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Formulation of Silver Nanoparticles of Hibiscus Sinesis Herbal Extract by UV Spectroscopy

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Abstract

For the past few decades, there has been a considerable research interest in particulate delivery systems. So, particulate systems like nanoparticles have been utilized as physical approaches to change and improve the pharmacokinetic and pharmacodynamics properties of various types of drug molecules. Different types of Nano particulate materials used in electronics, magnetic pharmaceuticals, cosmetics, energy, catalytic and materials industries. Nanoparticles are tiny materials having size ranges from 1 to 100 nm. They can be classified into different classes based on their properties, shapes or sizes. The nanoparticles show enhanced properties such as high reactivity, strength, surface area, sensitivity, stability, etc. Because of their small size. The nanoparticles are synthesized by various methods for research and commercial uses that are classified into three main types namely physical, chemical and mechanical processes that has seen a vast improvement over time. This paper presents a review on nanoparticles, their types, properties, synthesis methods and its applications.

Keywords: Nanoparticles, Preparation, Characterization, Application.

Introduction

1. Nanotechnology is associated with nano-meter sized objects. Living organisms are made up of cells.
2. These cell parts, however, are nano sized. Nanotechnology basically deals with design,production and characterization on nano sized particles.
3. Nano sized particles are basically small objects that act as a whole unit in accordance with their transport and properties. Fine particles have the range of 100-2500nm and ultrafine particles have the size of 1- 100nm.
4. They can also be designed to improve the pharmacological and therapeutic effects of the drugs.
5. They also have a very high surface area and they permit many functional groups to be adhered to them which in turn, can bind to tumor cells.
6. They have proven to be an excellent replacement for radiation and chemotherapy as they can easily assemble in the micro environment of the tumor.

Recent studies have developed a number of nano-sized particles such as metals, semiconductors and polymeric particles utilized in molecular imaging and particulate delivery vehicles.

Types of nanoparticles

Inorganic nanoparticles: In the field of Modern material science Inorganic nanoparticle has been

developed the role based upon their unique physical properties and particularly in biotechnology. Based upon these two factors of inorganic nanoparticles they have certain physical properties that mainly include size dependent optical, magnetic, electronic, and catalytic properties. Bio related application are involved for the preparation of these interesting nanoparticles like iron oxides, gold, silver, silica, quantum dots etc. Novel physical properties mainly related because of their size approaches nanometer scale dimension.

Polymeric nanoparticles :

Polymeric nanoparticle it is also a type of nanoparticle. In the recent year polymeric nanoparticle has a tremendous development in the field of research. The dispersion of preformed polymers and the Drugs and Cell Therapies in Haematology polymerization of monomers are two strong strategies mainly involved for preparation. 10 1000nm it is the range of size involved with solid particles. Solid lipid nanoparticles For controlling the drug delivery in 1990 s Solid lipid nanoparticles played a dominant role. There are certain alternate carrier systems to emulsions, liposomes and polymeric nanoparticles as a colloidal Carrier system.

Liposomes

Liposomes are one of the methods based upon the different types of nanoparticles. Structure of liposomes consists of one or more phospholipid bilayers and they are sphere-shaped vesicles to carry compound of interest. Today liposomes have been useful in the field of reagent and tool in various scientific disciplines.

Nanocrystal

A nanocrystal is a type based upon material particle having at least one dimension smaller than 100 nanometres and mainly composed of atoms in either a single or poly-crystalline arrangement. Nanocrystals are aggregates of around hundreds or thousands of molecules that combine in a crystalline form, composed of pure drug with only a thin coating comprised of surfactant or combination of surfactants.

Nanotube

A nanotube is a nanometer scale tube like structure. Nanotubes are members of the fullerene structural family. Their name is derived from their long, hollow structure with the walls formed by one-atom-thick sheets of carbon called graphene. These sheets are rolled at specific and discrete ("chiral") angles and the combination of the rolling angle and radius decides the nanotube properties; for example, whether the individual nanotube shell is a metal or semiconductor. Nanotubes are categorized as single-walled nanotubes (SWNTs) and multi-walled nanotubes.

