A REVIEW ON HERBAL NANOPARTICLES

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Abstract

They have fewer side effects than modern medications, herbal medicines have been utilised extensively throughout history and are now recognised by both doctors and patients for having a superior therapeutic value. To improve patient compliance and avoid repeated administration, phytotherapeutic require a systematic method for administering the components over time. The crude drug can be used to accomplish this. The therapeutic benefit of crude drug is increased by reducing toxicity and boosting bioavailability, which reduces the need for repeated administration to combat non-compliance. Nanotechnology is one of these cutting-edge strategies. Herbal medication delivery methods that are smaller than a human hair could improve plant activity and solve some of the challenges that come with it in the future.

Keywords: Herbal drugs, nanotechnology, novel drug delivery systems

1. INTRODUCTION

The size range of nanoparticles is between 1 and 100 (nm). A particle is a small ultrafine particle that functions as a single entity when it comes to its attributes and transport in nanotechnology. Diameter is used to further categorise particles. Herbs and herbal treatments have been utilised to treat illnesses since the dawn of time. "Herbal medicines" are NPs that have been isolated from plants[1]. Practically speaking, herbal treatments have been used since the dawn of human civilisation. Scientists are working to create new medications, which will be done gradually and in various ways. The origins of these medications, however, have always been in NPs and/or ancient or herbal therapies. Prior to the development of high throughput screening for drug discovery, 90–95 percent of drug materials were NPs in the past[2]. According to data on the location of new medications from 1981 to 2007, around half of them are based on NPs [3,4]. The fact that NPs are more willingly ingested than synthetic medications has been demonstrated. Although it is not believed that herbal remedies can effectively treat illnesses, they can aid in the patient's better disease management. Additionally, it can raise life quality by providing dietary supplements. For the extraction of the leaves from Cardiospermum helicon bacum silver nanoparticles have been created[5] When methods to create a synthetic equivalent for many of the medications that had been derived from the trees were established, the pharmaceutical firms were destroyed. Pharmaceutical companies are currently working hard to produce novel, indigenous treatments and to make plant-based medications and herbal remedies stand out from the crowd[6].

1.1 History of Nanotechnology:-

Natural items, including plants, have been used since the dawn of time, being the cornerstone of human disease treatment, the premise of the evolution of contemporary medicine remains founded in that philosophy in conventional treatments and medicine[7,8]. In various such as ancient China, Egypt, Africa, and America, Plants had been used as medicine in China and India long before the time of writing. First, a chemical analysis began to be accessible in the early 19th century, which the process of removing and modifying herbal ingredients[7,9]. Herbal remedies were not previously given much consideration for creation of new formulations due to a lack of processing challenges and scientific justification, such as standardisation, extraction, and personal identification psychoactive substances in intricate polyherbal systems. However, research on contemporary phytopharmaceuticals addresses the scientific the demand for natural remedies as in present-day medicine, which allows for the creation of innovative formulations like solids, matrix systems, microemulsions, and nanoparticles SLNs, liposomes, dispersions, and so on. Nano micellar Colloidal nanogels[10], systems[11], and nanotubes have all designed for the use of curcumin both by itself and in conjunction with additional chemotherapy drugs, such as paclitaxel[12].
1.2. Types of Nanoparticles:

Nanoparticles come in two varieties: inorganic and organic.

1.2.1. Inorganic nanoparticles

Lists the numerous kinds of inorganic particles, including magnetic, metallic, ceramic, and nanoshells, along with their descriptions, sizes, benefits, and drawbacks.

| Inorganic compound | Description | Size in nm |
|--------------------|-------------|------------|
| Metallic           | Gold and silver particles | <50        |
| Magnetic           | Super paramagnetic iron oxide particles | 5-100 |
| Nano cells         | Dielectric silica core in a thin gold metal shell | 10-300 |
| Ceramics           | Inorganic porous biocompatible material | <100 |

1.2.2. Organic nanoparticles

Lists the various organic nanoparticle kinds, including carbon nanotubes, quantum dots, dendrimers, liposomes, and polymers, as well as their descriptions and sizes.

| Organic compound       | Description                                      | Size in nm |
|------------------------|--------------------------------------------------|------------|
| Carbon tubes           | Cylindrical graphite sheets                      | 1.5-500    |
| Quantum dots           | Semiconductor crystals with a cadmium core and metal shell | <10        |
| Dendrimers             | Highly branched macromolecules                   | 5-20       |
| Liposomes Polymers     | Phospholipids Colloidal particles                | 5-100      |

