Mintage Journal of Pharmaceutical & Medical Sciences

Vol 9, Issue 2 Apr-Jun, 2020 ISSN: 2320-3315

Review Article

IMPACT OF NANOTECHNOLOGY ON HERBAL FORMULATIONS

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Received - 10.03.2020; Reviewed and accepted - 30.03.2020

ABSTRACT

Objective: Herbal formulations are one of the most demanded and preferred formulations because of the advantages it provides. The use of nanotechnology in developing a herbal formulation has gained a lot of importance and growth. Due to its ability to improve the efficacy and quality of herbal formulations, it is used today in abundance
Method: Various Literature articles have been considered through PubMed, science direct, MJPMS, etc. An attempt has been made to justify the use of nanotechnology for the herbal formulations.
Result: Various formulations like Nano emulsion, liposomes, solid lipid nanoparticles, can easily incorporate the herbal active ingredient and improve the performance characteristics.
Conclusion: This review helps in defining the use of various techniques used for the development of herbal formulations. Different herbal nanotechnological products are formulated till now and the future expectations of formulating difficult herbal active ingredients using nanotechnology have been carefully mentioned.

Keywords: Nanotechnology, Herbal Formulations, Bioavailability, Efficacy

INTRODUCTION

The basic principle of formulating any kind of formulation is to have more benefits than risks. Plants and other herbal sources are the ones that provide us with many benefits and the biggest benefit is lesser side effects or adverse effects as compared with the other synthetic ingredients. In earlier times, there were only herbal ingredients that were used to formulate the products, with the advancement of many other API the invention came up with the synthetic ingredients which led to more demand in today's time.

To bring back these herbal components we need a major scientific approach that could make it complimentary to the pharmaceutical industry. This can be accomplished through the Novel drug delivery system (NDDS) like nanotechnology [1]. The use of Nano sizing of the components has various advantages from increasing patient compliance, good penetration rate, increase in bioavailability, accurate diagnosis, etc.

With nanotechnology, we can aim the size range to be in the bracket of 1-100 nm. It helps in achieving many aspects of the formulation. The development of nanotechnological techniques in the scientific world can further help in the growth and commercialization of a new set of bioactive molecules.

In this review, the focus is primarily on the use of nanotechnology on herbal drugs. Formulating a herbal product is not an easy task since we require some standardized herbal Active Pharmaceutical Ingredient (API). For this, the scientist has developed various analytical tools and techniques to standardize the herbal API before formulating them [2].

Sources of Herbal medicines

Ayurveda

It is one of the oldest medicine systems of India and is widely used till now. The term Ayurveda means “The science of life’. It has obtained its originality from two Vedas Rigveda and Atharvaveda [3]. Ayurveda in India plays a great role, not only as a medical system but also to provide mental, bodily and a positive environment. This medicine system is now practiced in other countries also. The diagnostic parameters of this traditional system involve studying the patient from inside out and providing the treatment as per the patient's physiological and mental disposition [4].

Homeopathy

It is a holistic system of treating patients which consists of two major objectives, first treating the patient as a whole and second by collecting facts and data based on experiments [5]. This system of medicine is most comfortable and most demanded because of no side effects or adverse effects. The only disadvantage with this medicine system is its slow procedure of treatment.

Unani

This system of medicine deals with older Arabic version based on teachings of Greek physician Buqrat and Roman physicians. According to this system, tabiyat is considered to be the word which deals with the diagnosis and ailments of the human body. It deals with some basic versions of life i.e. temperament, elements, body fluids, organs, spirits, powers [6].

REQUIREMENT OF NANOTECHNOLOGY FOR HERBAL FORMULATIONS

During the absorption of the drug, there are chances that it gets destroyed due to increased acidic pH of the stomach and the constituents of the formulations may get metabolized by the liver, this activity could result in less concentration of drugs reaching the targeted site and producing a less therapeutic effect. Reduction in the size of the formulation to nano range will result in better absorption and an increase in the concentration of drugs reaching the targeted site [1].