Dendrimers

Dendrimers arise from two Greek words: Dendron meaning tree and Meros meaning part. Structure of dendrimers has a well-defined size, shape and defined molecular weight and also Dendrimers are hyper-branched, globular, monodisperse, three dimensional nanoscales synthetic Polymers. Molecular chemistry and polymer chemistry both exhibit well-defined characteristics features of Dendrites.

Advantages

Some of the advantages of using nanoparticles as a drug delivery system are as follows;

1. Ease of manipulation of the particle size and surface characteristics of nanoparticles so as to achieve both passive and active drug targeting after parenteral administration.
2. The nanoparticle surface can be modified to alter biodistribution of drugs with subsequent clearance of the drug so as to achieve maximum therapeutic efficacy with minimal side effects of the drug.
3. Controlled release and particle degradation characteristics can be readily modulated by the choice of matrix constituents.
4. 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.
5. Site-specific targeting can be achieved by attaching targeting ligands to surface of particles or use of magnetic guidance.
6. Liposomes and polymer based nanoparticulates are generally biodegradable, do not accumulate in the body and so are possibly risk free.
7. Small sized nanoparticles can penetrate through smaller capillaries, which could allow efficient drug accumulation at the target sites.
8. Various routes of administration are available including oral, nasal, parenteral, intra-ocular etc.

Limitations

In spite of these advantages nanoparticles do have limitations like,

1. Altered physical properties which lead to particle-particle aggregation, making physical handling of nanoparticles difficult in liquid and dry forms due to smaller size and larger surface area.
2. Smaller the particles size greater the surface area and this property makes nanoparticles very reactive in the cellular environment.
3. Small particles size results in limited drug loading and burst release. These practical problems have to be sorted out before nanoparticles can be used clinically or made commercially available.

METHODS OF PREPARATION OF NANOPARTICLES

Current methods used in preparation of drug nanoparticles can be divided into two groups, namely, those based on polymerization and those taking advantage of preformed polymers. The choice of the method for the preparation of nanoparticulate formulation depends upon various factors including (a) size of nanoparticles required; (b) inherent properties of drug, e.g., aqueous solubility and stability;(c) surface characteristics such as charge and permeability (d) degree of biodegradability, biocompatibility and toxicity (e) drug release profile desired (f) Antigenicity of the final product .

Emulsion/ Evaporation: This method can be used for preparation of particles with sizes varying from a few nanometers to micrometers by controlling the stirring rates and conditions, showing high efficiency in incorporation of lipophillic drugs. Organic solution of polymer and drug is emulsified in an aqueous solution containing stabilizer. Droplet size is reduced by using a high energy source followed by evaporation of organic phase under reduced pressure or vacuum to produce fine aqueous dispersion of nanoparticles and freeze dried for storage.

Double Emulsion: This method referred to as variant of the Emulsion/Evaporation method as this method suffers from poor entrapment efficiency of hydrophilic drugs. Therefore, this method is used for

incorporating hydrophilic drugs. Nanoparticles are recovered by ultracentrifugation and lyophilized. High encapsulation efficiency can be achieved by this method and considered as one of the appropriate methods for proteinateous substances due to high solubility of protein in water. Poly (lactide-co-glycolide) (PLGA)nanoparticles loaded with bovine serum albumin (BSA) were prepared by double emulsification method. Typically BSA and PLGA were dissolved separately in aqueous and organic phases
respectively and subjected to ultrasonication to yield water in oil emulsion (W1/O). This water in
oil was further added to a poly vinyl alcohol (PVA) aqueous solution to yield was evaporated during stirring first at atmospheric pressure and then at reduced pressure (from 100mmHg to 30mm Hg) to yield nanoparticles.

Salting Out:

This technique is suitable for drugs and polymers that are soluble in polar solvents, such as acetone or ethanol. Solution of polymer and drug in a slightly water miscible solvent is added to aqueous solution containing a salting out agent and stabilizer under stirring. A small amount of water is added to o/w emulsion for dilution which forces diffusion of organic solvent into a aqueous phase producing particles in nano size range. This process differs from Nano precipitation technique. In it, the organic phase is completely miscible in external aqueous phase but in case of salting out technique, the miscibility of both the phases is prevented by saturation of external aqueous phase with PVA.