1.3. Recent Development of Nanoparticles:

The drug delivery systems using nanoparticles have emerged as an effective method for the well-organized distribution of medications used in the treatment of different illness by navigating the reticuloendothelial system, improved retention and permeability effects, and targeting certain tumours.
Pharmaceutical scientists have recently redirected their attention to developing a scientifically sound medication delivery mechanism for natural remedies. Traditional Chinese medicine frequently uses cuscuta chinensis to support the liver and kidney. Its oral administration may have a limited effect on absorption because its main ingredients, flavonoids and lignans, are poorly soluble in water[14,15]. Therefore, the corresponding nanoparticles were created. A precipitation method has recently been established for an experimental research of polyactic acid nanoparticles of lipophilic anti-cancer herb medicine[14,16]. The development and characterization of SLNs for traditional Chinese medicine have also been studied in order to increase the bioavailability and effectiveness of their targeted administration[14,17]. For their potential to deliver anticancer medications orally, nanostructured carrier systems such as polymeric nanoparticles, liposomes, SLNs, polymeric micelles, nanoemulsions etc. have been studied[14,18,19]. Additionally, the oral route has a lot of promise for cytotoxic drug administration, hence the development of oral chemotherapy in oncology has received a lot of attention[14,20,21]

1.4.Properties Of Nanoparticles[22,23,24]:

They act as a link between bulk materials and the atomic or molecular composition.

- Nanoparticles' large surface-to-volume ratio generates a powerful force that drives diffusion, especially when the temperature is high and shorter time periods vs bigger particles

- Nanoparticle suspensions are conceivable thanks to The solvent's surface interacts with the particle's surface in capable of overcoming disparities in density, otherwise frequently cause a substance to sink or floating within a fluid.

- Nanoparticles frequently have unexpected optical properties, since they are compact and contain quantum effects are produced by their electrons. For As an illustration, the appearance of gold nanoparticles in solution.

The phrase "Janus particle" refers to a type of nanoparticle that is half hydrophilic and half hydrophobic. These particles are particularly good at maintaining emulsions. It is crucial to verify this point before combining a polymer matrix and nanoparticles because the photocatalytic activity of the nanoparticles must not cause the composite system to self-destruct. They can self-assemble at water/oil interfaces and behave as solid surfactants.

![Figure 1: Transport of drug molecules through skin](image)

- Nanoparticles that are 50% hydrophilic and 50% non-hydrophilic Janus particles, which are partly hydrophobic, are especially efficient in keeping emulsions stable.
1.5. Role of Nanoparticles[25]:

- To distribute the medication in tiny particles that improve the medicines' full surface area distributing more quickly removal from the blood.
- The drug delivery method is specifically targeted.
- The medications' ability to overcome epithelial and endothelial barriers.
- To distribute the medication to the target areas.
- Combining the two various techniques in therapy drugs.

Nanoparticles Advantages:

- Because it is smaller than liposomes and micro spheres can effortlessly flow through the bone's sinusoidal gaps, marrow, and spleen versus other organ systems with long period of circulation.
- Nanoparticles improve a drug's or protein's resistance to enzymatic breakdown.
- They provide a considerable advancement above current practises. The administration routes of oral and intravenous (IV) in terms of efficacy and efficiency.
- It lessens the liver's toxicity.
Nanoparticles Disadvantages:

- Significant immunogenicity
- Protracted and costly to expense
- Potential for subpar targeting.

1.6. Need Of The Nanoparticle In Herbal Remedies:

The following factors led to the selection of herbal nanoparticles to address the shortcomings of conventional herbal medicine[26].

- Targeting herbal medicines to specific organs with nanoparticles enhances selectivity, medication delivery, efficacy, and safety.

- Nanoparticles can be used to make herbal drugs more soluble and to localise the medicine at a specific spot, which improves effectiveness[27].

- Due to their distinct size and high loading capabilities, nanoparticles are able to deliver high concentrations of medicines to disease locations.

- Giving the medication in little particles increases its surface area overall, hastening its absorption into the circulation.

- Demonstrates improved penetration and retention effects, including greater permeation through the barriers due to the tiny size and retention due to inadequate lymphatic drainage[28].

- Does not require the inclusion of any specific ligand moiety and exhibits passive targeting to the disease site of action.

- Reduces negative effects.

NANO DRUG DELIVERY SYSTEMS FOR HERBAL EXTRACT:

To maximise patient compliance and prevent repetitive administration, phytotherapeutics require a systematic approach to administer the components over time. This might be obtained by creating NDDSs for the ingredients in herbs. NDDSs minimise the frequency of administration in order to combat noncompliance but also contribute to boosting therapeutic value by lowering the toxicity and boosting bioavailability[28]. Idealistically, the innovative carriers should meet two requirements. It should first give the medication at the pace specified by the during the course of treatment, the body's requirements. Further, it should direct a herbal drugs active ingredient to the desired location in motion. Standard dose forms, such as extended release None of these can be satisfied by dose formulations. Due to their small size, nanocarriers applied to herbal remedies will enable the medicine to pass through all barriers, including the liver's metabolism and the stomach's acidic pH, and deliver the maximum amount of the drug to the site of action[29,30]. Therefore, using herbal remedies in an NDDS will improve the usage of herbal remedies that emerge to treat the different chronological diseases[31].