One of the biggest challenges in formulating with herbal constituents is its poor solubility and bioavailability which causes a great challenge to combine them with other ingredients. This can also be changed by formulating it in the form of nanocarriers or liposomes. For problems of the hydrophobic or hydrophilic property of constituents, these constituents can be formulated in the form of solid lipid nanoparticles, Nanocapsules, phytosomes, Nanoemulsion [7]

Because nanoparticles have increased surface area to volume ratio, it makes easier penetration of drugs inside the skin, and also targeted action increases owing to better results. Drugs are either named on the surface or can be incorporated in the hollow spheres of nanoparticles. These nanoparticles help in providing extended-release effects of the drugs [8].

Most demanded Curcumin (Curcuma longa) which is widely used as herbal ingredients because of its antiseptic, antibacterial, anti-inflammatory, and antioxidant properties. For a long time, curcumin possessed various issues such as low solubility, stability, and low bioavailability. These issues were found to be resolved by using curcumin in a novel way with the help of NDDS.

Today herbal formulations are widely used in treating conditions like psoriasis and dermatitis; these conditions are most prevalent today all over the world. These herbal constituents create a great issue in transdermal absorption because of their low penetration power and require an NDDS to overcome this issue and provide better therapeutic action[9].

Many researchers were also trying to figure out poor absorption, high molecular size, and low penetration in skin and thereby low bioavailability of certain active constituents like flavonoids, tannins, terpenoids. Although these constituents possess high water solubility but were circulated with these issues. After many years these constituents were tried formulating in the form of solid lipid nanoparticles, niosomes, liposomes, and found some sort of success [10].

Many formulations have been made and are being made using nanotechnology in the form of solid lipid nanoparticles, liposomes, nanoemulsion, and others because of their big list of advantages and majorly it has a big role to play in the usage of herbal active constituents. These herbal active constituents are again pushed forward to provide therapeutic action because of these novel drug delivery systems.

APPLICATIONS OF NANOTECHNOLOGY IN HERBAL DRUGS

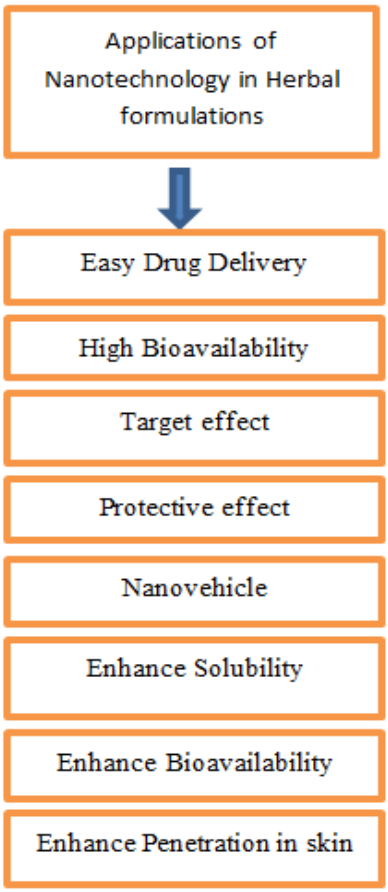

Fig.1: depicting applications of nanotechnology in herbal drugs [11]

DIFFERENT NANO FORMULATIONS

Nano Emulsion

Nanoemulsion is a class of pharmaceutics dealing with nano-sized emulsion particles. They are the colloidal system that incorporates the drug molecule and enhances its activity. The size ranges from 10- 1000nm[12]. The nanoemulsion consists of three phases: an aqueous phase, an oil phase, and an emulsifier (surfactant/cosurfactant). These three phases together create an emulsion that is then reduced to nano-size using various techniques such as high-speed homogenization, microfluidization, and phase inversion temperature method[13].