Emulsification – Diffusion: It is a modified version of solvent evaporation method. In this method, the water miscible solvent along with a small amount of water immiscible organic solvent is used as an oil phase. Due to the spontaneous diffusion of solvents an interfacial turbulence is created between the two phases leading to formation of small particles. As the conc. of water miscible solvent increases, a decrease in size of particle can be achieved.

Both solvent evaporation and diffusion method can be used for hydrophobic and hydrophilic drugs. In case of hydrophilic drug, a multiple w/o/w emulsion needs to be formed with the drug dissolved in internal aqueous phase. Although this method is a modification of salting out procedure, it provides an advantage of avoiding the use of salts, thus eliminates for intensive purification steps. **Limitation** of this method is that it suffers from low entrapment efficiency of hydrophilic drug in nanoparticles, which can be overcome by incorporation of medium chain glycerides into aqueous solution which has been found to increase the efficiency of water soluble drugs into nano spheres offering the advantage of simplicity, narrow particle size distribution and ready dispersibility of resultant particles.

Solvent Displacement/ Nanoprecipitation: This method incorporates the solution of polymer, drug and lipophillic surfactant in a semi polar water miscible solvent and then poured into solution containing stabilizer under stirring. Rapid diffusion of solvent results in nanoparticles formation. Hydrophilic drugs possess low drug loading efficiency than hydrophobic drugs because of their poor interaction with polymer leading to diffusion of drug from polymer in organic phase to the external aqueous environment. Barichello et al demonstrated improved bioavailability of proteins and peptides using PLGA nanoparticles by the nano precipitation method. Jaing et al established precipitation method for formation of ibuprofen (IBU) nanoparticles stabilized by DEAE dextran (Ddex). The process fabricated core shell particles by which poor water soluble drugs can be dispersed effectively with rather good stability during storage. The method includes precipitation of IBU in a super saturated solution and deposition of Ddex onto the precipitated IBU particles through electrostatic interaction. The difficulty faced in this preparation method

is the choice of drug/polymer/solvent/non solvent system in which the nanoparticles would be formed and the drug efficiently entrapped.

Emulsion-Difussion-Evaporation: This method incorporates both evaporation and diffusion process in nanoparticles formation. Solution of polymer in solvent is added to aqueous phase under stirring .To this emulsion, water is added which results in nano precipitation. The basic methodology involves dispersion of organic phase as globules in equilibrium with external aqueous phase due to continuous stirring. The emulsion is stabilized by adsorption of stabilizer at the interface. The globule size is further lowered by homogenization. Addition of water destabilizes the equilibrium and diffusion of organic solvent to aqueous phase causes local super-saturation near the interface resulting in nanoparticles formation. The organic phase is removed from the preparation by evaporation at 400C.

Coacervation or Ionic Gelation Method: Much research is now focused on the nanoparticles using biodegradable hydrophilic polymers such as chitosan, gelatin and sodium alginate. Calvo and co-workers proposed a method for preparation hydrophilic chitosan nanoparticles by ionic gelation. The method involves a mixture of two aqueous phases; of which is the polymer chitosan, a di-block co-polymer ethylene oxide or propylene oxide (PEO-PPO) and the other is a poly anion sodium tri-polyphosphate. In this method, positively charged amino group of chitosan interacts with negative charged Tripolyphosphate to form coacervates with a size in the range on nanometer. Coacervates are due to the result of electrostatic interaction two aqueous phases, whereas, ionic gelation involves the material undergoing from lipid to gel due to ionic interaction conditions at temperature room.

Spray Drying: Spray-drying has been widely used for the production of micron-sized particles. Spray-dry involves the conversion of a solution droplet into a dry particle by evaporation of the solvent in a one-step process. Temperature –liable compounds such as proteins and enzymes have been successfully spray-dried. It has been shown that particles consisting of various polymers and drugs, both water –soluble and water-insoluble, can be prepared without problem of drug leakage to another phase and thus, the recovery of drug in the particles is almost the particle properties, especially morphology, can be controlled by the solvent properties and the spray-drying variables.

