bulks size particles are converted are converted into nano particles. Since the increase in the surface area will give a benefit in catalysis. The morphology of such particles play an important role in the various fields of chemistry



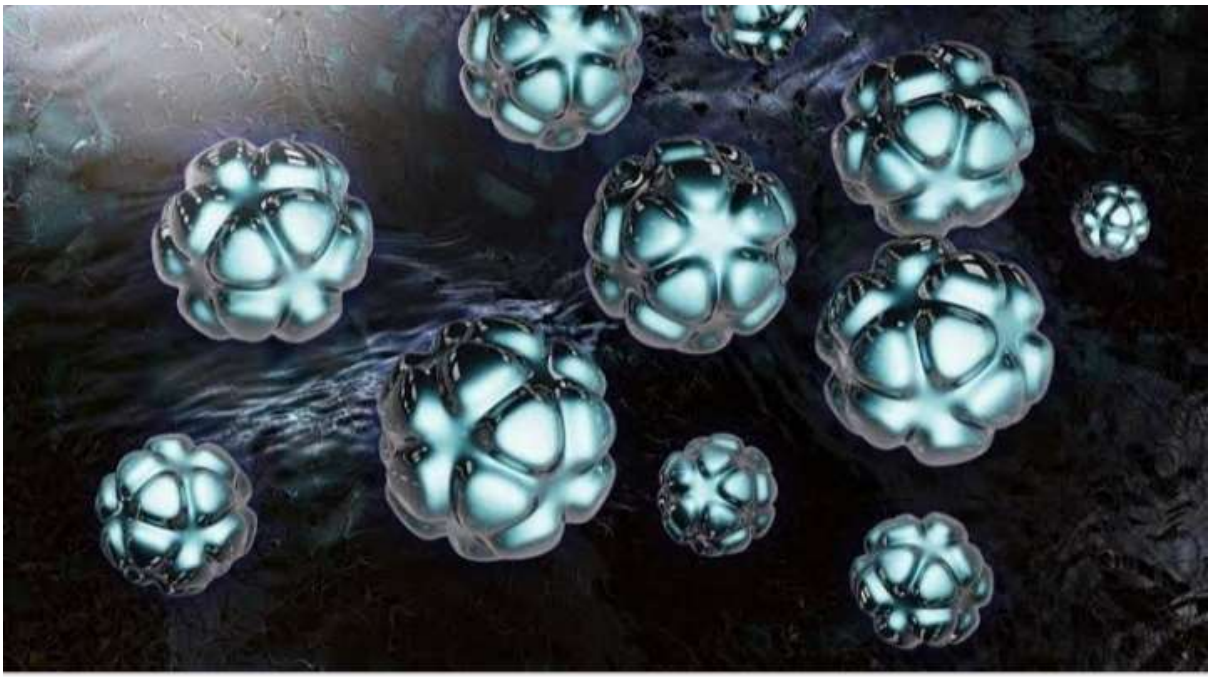


A) Single walled carbon nano tube **B)multi Walled Carbon nano tube**

The reason why nanoparticles plays a substantial role is because it is based on their important and unique features, such as their large surface are to its mass ratio, which is much larger than that of other particles and materials, allowing for catalytic promotion of reactions, and their ability to adsorb and carry other compounds. Nanoparticle is capricious because, the surface is modified after the synthesis of nanoparticles, depending on the presence of reactants and adsorbing compounds, which may instantaneously change with changing compounds and thermodynamic conditions. Therefore, on one hand, nanoparticle have a large (functional) surface which is able to bind, adsorb and carry other compounds such as drugs, probes and proteins. On the other hand nanoparticle has a surface that might be chemically more reactive compared to their fine analogues

1.1 TYPES OF NANO PARTICLE

Inorganic based nano particle are classified into metal particle and metal oxide particles . Mostly inorganic nano particles are non-toxic, biocompatible and highly stable compared to organic materials. Nanoparticles are now having highly advanced chemical properties and many Inorganic nanoparticles have been used as drug carriers.



Nano particles can be classified into different types according to the size, morphology, physical and chemical properties. Some of them are carbon based naoparticels, ceramic nanoparticles, metal nanoparticles, semi conductor nanoparticles, polymeric nanoparticles and lipid –based nano particles.

