Review Article

Facile Herbal Nanotechnology: Glimpse of Immense Potential for Superior Bioavailability to its vital Components

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ABSTRACT

Incorporation of Nanotechnology on herbal constituents to tailoring for its potential benefits has been gained an imperative circumstance in recent times. Researchers are focused on the nanotizing the herbal proportions to render and take diversified advantages, as well as to precede futher explorations in the field. Several proven studies were been reported on the preparation of nanoparticles of herbal origin. Newer nanotechnology based herbs have been developed that have efficient biopharmaceutical properties and desirable target characteristics. In this review a detailed elaboration of the nanotechnology in herbal compositions offering varied outcomes, possibly ranging form the ease of preparation, newer attempts on nanotizing the herbal components, bioavailability pattern has been in focus. Besides the discussion has been extented to impart the basic techniques available to develop the herbal nanoparticles. The primary objective is to obtain the herbal nanoparticles, devoiding the stresses it incurring during the extraction process which involves typical oxidation, hydrolysis and other environmental degradations. The aforementioned has provided a shelter to indexing importance of safeguarding the formulations Shelf life. So the concerns are put across in two fronts, to develop a method to produce stabilised nanoherbal product and targeting it to the desired site of delivery. As most of the diseases are dealt with defected cellular components within, and it mandates the penetration of drug that rushing inside the cell. The tangling beneficiaries are the reduction in dosages and gripping the plasma concentration a stable of the herbal constituents.

Keywords: Newer approaches, bioavailability, formulation.

INTRODUCTION

The nanoherbal extracts preparation methods caters various delivering techniques such as nanoparticles, nanocapsules, liposomes, phytosomes, nanoemulsion, microspheres, tranferosomes and ethosomes. The above techniques of utilizing nanocarries or polymer coating have given a herbal ingredient a robust strength against physical, chemical and environmental degradation, which in turn increases the safety and pharmacological activity. It also paves the way for the improvising the bioavailability and overcoming the solubility problems[1]. The nanotized herbal ingredients is a promising approach to lend various the benefits[2] as shown in the Fig. 1

Nanotechnology savvy would benefits in numerous ways viz providing vertical atoms, material processing, creating high technology products and so on. All it is considered the most likely tool, the next decades or less great changes in mankind technology, one of the present, satisfied introduction of modern rice technology research and development of traditional Chinese medicine, proposed a nanometer Medicine concept. Nanomedicine is the use of nano-technology manufacturing tablets. The particle diameter less than 100 nm of Chinese medicine is the original drug and its compound preparations. There are two basic techniques, 'bottom up' or 'top down', to prepare Chinese herb nanoparticles[2,3].Furthermore, specific surface modifications and new design strategies of Chinese herb drug nanoparticles are created to profit clinical applications.

Nanocarriers and Nanodevices

Substantial researches on developing biocompatible and biodegradable nanocarriers and nanodevices as novel drug delivery systems. Natural polymers or biopolymers are generally biocompatible, biodegradable, non-toxic and non-immunogenic. Basically they are in bifold viz., polysaccharides and proteins[3]. Chitosan, starch, dextran, and alginate are examples of commonly used polysaccharides while collagen, gelatin, and albumin are examples of commonly used proteins. These biopolymers are widely applied in formulation of nanospheres, nanocapsules, and recently nanofibers in order to enhance drug delivery to

specific pharmacological sites or tissue engineering[4]. Since the polymers are from natural origin, really it does not harm the living tissues[5].

Nanocrystals

The microscopic crystals of a pharmaceutical product can make it soluble in water even if the bulk compound is not. The tiny particle size means a much greater surface area to volume ratio giving access to more water molecules that can surround the particles, which is the essence of dissolving a compound. This effect can then allow the particles to be carried across the lining of the gut wall where they would previously simply move fast with no interaction. The nanocrystals of active herbal components were shown in Fig. 2. A demonstration of gymnemic acids derived from the herb Gymnema sylvestre, can be made more readily bioavailable by forming the active compounds as nanoscopic crystals, called Nanocrystals[6]. The compounds have medicinal activity in a range of diseases, in particular diabetes mellitus, with the native herb having been used in traditional medicine for several centuries. The Nanocrystals of gymnemic acids could provide important clues as to how to transfer the medical benefits of the herb to a regulated pharmaceutical product for further investigation and with a more strict profile in treating disease.

Nanoscale Herbal Decoction

The decoction of a traditional Chinese medicine containing Rhei rhizome, Coptidis rhizome, and Scutellariae radix, is widely used in hepatoprotective therapy. However, preparation of the decoction requires addition of boiling water that causes loss of numerous effective components. Nanoscale SHXXT decoction prepared in room temperature water could have preserved hepatoprotective ability[7]. The results of this study indicate that nanoscale SHXXT could be extracted easily. The simple preparation of this herbal decoction is more convenient and energy-efficient.

Nanodrug Carriers for Photosensitisation

The treatment protocol involves applying a photosensitizing drug and light over the area to be treated. The results are encouraging, with cure rates that border the 100% for certain types of cancer. Nevertheless there are important side effects related to photodynamic therapy, such as the patient's skin photosensitization. The reduction of side effects and increased therapeutic efficacy can be achieved by association of the nanocarriers photosensitizers which are directed to target cells, such as neoplastic diseases, bacterial or fungal.