Application of Nanoparticles

Application

- Nanomedicines
- Nano drugs, Medical devices, Tissue engineering
- Chemical and Cosmetics
- Nanoscale chemicals and compounds, paints, coatings etc
- Materials
- Nanoparticles, carbon nanotubes, biopolymers, points, coatings
- Food Sciences
- Processing, nutracetical food, nanocapsules.
- Environment and Energy
- Water and air purification filters, fuel cells, photovoltaic
- Military and Energy
- Biosensors, weapons, sensory enhancement
- Electronics

- Semiconductors chips, memory storage, photonica, optoelectronics
- Scientific Tools
- Atomic force, microscopic and scanning tunnelling microscope
- Agriculture
- Atomic force, microscopic and scanning tunnelling microscope

Characterization of Nanoparticles

Nanoparticles are generally characterized by their size, morphology and surface charge, using such advanced microscopic techniques as scanning electron microscopy (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM). The average particle diameter, their size distribution and charge affect the physical stability and the in vivo distribution of the nanoparticles. Electron microscopy techniques are very useful in ascertaining the overall shape of polymeric nanoparticles, which may determine their toxicity. The surface charge of the nanoparticles affects the physical stability and redispersibility of the polymer dispersion as well as their in vivo performance.

Particle size

Particle size distribution and morphology are the most important parameters of characterization of nanoparticles. Morphology and size are measured by electron microscopy. The major application of nanoparticles is in drug release and drug targeting. It has been found that particle size affects the drug release. Smaller particles offer larger surface area. As a result, most of the drug loaded onto them will be exposed to the particle surface leading to fast drug release. On the contrary drugs slowly diffuse inside larger particles. As a drawback. smaller particles tend to aggregate during storage and transportation of nanoparticle dispersion. Hence, there is a compromise between a small size and maximum stability of nanoparticles. Polymer degradation can also be affected by the particle size. For instance, the degradation rate of poly (lactic-co-glycolic acid) was found to increase with increasing particle size in vitro.
There are several tools for determining nanoparticle size as discussed below:

Dynamic light scattering (DLS)

Currently, the fastest and most popular method of determining particle size is photon-correlation spectroscopy (PCS) or dynamic light scattering (DLS). DLS is widely used to determine the size of Brownian nanoparticles in colloidal suspensions in the nano and ubmicron ranges. Shining monochromatic light (laser) onto a solution of spherical particles in Brownian motion causes a Doppler shift when the light hits the moving particle, changing the wavelength of the incoming light. This change is related to the size of the particle. It is possible to extract the size distribution and give a description of the particle's motion in the medium, measuring the diffusion coefficient of the particle and using the autocorrelation function. The photon correlation spectroscopy (PCS) represent the most frequently used technique for accurate estimation of the particle size and size distribution based on DLS. Scanning Electron microscopy
Scanning electron microscopy (SEM) is giving morphological examination with direct visualization. The techniques based on electron microscopy offer several advantages in morphological and sizing analysis; however, they provide limited information about the size distribution and true population average. For SEM characterization, nanoparticles solution should be first converted into a dry powder, which is then mounted on a sample holder followed by coating with a conductive metal, such as gold, using a sputter

coater. The sample is then scanned with a focused fine beam of electrons. The surface characteristics of the sample are obtained from the secondary electrons emitted from the sample surface. The nanoparticles must be able to withstand vacuum, and the electron beam can damage the polymer. The mean size obtained by SEM is comparable with results obtained by dynamic light scattering. Moreover, these techniques are time consuming, costly and frequently need complementary information about sizing distribution.