1.2 MODERN METHODS OF PRODUCING NANOPARTICLES

\ Synthesizing the nano particles in a green chemical way in the current focus of material chemist due to the environmental concern. Nano particles are produced in nature and they are called nature nano particles. They are produced in the plants in their leaves, stem, root and seeds.

The conversion of bulk particles into nano particle by a mechanical way is easier than their production. This conversion is usually done by mechanical grinding. Engineerd nano particle are produced by a simple combustion. Ore refining and smelting (Rogers. 2005) For example Tio_2 produced in such a way is used in cosmetics, sunscreen and tooth paste.

The conversion of biological compounds such as DNA as nano materials play a major role in the medicinal chemistry especially in the cancer treatment. There are mainly four types of nano structures zero, one, two, and three dimension structures (Tiwari, J. N Prog. Mater Sci 2012)

A rich variety of physical and chemical methods have been developed for fabricating OD nano material structures with well-controlled dimensions. Recently, OD NSM_s such as uniform particle arrays, heterogeneous particle arrays, core- shell quantum dots, onions, hollow spheres and nano lenses have been synthesized by several research groups.

ID materials with having one dimension on thee nanometer scale, only the thickness of the surface of the object is found between 0.1 nm and 100 nm. They are also expected to play an important role as both interconnections and the key units in in fabricating electronic,opto electronic and EED_S with nano scale dimensions .

2D nano materials have two dimensions on the nano scale (ie) diameter of tube is between 0.1 nm and 100 nm, its length Can be for more. 2D NSM_S with certain geometers exhibits unique shape- dependent characteristics and subsequent utilization as building blocks for the key component of nano devices.

The 2D NSM_S are particularly interesting not only for basic understanding of the mechanism, but also for investigating and developing novel application in sensors, photocatalysts, nano containers, nano reactors and templates for 2D structures of other materials.(Polropivny , V.V.2007).

3D nano materials have three dimensions on the nano scale, (ie) the particle is between 0.1 nm and 100 nm in each spatial dimension. It is well knownthat the behaviours of NSM_S Strongly depend on the sizes, dimensionality and morphologies. In addition , 3D nanostrucutres are important materials due to its wide range of application in the area of catalyst, magnetic material and electrode material for batteries. (Pokropivny, V. V.2007)

Moreover, the 3D NSM_S have recently attracted intensive research interests, because the nanostructures have enough absorption sites for all involved molecules in a small space. Chemical and Physical nano particle synthesis cannot be expanded easily to large- scale production of hazardous by-products and intermediary compounds and high energy consumption . Aqueous media are prevalent in the synthesis of metal nanoparticles. Because of the presence of attractive forces eg. Vander waals , those particles may produce aggregates. Some synthetic molecules, named capping agents were added in the steric stabilizers to prevent particle aggregation and to control nanoparticle morphology.

Besides other problems are found inn nano particle synthesis , structural particle deformation, and inhibition of particle growth. Additionally, chemical

nano particle synthesis included in nano composites (or) molecules which could increase the particle reactivity and toxicity and might harm human health and thee environment due to the composition ambiguity and lack of predictability.

Biochemical nano particle synthesis. Beyond being environmentally friendly, is simple, cost-effective , more reproducible and with defined physicochemical poperties. Biochemical nano particles can be classified into organic, inorganic, and hybrid.

Among the biochemical nanoparticles, most of macromolecules and cellular sub structures are able to form nano particles based on environmental conditions and sample treatment. The ability of biological structures to produce nano particle was reported in many living organisms ranging form yeast, fungi, plants, algae, bacteria (eubacteria, cyanobacteria), as recently reviewed. Biochemical nano particles Can be synthesized from carbohydrates, lipids, DNA, proteins and also complex mixtures (Hosea, M., Greene,B) Inorganic biochemical nano particles can be classified into oxides and metallic. The synthesis of inorganic biochemical nano particles is carried out by unspecific reducing agents present in the medium and / or as the result of triggering the SOS system in the cell to reduce toxicity.