Liposomes

Liposomes are spherical shaped tiny, artificial vesicles that are prepared from cholesterol and phospholipids. They are highly preferred because of their different properties in the drug delivery system. One of the major properties is its hydrophilic and hydrophobic nature which makes it a preferred choice by many scientists. It increases efficacy and stability by the encapsulation process. Because of its non-toxic and flexible nature, it provides easy incorporation of the drug. Liposomes also possess certain disadvantages like high cost, short half-life, low solubility [14]

Nano Gel

They are the highly cross-linked Nano-sized system that is used to promote the drug delivery system. Nano gels range from 20-200nm. Advantages of nano gel are it provides with thermodynamic stability, prolong serum half-life, the capacity of solubilization, low viscosity, widely used in gene and protein delivery, increase in lipophilicity of drug, widely used in dermatological applications, high bioavailability and biodegradability[15].

Nanoparticles

Nanoparticles (NPS) have been classified in many ways as per the morphology, size, and chemical reactions. Majorly physical and chemical characteristics of nanoparticles are widely used. They are classified as carbon-based NPs, metal NPs, ceramic NPs, semiconductor NPs, Polymeric NPs, etc. They are prepared by two methods that are bottom-up methods and top-down methods. Bottom-up methods consist of various processes: spinning, template support synthesis, laser pyrolysis, atomic or molecular condensation. The top-down method consists of mechanical milling, chemical etching, sputtering, laser ablation [16]

Solid Lipid Nanoparticle

SLN comes in the size range 10-1000nm. They help in stabilizing the absorption and bioavailability properties of the Biopharmaceutical Classification System (BCS) class 2 drugs through their size-dependent characteristics. It also acts by protecting labile drugs from chemical degradation. Also, it is used as occlusive that is it works by increasing the water content of the skin. Various techniques are used for its preparation like high shear homogenization, solvent emulsification, Micro emulsion-based SLN preparation [23]

Niosomes

A noisome is defines as a non-ionic surfactant based vesicle in it. Various surfactants used are spans (span 60, 20, 80) tweens (tween 20, 60, 80). This surfactant vesicle is stabilized by the inclusion of cholesterol in it. The other role of cholesterol is to provide stiffness and proper shape to the niosomes final product. Various methods used to prepare niosomes are ether injection method, hand shaking method, sonication method, micro fluidization method, reverse phase evaporation technique [22].

DIFFERENT TECHNIQUES OF PREPARING HERBAL FORMULATION USING NANOTECHNOLOGY

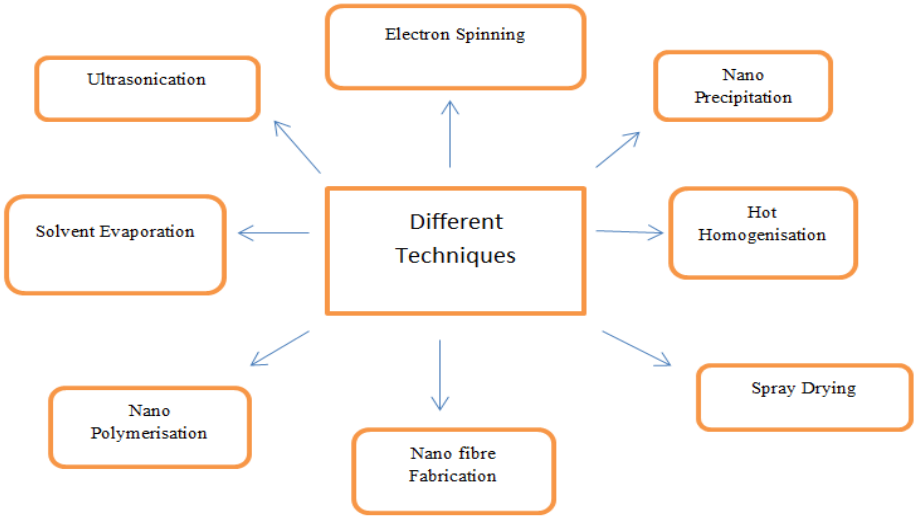

Fig. 2: Techniques describing the preparation of herbal Formulation using Nanotechnology [11]

Table 1: Different herbal formulations using nanotechnology [17, 11]