Transmission electron microscope

TEM operates on different principle than SEM, yet it often brings same type of data. The sample preparation for TEM is complex and time consuming because of its requirement to be ultra thin for the electron transmittance. The nanoparticles dispersion is deposited onto support grids or films. To make nanoparticles withstand the instrument vacuum and facilitate handling they are fixed using either a negative staining material, such as phosphotungstic acid or derivatives. uranyl acetate, etc, or by plastic embedding. Alternate method is to expose the sample to liquid nitrogen temperatures after embedding in vitreous ice. The surface characteristics of the sample are obtained when a beam of electrons is transmitted through an ultra thin sample, interacting with the sample as it passes through Atomic force microscopy Atomic force microscopy (AFM) offers ultra-high resolution in particle size measurement and is based on a physical scanning of samples at sub-micron level using a probe tip of atomic scale. Instrument provides a topographical map of sample based on forces between the tip and the sample surface. Samples are usually scanned in contact or noncontact mode depending on their properties. In contact mode, the topographical map is generated by tapping the probe on to the surface across the sample and probe hovers over the conducting surface in non-contact mode. The prime **advantage** of AFM is its ability to image non-conducting samples without any specific treatment, thus allowing imaging of delicate biological and polymeric nano and microstructures.39 AFM provides the most accurate description of size and size distribution and requires no mathematical treatment. Moreover, particle size obtained by AFM technique provides real picture which helps understand the effect of various biological conditions.

Surface Charge

The nature and intensity of the surface charge of nanoparticles is very important as it determines their interaction with the biological environment as well as their electrostatic interaction with bioactive compounds. The colloidal stability is analyzed through zeta potential of nanoparticles. This potential is an indirect measure of the surface charge. It corresponds to potential difference between the outer Helmholtz plane and the surface of shear. The measurement of the zeta potential allows for predictions about the storage stability of colloidal dispersion. High zeta potential values. either positive or negative, should be achieved in order to ensure stability and avoid aggregation of the particles. The extent of surface hydrophobicity can then be predicted from the values of zeta potential. The zeta potential can also provide information regarding the nature of material encapsulated within the nanocapsules or coated onto the surface.

EXPERIMENTAL WORK :-

Materials And Methods

Materials Materials And Methods Silver Nitrate (AgNO3, 99% purity, Merck Products), hibiscus leaves collected from Garden.

Preparation of the plant extract : The leaves of Hibiscus rosa simensis plant were collected from the local garden and then washed thoroughly with tap water to remove the dust and dirt particles. The leaves are then dried under shade for about four days and finely powdered. About 2 grams of the powder was taken and mixed with distilled water. The aqueous leaf extract was taken and then filtered using wattmen filter paper to obtain pure hibiscus leaves extract with pale green colour to be used as reducing and capping agents in AgNP synthesis.

Preparation of Silver Nitrate Solution 0.125g of Silver nitrate was added into 100ml of distilled water and stirred continuously for 1-2 min to get Silver Nitrate solution. 2.4. Silver nano particle synthesis. The best volume of plant extract were added to the best molarity of AgNO3 solution at room temperature and stirred continuously for ten minutes using Magnetic Stirrer. Slow reduction takes place and kept for 24 hours to obtain the colour change. After 24 hours pale green colour changes to red colour, which indicate the formation of silver nano particle. The Hibiscus leaves extract and AgNO3 solution mixture was then characterised using UV and SEM.

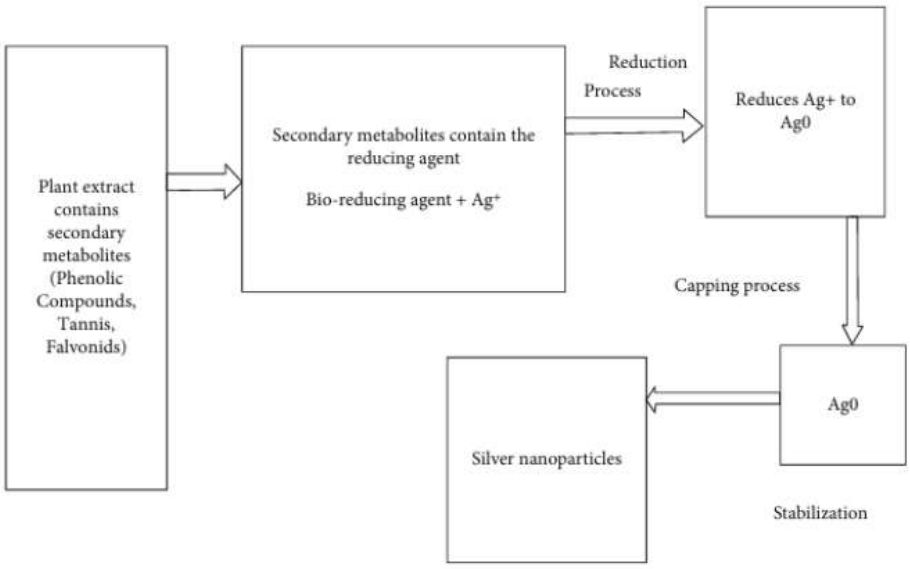

FIGURE 2: Green synthesis method of AgNPs.