In the case of hybrid biochemical nano particles, the synthesis can be driven by molecular precursors in the presence of biological templates (eg.DNA, proteins). The advantage of using biological templates os the huge diversity of tridimensional biostructures available as templates that can be used to create nano particles with many different characteristics and properties. Two main strategies were developed for biochemical nano particles production by means of the use of biological extracts or specific molecules, named as in –vitro biosynthesis, and using living cells, named as in – vivo biosynthesis.(Buzea, C .2007)

1.3 NANO PARTICLES IN BIOTECHNOLOGY

Nano particles are being expressed as fundamental builing block of nano technology. Nano biotechnology is the application of nano technologies in biological fields . While biotechnology deals with metabolic and other physiological processes of biological subjects including micro organisms, in combination with nano technology. T he nano biotechnology can play a vital role in developing and implementing many useful tools in the study of life. Although the intergration of nano fundamaterials with biology has led to the development of diagnostic devices, contrast agents, analytical tools, therapy and drug –delivery vehicles, biotechnology research is still in its infancy.

Nano technology in medicine is a wide are that encompasses disease diagnosis, target-specific drug delivery and molecular imaging . While Conventional electrodes for brain stimulation, pace makers and limb stimulation The use of nanomaterials and nano scale applications will bring a further push towards implanted electronics in the human body.

Nano particle play an important role in a number of these application , which in genral terms are defined as engineered structures with diameters of <100 nm, are devices and system produced by chemical and physical processes having specific properties. The reason why nano particles attractive for such purpose is based on their important and unique features, such as their surface to mass ratio, which is much larger than that of other particles and materials, allowing for catalytic promotion of reactions, as well as their ability to be adsorbed and carry other compounds.

The reactivity of the surface organisms from quantum phenomena and can make nano particle unpredictable immediately after generation. Nano \ particles may have their surface modified, depending on the presence of

reactants and adsorbing compounds , which may instantaneously change with changing with compounds and thermodynamic conditions. Therefore, on one hand, nano particle have a large (functional) surface which is able to binds, adsorb and carry other compounds such as drugs, probes and proteins . On the other hand nano particles has a surface that might be chemically more reactive compared to their fine analogues.

1.4 SYNTHESIS OF ZINC NANO PARTICLES:

Nano technology deals with the production and usage of material with nanoscale dimension. Nano scale dimension provides nanoparticles a large surface area to volume ratio and thus very specific properties. Zinc oxide NP_S had been in recent studies due to its large bandwidth and high excition binding energy and it has applications like antibacterial, antifungal, anti-diaetic , anti-inflammatory, wound healing , antioxidant and optic properties. Due to the large rate of toxic chemicals and extreme environment employed in the physical and chemical production of these NP_S , gren methods employing the use of plants, fungus, bacteria and algae hae been adopted.The green synthesis of ZnO NP_s using different biological sources.

1.4 GREEN PRODUCTION OF ZINC NANO PARTICLES

Biosynthesis of nanoparticels is an approach of synthesizing nanoparticels using microorganisms and plants having biomedical applications. This approach is environmentally friendly , cost effective, biocompatible, safe, green approach. Green synthesis includes synthesis through plants, bacteria, fungi,algae etc.The zinc nano particles free of additional impurities.
These natural strains and plant extract some phytochemicals that act as both reducing agent and capping or stabilization agent.

Extensive research work is carried out using plant and its part for nano particles synthesis due to its scaling up for large production apart

from being cost effective friendly.Most commonly applied method for simple preparation of ZnO NPs from leaves or flowers is where the plant part is washed thoroughly in running tap water and sterilized using double distilled water Then, the plant part is kept for drying at room temperature followed by weighing and then crushing it using a mortar and pestle. H_2O is added to the plant part according to the desired concentra tion and the mixture is boiled under continuous stirring using a magnetic stirrer . The solution is filtered using What- man filter paper and the obtained clear solution was used as a plant extract (sample). Some volume of the extract is mixed with 0.5 ml hydrated Zinc chloride and Zinc sulphate take in the burette poured in to the plant extract and the mixture is boiled at desired temperature and time to achieve efficient mixing . Some perform optimization at this point using different temperature, extract concentration and time . Incubation period results in a change of color of the mixture to yellow which is a visual confirmation of the mixture to carbonization which is visual confirmation of the synthesized NP_S mixture and drying the pellet in a hot air oven to get the crystal nano particles. Further syntheisized nano particles are further characterized using particle size analysis.

CHAPTER- II

2. AIM AND SCOPE

- To synthesis Zinc Nano particles in a green synthetic way
- To derive the Nano particles being cost effective treatment
- To prepare leaf extracts and precursor

Zinc nano particles for the treatment of water are being due to its specific properties . high specific surface area, unique absorption phenomenon and wide distributions of reactive surface sites. The conventional methods of syntheisizing zinc nano particles have several limitations viz., low production rate, high temperature and pressure or energy requirements and thus is relatively expensive.