Due of its distinctive small size and regulated medication release, nanotechnology is nearing a new paradigm for drug delivery systems. Consequently, the potential for treating a variety of chronic diseases and providing health benefits will expand with the use of "herbal remedy" in nanocarriers. This area of pharmaceutical technology has expanded and diversified quickly in recent years, emerging from the macro to the micro level and now expanding at the molecular, or nano level. Due to the evolving trends in creating medications and drug delivery systems, technology has become increasingly important in the fields of pharmaceutics and medicine[32]. Nanotechnology in some NDDSs like ocular drug delivery has been used to enhance the bioavailability by overcoming the drawbacks of the conventional dosage forms. This is possible due the capacity of the nanocarriers to protect the encapsulated drug molecule and transport it to various areas of the eyes[33-35]
2. Crude drugs as Nanoparticles:-

ARTEMISIA ANUA:-

Common name:- Wormwood or Sweet sagewort

Biological sources:- Leaves and flowering top of the plant Artemisia vulgaris.

Family:- Asteraceae.

![Fig 3. Artemissia Anua](image)

Chemical constituents:-

The important chemical constituents of Mug wort are thujone, cineole, volatile oil, acrid resin and tannin. It also contains flavonoids, triterpenes, and coumarin derivates.

Uses:-

It has a strong antimalarial effect. Its clinical applicability is constrained by its poor pharmacokinetic characteristics and brief half-life. To solve the issues with artemisinin, the drug has been coated with nanoparticles. After encapsulation, the hydrophilicity of the artemisinin crystals also increased, and these nano capsules dispersed efficiently in aqueous solutions[36].

BERBERINE:-

Common name:- Barberry

Biological sources:- Berberine, an isoquinoline alkaloid that occurs naturally, is found in the roots, rhizomes, and stem bark of several medicinal plants, including Berberis vulgaris.

Family:- Berberidaceae.
Chemical constituent:

Berberine is a quaternary ammonium salt from the protoberberine group of benzyl isoquinoline alkaloids found in such plants as barberry, tree turmeric, Orego grape, goldenseal, yellowroot, Amur cork tree, Chinese goldthread, prickly poppy, Californian poppy.

Uses:

In addition, human malignant brain tumour, esophageal cancer, human leukemic, and colon cancer cell lines have been successfully treated using berberine's anti-tumor characteristics. For prolonged drug release, single emulsion, multiple emulsion, and ionic gelation procedures are successfully used to create berberine-loaded nanoparticles[37,38].

LCNs nanoparticles are synthesized by ultra-sonication Method using mono olein, PEG, poloxamer, and transcutol.

INDIAN PANNYWORT:

Common name: Gotu, kola, kodavan

Biological source: The little herbaceous creeper Centella asiatica

Family: Apiaceae
Chemical Constituent:-

Phytochemical identified from centella asiatica to date include isoprenoids (sesquiterpenes, plant sterols, pentacyclic triterpenoids and saponins) and phenylpropanoid derivatives (eugenol derivatives, caffeoylquinic acids and flavonoids).

Uses:-

In addition, leprosy, wounds, cancer, fever, allergies, and syphilis are all treated with it[39]. The clinical use of Centella asiatica extract (CAE), despite having significant potential biological activity, is somewhat constrained by its physical instability. A powder extract called CAE has considerable hygroscopicity. Therefore, the creation of nanoparticles with the extract enclosed inside them might shield it from incoming moisture. By using the ionic gelation process, chitosan-alginate nanoparticles of CAE have been created. Physical stability was obtained by CAE nanoencapsulation as opposed to its extract alone[40].

CURCUMIN:-

Common name:- Turmeric, Curcuma, Curcuma aromatica

Biological source:- Turmeric contains a powerful phyto molecule called curcumin, a hydrophobic polyphenol (diferuloyl methane).

Family:- Zingiberaceae.

![Fig.6 Curcumin](image)

Chemical constituent:-

The major compound were arturmerone (20.20%), B-sesqui phellandrene(5.20%) and curcumenol(5.11%) curcumin was identified using IR,1H and 13C NMR

Uses:-

Due to its short half life, poor water solubility, fast metabolism, and rapid elimination, which eventually leads to poor bioavailability upon oral administration, its therapeutic applicability has been restricted[41]. Drug delivery methods based on nanoparticles may be able to alter curcumin's hydrophobic characteristics. Wet milling technology has been used to create curcumin nanoparticles. Nanocurcumin is widely dispersible in water in contrast to curcumin[42].
DANSHEN:-

Common name :-Red sage

Biological source:- Salvia miltiorrhiza dried roots called danshen

Family:-Lamiaceae.