Chemical Compound used :

Reducing agent	Precursor agent	Capping agent	Experimental conditions
Trisodium citrate	Silver nitrate	Trisodium citrate	Diameter ≈ 10–80 nm; temperature ≈ boiling point
Ascorbic acid	Silver nitrate	Daxad 19	Diameter ≈ 15–26 nm; temperature ≈ boiling point
Alanine/NaOH	Silver nitrate	DBSA (dodecylbenzenesulfonic acid)	Diameter ≈ 8.9 nm; temperature ≈ 90°C; time ≈ 60 min
Ascorbic acid	Silver nitrate	Glycerol/PVP	Diameter ≈ 20–100 nm; temperature ≈ 90°C
Oleic acid	Silver nitrate	Sodium oleate	Diameter ≈ 5–100 nm; temperature ≈ 100–160°C; time ≈ 15–120 min
Trisodium citrate	Silver nitrate	Trisodium citrate	Diameter ≈ 30–96 nm; temperature ≈ boiling point; pH ≈ 5.7–11.1
Trisodium citrate	Silver nitrate	Trisodium citrate/Tannic acid	Diameter ≈ 10–100 nm; temperature ≈ 90°C

Results and Discussion :

The majority of the world's population is using herbal med icines for many diseases nowadays. From the ancient days, the herbs were used as the medicinal drugs for number of diseases. Many herbs are having pharmacological actions, which are abundant in nature. The medicinal herbs are having compounds like secondary plant metabolites like f lavonoids and tannins which have been used for thou sands of years for the healthcare. The Hibiscus rosasinensis is a medicinal herb which is rich in secondary plant metabolites, and these compounds are acting as reductant and the capping agent in the forma tion of silver nanoparticles. In this green chemistry synthesis method of silver nanoparticles, the metal salts are reduced into the aqueous metal ion precursors [19]. As a result of this reduction, the colour changes in the mixture. This colour change of the solution indicates the formation of the silver nanoparticles .

Extract	Wavelength (nm)	Absorbance (AU)
Flower	357.55	2.2307
Leaf	458.35	1.4279
Bark	458.35	1.1062

UV-Visible Spectroscopy : The AgNPs formation was observed through the UV-visible spectrometer. The UV visible spectrophotometer has a quartz cuvette with path length of 1cm. The AgNP sample obtained from leaf, flower, and bark extracts of Hibiscus was placed in the cuvette. The UV-visible spectrum is produced between the wavelength ranges of 300–700nm.