In addition to this , drawbacks of this methods include contamination of precursors an released of harmful by – products to the ecosystem. Green production of Zinc nano particles in the process in which plants extracts, micro organism like bacteria, fungi, alagae, yeaste and enzymes play a significant a role in many ways . Among those, synthesis by plant extract is advantageous because it reduces the risk of further condamination by decreasing the reaction time and maintaining the cell structure. Hence the green synthesis is proposed to be a suitable alternative candidate to conventional methods as their is an increasing demand on ecofrirendly, cost effective and less toxic way of synthesizing nanoparticles .

CHAPTER –III

3. EXPERIMENTAL PART:

Characterization of zinc Nano particles for different leaves (MINT, NEEM, DRUMSTICK LEAVES, CURRYLEAVES) extracts was done using PSA (Particle Size Analysis)

3.1 PREPARATION OF LEAF EXTRACT:

Leaves were collected from my home. Leaves were washed with tap water and extract were prepare using the following procedure. Azadirachta indica (Neem) ,Mentha (mint), Murraya koenigii (curryleaves), Moringa Oleifera (Drumstick leaves) were washed with de ionized water and dried in room temperature for 15 days . The leaves were completely dried to the brittle stage . The leaves were separately in powder form and it was kept in separate closed pack container.

The beaker was thoroughly washed with distilled water and 6 gram of leaf powder was weighed in the beaker. The powder leaves were taken with 100 ml of distilled water in beaker and heated at 80^0C for one hour inwater bath. After 1 hour the mixture is fully heated and the residue was separated using funnel . The filterate was collected in a conical flask.

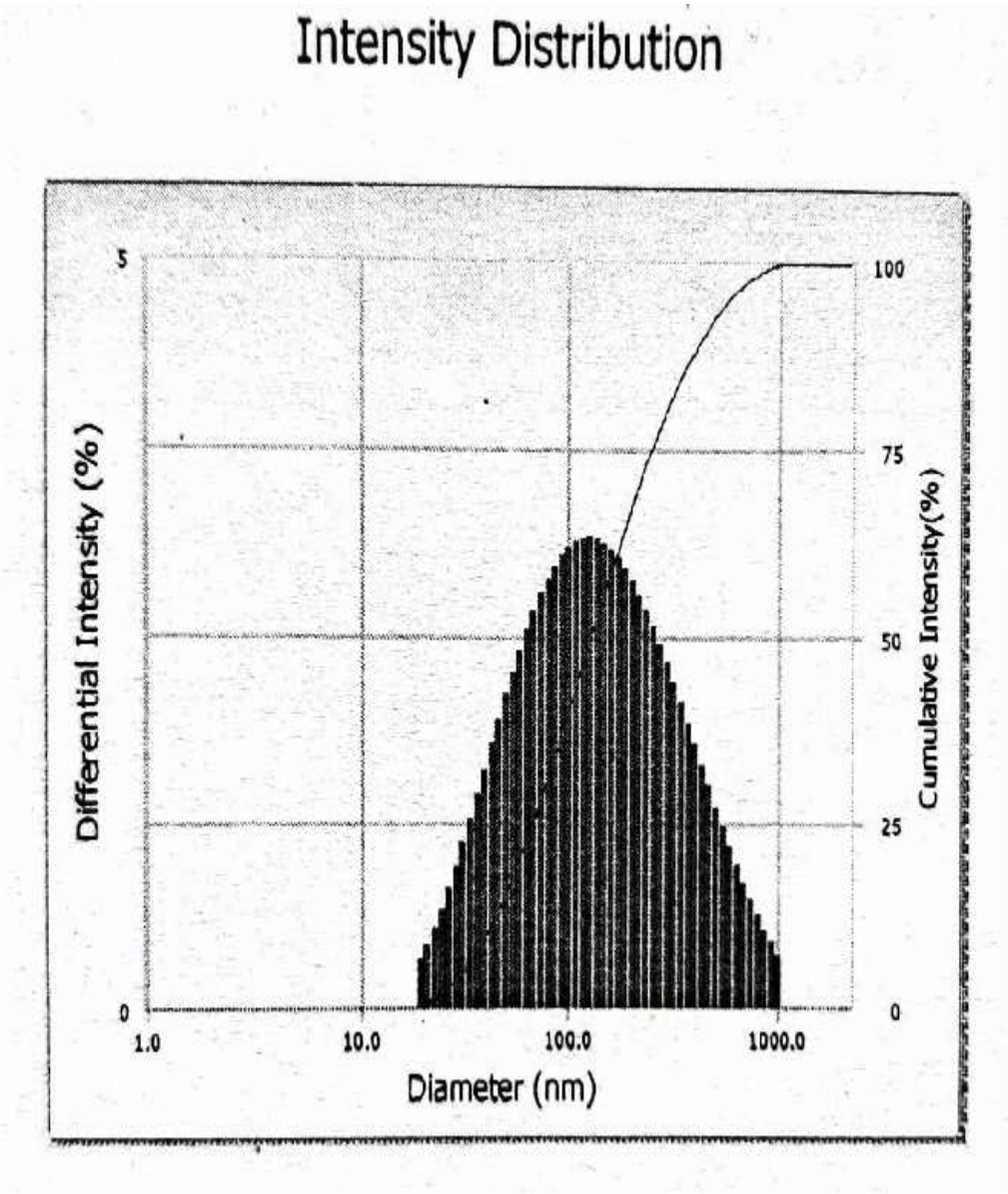
3.2 PREPARATION OF PRECURSOR:

About 1.61 g of zinc sulphate was weighed and made into 100 ml in a standard measuring flask. The solid was dissolved using a small amount of dilute sulphuric acid to make a very clear solution of 0.1 M $ZnSO_4$. About 10 ml of extract solution was taken up in round bottom flask and it was kept in a magnetic stirrer. Zinc sulphate was taken up in a burette for point addition. The extract was heated in a hot air oven for 2 hour and then inn a muffle

furnace to remove the organic impurities. The pure Zinc particles were got from the extract in the powder form.

CHAPTER-IV

RESULT AND DISCUSSION:

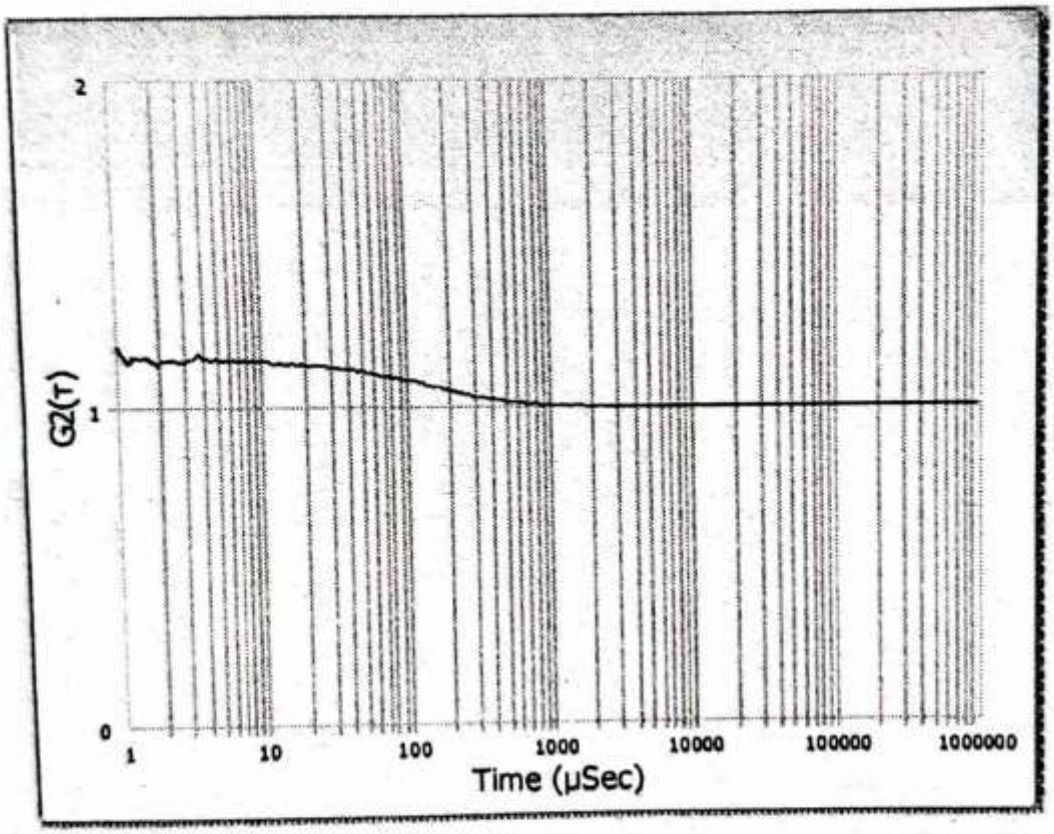


DS4

Fig Plot appeared from powder PSA results of Murraya Koenigii leaf extract

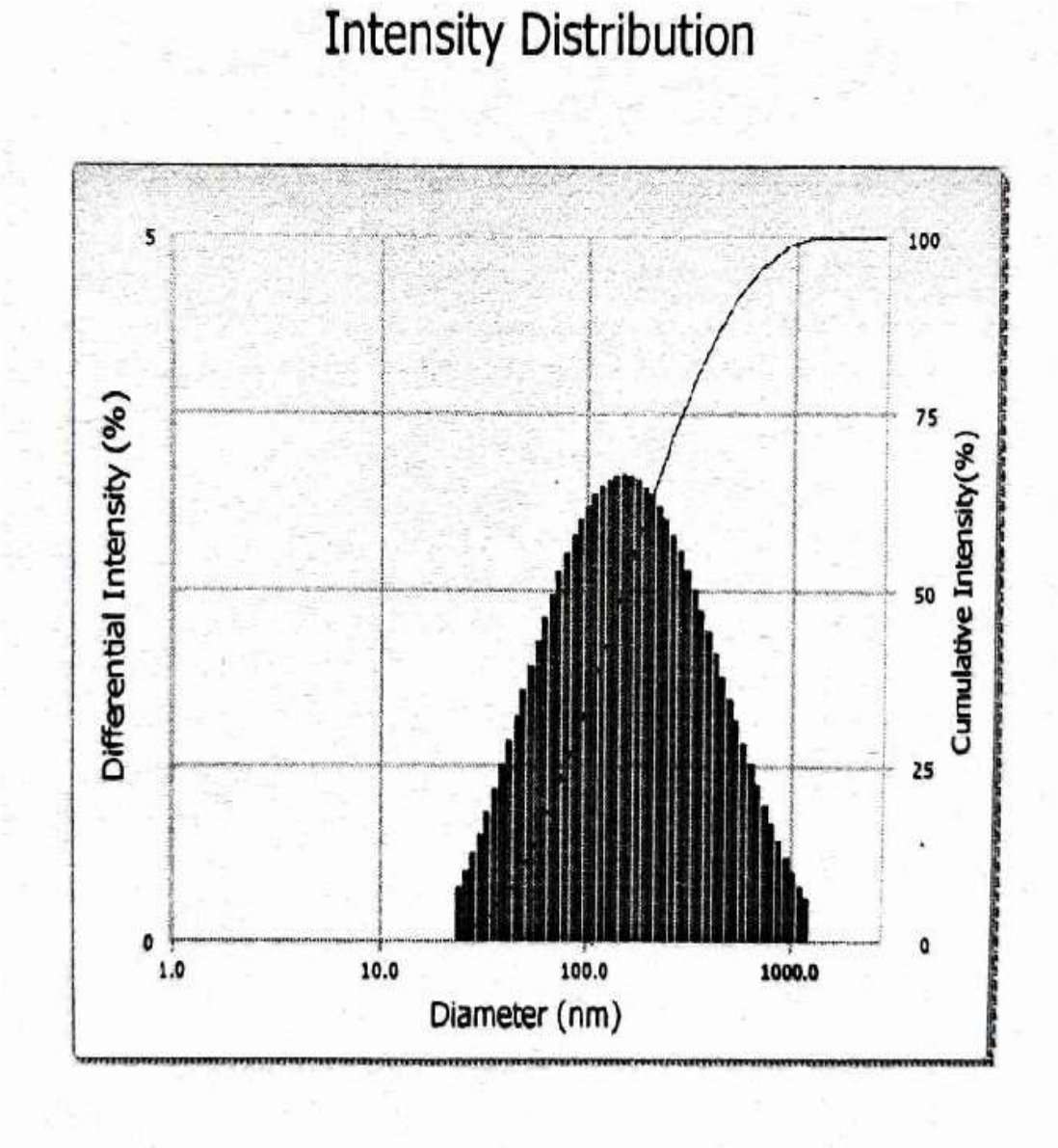
The Cumulants results of Diameter (d) :107.4 nm. At temperature of measurement condition 25.2 ^{0}C

^{0}C.