![Fig.7 Danshen](image)

Chemical constituent:-

Hydrophilic substances, like salvianolic acids, and lipophilic chemicals, including diterpenoids and tanshinones, make up the majority of Salvia miltiorrhiza. The majority of these compounds are pigmented, giving the roots their reddish hue.

Uses:-

Danshen are frequently utilised in medical treatments to improve blood clotting and circulation. Danshen is widely used to treat hyper lipidemia, cerebrovascular illness, and coronary heart disease[43,44]. The primary disadvantage of this herbal medicine is its slow pharmacological activity. Salvia miltiorrhiza coated with nanotechnology has substantially faster release than conventionally powered samples and better antioxidant properties[45]. Nanoparticles loaded with phospholipids complex improved oral absorption as well[46].

DODDER:-

Common name:-Cuscuta campestris, Golden dodder, Yellow dodder

Biological Source:- Dodder is made from the parasitic Cuscutta chinensis plant.

Family:-convolvulaceae
Chemical constituent:-

The main chemical components are lignans and flavanoids.

Uses:-

Its pharmacological effects include immune-stimulating properties, anti-aging properties, and anti-cancer properties[47,48]. Due to its weak aqueous solubility, its oral absorption may be constrained[49]. By using the nano-precipitation process, Cuscutta chinensis nanoparticles have been created [50]. It is also used in cancer, depression, and pain.

MURVA:-

Common name:- Madhurasa, Devi, Morata

Biological source:- Murva is a contentious medication that can be made from a variety of medicinal plants, including Marsdenia tenacissima.

Family:- Asclepiadaceae.
Chemical constituent:

Caoutchouc-containing milky fluid can be found in the bark of the shoots. Pregnane glycosides can be found in the root and seed. Tena cis soides is a glycoside found in the plant's stem.

Uses:

It may be used to treat conditions such as anaemia, fever, diabetes, stomach problems, typhoid, urinary infection, and cough[51]. Its use is restricted in clinical applications due to its poor bioavailability and low water solubility. It is therefore made into nanoparticles to enhance its solubility and bioavailability.

PACLITAXEL:

Common name:- Taxol

Biological source:- A powerful anticancer medication called paclitaxel was discovered in the bark of the Taxus brevifolia Nutt tree.

Family:- Taxaceae.

![Fig.10 Paclitaxel](image)

Chemical constituent:

The structure of only two of the alkaloids constituent is known taxine A, which accounts for 30% and taxine B, which accounts for 2%.

Uses:

The chemotherapeutic drug paclitaxel is used to treat non-Smack cell lung cancer, ovarian cancer, and breast cancer. Its very low water solubility (0.7–30 ug/ml–1) due to its high lattice energy hampered its effectiveness[52]. As a result, paclitaxel's anti-tumor effectiveness was increased by integration into nanoparticles[53]. Paclitaxel-loaded nanoparticles were created using the sequential simplex optimization method and the nanoprecipitation method [54,55]. Paclitaxel nanoparticles facilitate sustained drug release, increase bioavailability, and improve drug stability.

QUERCETIN:

Common name:- Citrus bioflavonoid, Quercitol, Flavin
Biological source:- A flavonoid called quercetin is excreted from air-dried plant parts of the steam and bark of Spohora japonica.

Family:- Fabaceae.

chemical constituent:-

Quercetin is a plant flavonol from the flavonoid group of polyphenols. It is found in many fruits, vegetables, leaves, seeds, and grains; capers, red onions, and kale are common foods containing appreciable amounts of it. It has a bitter flavor and is used as an ingredient in dietary supplements, beverages, and foods.

Uses:-

Quercetin has greater antioxidant activity than well-known antioxidants like ascorby and Trolox[56]. Along with antioxidant activity, it also exhibits antiviral and anticancer properties [57,58,59]. Despite having such a broad range of pharmacological qualities, its employment in the pharmaceutical industry is restricted because of its poor water solubility and instability in physiological medium [60], The therapeutic efficacy and bioavailability are dramatically increased when quercetin is nano-encapsulated into PLA (poly-D, L-lactide) nanoparticles.

CONCLUSION

Due to their potential to heal practically all diseases, herbal medicines are currently receiving increased attention. However, the use of herbal medications is constrained by number of issues, including poor solubility, poor bioavailability, limited oral absorption, instability, and unpredictable toxicity. Nanotechnology has developed appealing therapies for the pharmaceutical industry that will deal with the issue posed by herbal medications in order to solve such issues. It is projected that the useful and significant relevance of using nanocarriers in combination with natural products and herbal cures would increase the significance of current medication delivery methods.

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