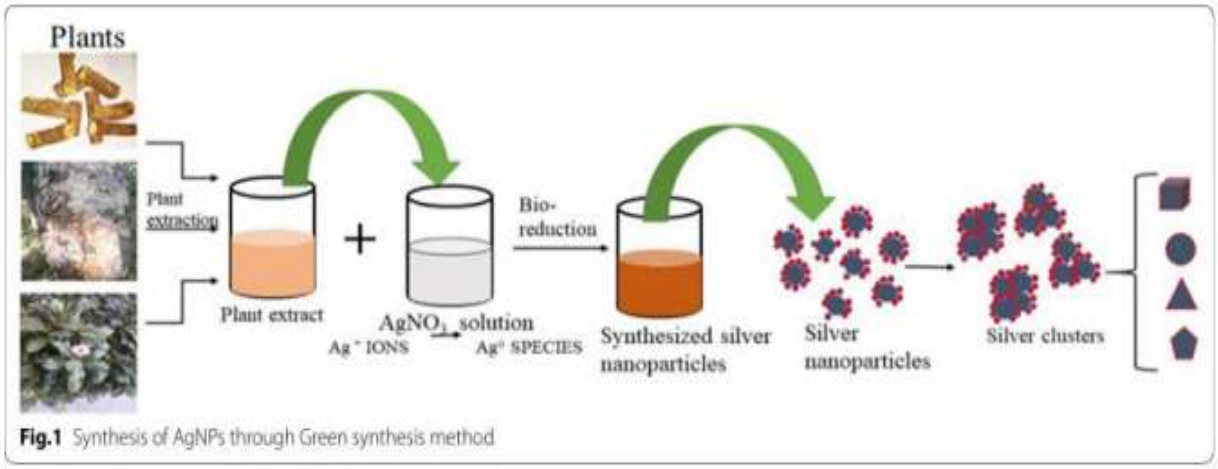

Figure 3 :synthesis of silver nanoparticles by green synthesis method

Characterization Analysis of AgNPs. The silver nanoparticles were synthesized using the leaves, flower, and bark of the Hibiscus rosasinensis plant. When silver nitrate solution is added with the plant extract, colour change of the extracts to dark brown showed the development of the silver nano particles. This property is called as the surface plasmon resonance of silver [21]. The UV-visible spectrophotometer was used to analyse the formation and stability of the AgNPs in the colloidal solution. The maximum absorbance peaks found for the flower, leaf, and bark extracted AgNPs were 357-400nm, 440-460nm, and 400-460nm, respectively, shown in Figure 4

Figure 4 : Diagram of wavelength maxima by UV spectroscopy

Figure 5 : Formulation of silvernanoparticles by Hibiscus rosasenesis

CONCLUSION

Nanoparticles represents promising drug carrier for various drug delivery systems Nanotechnology is breakthrough technology pervading all fields newer applications of this field are being explored worldwide. Nanoparticles represent a technology to overcome solubilities and bioavailability problems of drugs which can be generally applied to all poorly soluble drugs. Any drug can be transformed to drug nanoparticles leading to increasing saturation solubility, dissolution rate and providing in general feature of an increased adhesiveness to surfaces. Nanoparticulate drug delivery system is increasingly viewed as an advantageous solution for biological drugs. In addition, nanoparticles provide efficient treatment by enabling targeted and controlled release thus in feature nanoparticulate drug-delivery system seem to be a viable and promising stratergy for the biopharmaceutical industry.

REFERENCES

1. Feynman R: There's plenty of room at the bottom. Science 1991,254:1300-1301.
2. Murray CB, Kagan CR, Bawendi MG: Synthesis and characterization of monodisperse nanocrystals and close-packed nanocrystal assemblies. Annu Rev Mater Sci 2000, 30:545-610.
3. S. Majuru and O. Oyewumi, “Nanotechnology in Drug Development and Life Cycle Management,”
4. Nanotech-nology in Drug Delivery, Vol. 10, No. 4, 2009, pp. 597-619. 2_20
5. C. Buzea, I. I. Pacheco and K. Robbie, “Nanomaterials and Nanoparticles: Sources and Toxicity,”
6. Biointerphases, Vol. 2, No. 4, 2007, pp. 17-71.
7. M. Smola, T. Vandamme and A. Sokolowski, “Nanocar-riers as Pulmonary Drug Delivery Systems to