Cumulants Results

Diameter (d) : 107.4 (nm)

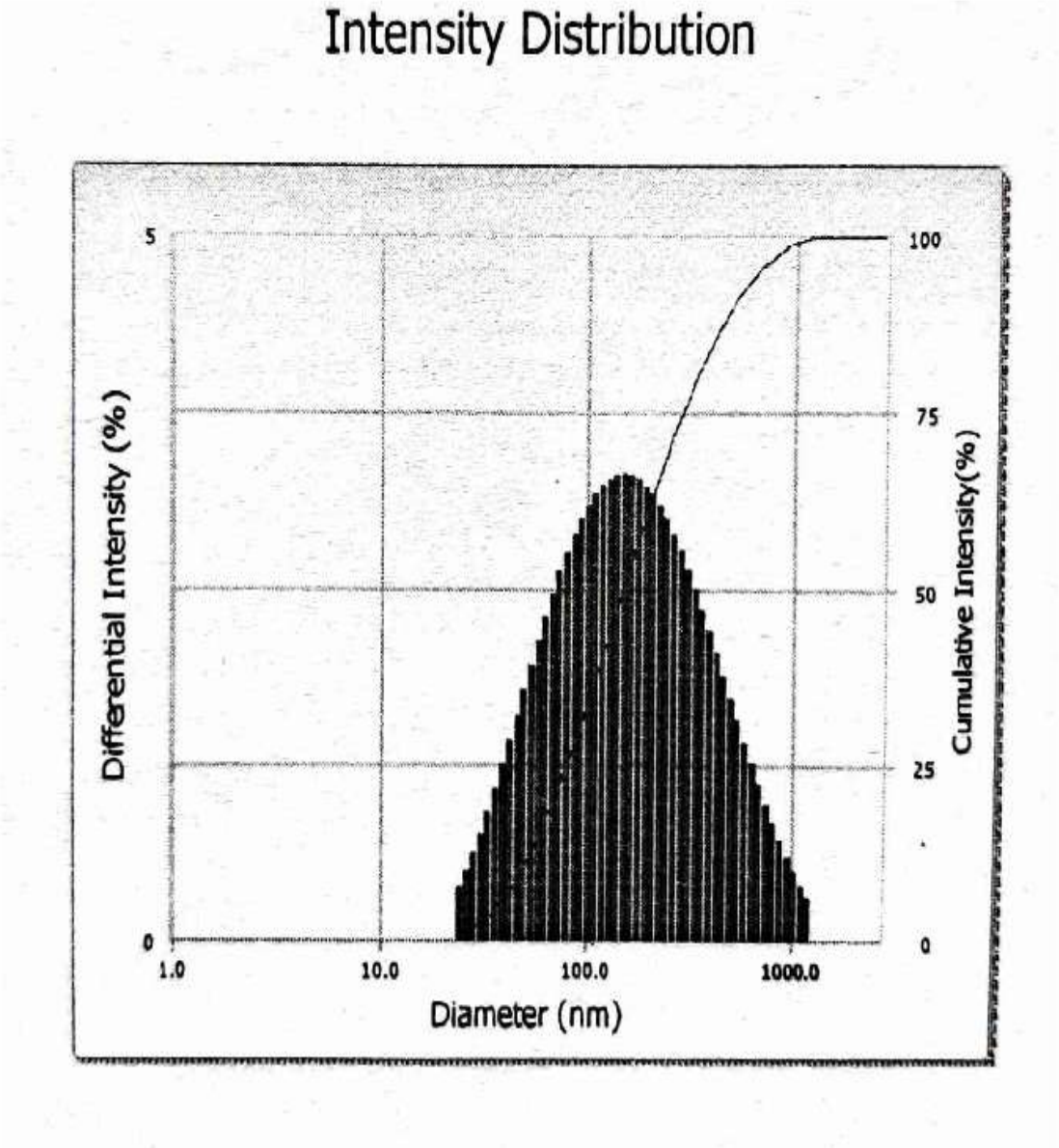


DS6

Fig plot appeared from powder PSA results of Moringa Oleifera leaf extract.