Formulations	Active Ingredients	Biological Activity	Method of Preparation
Solid Lipid Nanoparticles of Curcumin	Curcuminoids	Anti-Cancer and Antioxidant	Micro-Emulsion Technique
Cuscuta Chinensis Nanoparticles	Flavonoids and Lignin	Hepatoprotective and antioxidant	Nanosuspension method
Artemisinin nanocapsules	Artemisinin	Anticancer	Self Assembly procedure
Glycyrrhizic acid loaded nanoparticles	Glycyrrhizin acid	Anti-inflammatory and antihypertensive	Rotary-evaporated film ultrasonication method
Berberine loaded NPs	Berberine	Anti-Cancer	Ionic Gelation Method
Diclofenac diethylamine and curcumin nanocarrier transdermal gel	Curcumin	Anti-inflammatory	Encapsulation with Sonication
Curcumin loaded NPs of HPMC and PVP	Curcumin	Antimalarial	Solvent evaporation technique
AgNPs of *Mukia scabrella*	Cystein residues	Antimicrobial	Nano suspension
Fluorescent AgNPs of *Artemisia Annua*	Amides and Phenolics	Anti-Cytotoxicity	Nano suspension
Diclofenac diethylamine and curcumin Nanotransfersomes	Curcumin	Anti-inflammatory	Encapsulation with Sonication
SNEDDS formulation of quercetin	Quercetin	Anti –liver toxicity	Self Nanoemulsion

FUTURE EXPECTATIONS OF NANO HERBAL FORMULATIONS

The requirement of nanotechnology in every aspect of the scientific formulation was a big necessity for the medical field. Talking about India, the nanotechnology started with the development of Nano Science and Technology Initiative (NSTI). NSTI's constant funding for nanotechnological research continued until many years [18].

It has been a practice since many times that the scientists unable to launch a particular drug or formulation for a prevalent disease in a stipulated time. This is because of a lack of the fastest means of designing formulations with appropriate results. Nanotechnological approaches provide the quality of work, fastest results, and resolving the issues about research and development.

This emerging technology provides many advanced tools that can be incorporated into various formulations with a good number of advantages. It is of good use only when it is used judicially. Using nanotechnology in formulating herbal drugs leads to good numbers of patents, business options, and good numbers of scientific data. There are many categories of nanoparticles that are under consideration for formulating various kinds of herbal formulations. Some of them are NPs of biological substance like Peptides, amino acids, metal NPs like zinc, titanium, silver, gold [19]

For a long time, herbal drugs were not used for treating cancer cells because of the major disadvantage of providing slow effects.

Today after long research of herbs and newer technologies of reducing the size of active ingredients to nano range, big firms and industries are putting in their precious time to formulate a herbal formulation to treat these cancerous cells. The major advantage of upcoming herbal formulations would be no or fewer side effects, as already the market is flooded with synthetic formulations for cancer treatment which results in some or other adverse effects to an individual [20].

A new approach started and will be followed in the future is Green Nanotechnology, which follows the use of plant and its science with a combination of tools and technologies of nanotechnology. This area is getting huge funds and will be seen with a good amount of patents shortly. Various new formulations are being set up with new research and development for future use to have a safe and good quality product with the advancement of nanotechnology in it [21].

CONCLUSIONS

Nanotechnology is one such scientific tool that enables an individual to work on those difficult parts of an active ingredient which were untouched at some point of time. It helps in developing newer formulations with increased efficacy and high-quality performance. For the herbal formulations, it has provided many solutions to various issues like solubility problems, low bioavailability, poor penetration, and absorption. Today formulating a herbal product for many life-threatening diseases has gained importance. Out of these life-threatening diseases, the most prevalent one is cancer for which the herbal remedy is already formulated using nanotechnology. The medical field requires more tools and technologies similar to nanotechnology to enhance the overall performance and reduce the adverse effects or possible side effects of the drugs. Using nanotechnology various firms are developing new formulations and can patent their product which also makes them a way of making business. Although, this technique is costly and needs a good amount of funding without such techniques and novel delivery system our medical field would never reach new heights and developments.

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