8. Treat and to Diagnose Respiratory and Non Respiratory Diseases," International Journal of Nanomedicine, Vol. 3, No. 1, 2008, pp. 1-19.
9. R. Pandey and G. K. Khuller, "Nanotechnology Based Drug Delivery System(s) for the Management of Tuber-culosis," Indian Journal of Experimental Biology, Vol. 44, No. 5, 2006, pp. 357-366.
10. Y. Y. Liu, H. Miyoshi and M. Nakamura, "Nanomedicine for Drug Delivery and Imaging: A Promising Avenue for Cancer Therapy and Diagnosis Using Targeted Functional Nanoparticles," International Journal of Cancer, Vol. 120, No. 12, 2007, pp. 2527-2537
11. Drugs and Cell Therapies in Haematology (ISSN: 2281-4876) Volume 10 Issue 1 (2021) 1495
12. X. Wang, L. L. Yang, Z. Chen and D. M. Shin, "Applica-tion of Nanotechnology in Cancer Therapy and Imaging," A Cancer Journal for Clinicians, Vol. 58, 2008, pp. 97-110.
13. K. Riehemann, S. W. Schneider, T. A. Luger, B. Godin, M. Ferrari and H. Fuchs, "Nanomedicine-Challenge and Perspectives," Angewandte Chemie International Edition, Vol. 48. No. 5, 2009.
14. R. Sinha, G. J. Kim, S. Nie and D. M. Shin, "Nano- technology in Cancer Therapeutics: Bioconjugated Nano- particles for Drug Delivery," Molecular Cancer Thera-peutics, Vol. 5, No. 8, 2006, pp. 1909-1917.
15. K. J. Cho, X. Wang, S. M. Nie and D. H. Shin, "Thera-peutic Nanoparticles for Drug Delivery in Cancer," Clinical Cancer Research, Vol. 14, 2008, pp. 1310-1316.
16. S. Jiang, M. K.Ganesammandhan and Y. Zhang, "Optical Imaging Guided Cancer Therapy with Fluorescent Nano- particles," Journal of the Royal Society Interface, Vol. 7, No. 42, 2010, pp. 3-18.
17. S. Sandhiya, S. A. Dkhar and A. Surendiran, "Emerging Trends of Nanomedicine—An Overview," Fundamental & Clinical Pharmacology, Vol. 23, No. 3, 2009, pp. 263-269.
18. Mosqueira VC, Legrand P, Morgat JL, Vert M, Mysiakine E, Gref R, Devissaguet JP, Barratt G. Biodistribution of long-circulating PEG-grafted nanocapsules in mice: effects of PEG chain length and density. Pharm Res. 2001; 18(10):1411-1429.
19. Allen TM, Cullis PR. Drug delivery systems: entering the mainstream. Science 2004; 303(5665):1818-1822.
20. Calvo P, Remunan LC, Vila-Jato JL, Alonso MJ. Novel hydrophilic chitosan-polyethylene oxide nanoprticles as protein carriers. J. Appl. Polymer Sci. 1997; 63: 125-132.
21. Alex R, Bodmeier R. Encapsulation of water-soluble drugs by a modified solvent evaporation method. I. Effect of process and formulation variables on drug entrapment. J Microencapsul 1990; 7(3):347-355.
22. Pignatello R, Bucolo C, Ferrara P, Maltese A, Puleo A, Puglisi G. Eudragit RS100 nanosuspensions for the ophthalmic controlled delivery of ibuprofen. Eur J Pharm Sci. 2002; 16(1-2):53-61.
23. Mu L, Feng SS. Fabrication, characterization and in vitro release of paclitaxel (Taxol) loaded poly (lactic-co-glycolic acid) microspheres prepared by spray drying technique with lipid/cholesterol emulsifiers. J Control Release 2001; 76(3):239-254.
24. Boudad H, Legrand P, Lebas G, Cheron M, Duchêne D, Ponchel G. Combined hydroxypropyl-beta-cyclodextrin and poly(alkylcyanoacrylate) nanoparticles intended for oral administration of saquinavir. Int J Pharm 2001; 218(1-2):113-124.
25. R. Das, S. S. Nath, D. Chakdar, G. Gope and R. Bhat-tacharjee, "Preparation of Silver Nanoparticles and Their Characterization," AZojono Journal of Nanotechnology Online, Vol. 5, No. 10, 2009, p.

2240.
26. Rai M., Yadav A. and Gade A., Biotech. Adv., 27, 76-83, (2009)
27. Sharma V.K., Ria A.Y. and Lin Y., Advances in Colloid and Interface Science, 145, 83-96, (2009)
28. Shankar S.S., Rai A., Ankamwar B., Singh A., Ahmad A. and Sastry M., Nat. Mater, 3, 482-488, (2004)
29. Bar H., Bhui D.K., Sahoo G.P., Sarkar P., De S.P. and Misra A., Colloids and Surfaces A, Physicochem. Eng. Aspects, 339, 134-139