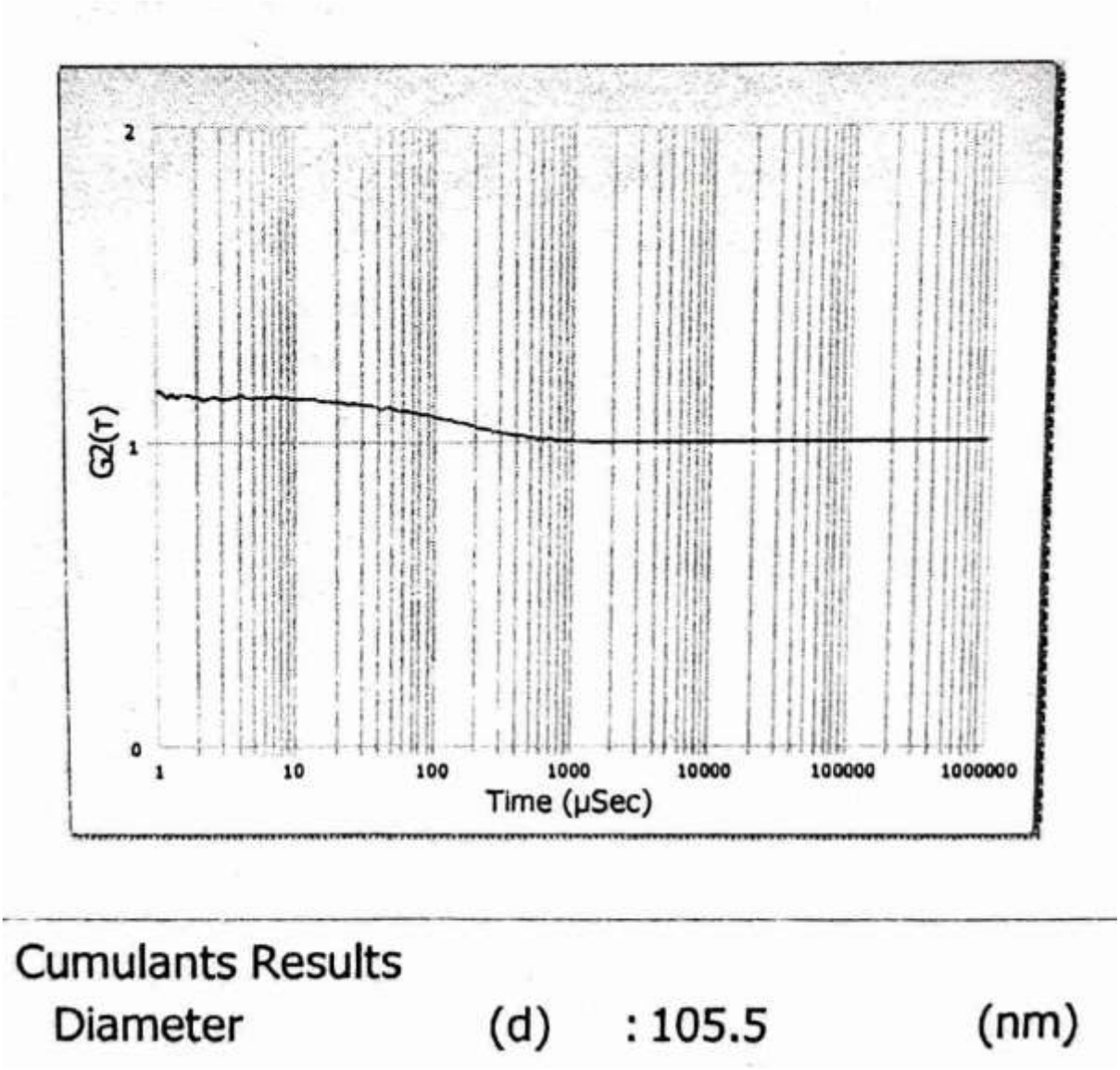
The cumulants results of diameter (d):121.2 nm.at temperature of measurement condition 25.0 ^{0}C.

DS7



Fig

The plot appeared from powder PSA results of Azdirachta indica leaf extract.



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