Nanostructured cosmetics from Plant Extracts

In cosmeceuticals, the most common designed platform included micelles, polymeric micelles, dendrimer, liposomes niosomes, ethosomes, glycosomes nanoparticles and nanocapsules. Smaller particles can be more readily absorbed into the skin to optimize the delivery of functional ingredients into the skin and enable these materials to reach the action site quicker. Examples of using nanotechnology for herbal extract in cosmeceuticals are the use of Phyllanthus embillica extracts in anti-aging products.

The Different plant extracts form Brazilian biodiversity have shown potential moisturizing, nourishing and antioxidant vis-à-vis they are desired in various types of formulation. The combination of these structures in the formulation can lead to cosmetics products totally new and more efficient in relation to conventional. Adding value to the plant extracts of flora contributes decisively to environmental and sustainable development as well[8].

Biomimetic Nanosized particles (Herbal Extracts)

Recently adapted methods offer a convenient and bio friendly approach to fabricate complex structures from simple components with sub-nanometer precision. The synthesis of metal and inorganic materials nanoparticles has emerged as a simple and viable strategy within the utilization of biomimetic assembling[9]. For this notion microorganisms or plant extracts are more regularly utilized. Biomimetic synthesis of nanoparticles employing organic molecules with the hope that such developments will be helpful to introduce novel nano-particle formulations that will not only be more effective but would also be devoid of nano-particle associated putative toxicity constraints[10]. Several efforts to dissect various possible modes of biomimetic synthesis, it is still not clear that what specific components are present in these extracts that lead to the formation of nano-assemblies. It is speculated that cytosolic as well as secretory components of living cells might offer a template that facilitates the formation of nano-assembly in an aqueous environment[11]

An attempt has been made for biological synthesis of nano-particles to organic

molecules, namely the anticancer agent 5-fluorouracil (5-FU), using Aloe vera leaf extract .Leaf extracts from Aloe vera, Azardirachta indica, Cymbopogon flexuosus have been used in the synthesis of gold, silver, cadmium and bismuth nano-particles[12].

Nanotechnology for Herbal Diet

Using nanotechnology in herbal drinks has been augmented. The beverage shots use botanical extracts from four plants curcuma, mangosteen, chili and roselle. They are made in shots to increase the concentration of herbs to maximize their benefits. Also, small particles make absorption more effective; adding that herbal beverage shots tend to have problems such as bad taste and unstable color, but nanotechnology can solve these issues[13]

Herbal Carriers for clinical significance

Herbal balls are the traditional massage tools for the relief of pain. They have been widely used traditionally for many decades. However, herbal balls have many problems, for examples, it is not convenient to use and has low efficiency because of instability of the herbal oil and the bioactive compounds. The spray containing extracts from Thai Lanna medicinal plants imitated herbal balls entrapped in niosomes in comparison with the placebo and the commercially available emulgel product. The spray containing the plant extracts such as plai (Zingiber cassumunar Roxb), tumeric (Curcuma longa L), lemon grass (Cymbopogon citratus (DC) Stapf), kaffir lime (Citrus hystrix DC) and usompoiu (Acacia rugata Merr) entrapped in niosomes was developed and prepared. Spray containing the Thai Lanna extracts entrapped in niosomes showed the similar antipain activity to the commercial available emulgel containing an antipain drug. This study has demonstrated the potential of the Thai Lanna plant for pharmaceutical application[14].

Nanotechnology in Traditional system of medicine

Traditional medicine systems such as Ayurveda can serve as an excellent tool for human in nanomedicine category. A study shows that traditional medicines such as Ayurveda Bhasms may hold strong relevance in the emerging area of nanomedcine. The purposeful advantage emerges if the traditional system of medicine combines with metal-based nanomedcine[15.] Recent study reveals that Ayurvedic Bhasms are alike the nanocrystalline material. This serves the usage of Bhasms as targeted drug delivery, the reason behind they are biocompatible and non-toxic[16,17].

Herbal Nanoformulation for Tumor Therapy

Curcumin, a natural diphenolic compound derived from turmeric Curcuma longa, has proven to be a modulator of intracellular signaling pathways that control cancer cell growth, inflammation, invasion and apoptosis, revealing its anticancer potential[18]. A comprehensive review of the literature characterized curcumin as an excellent molecule among many naturally occurring compounds for cancer therapeutics .Curcumin is to improve its bioavailability, protect it from degradation and metabolism, and increase its targeting capacity toward cancer tumor(s). Various types of nanoparticles (NPs), such as polymer NPs, polymeric micelles, liposome or phospholipid, nano or microemulsions, nanogels, solid lipid NPs, polymer conjugates, self-assemblies, and so on, are suitable for the delivery of an active form of curcumin to tumors[19] Fig. 3 The improved solubility, bioavailability and pharmacokinetic properties of curcumin through various micro and nanoformulations have been reviewed systematically[20,21]. The various nanoformulation of curcumin were shown in Fig.3. The use of curcumin nanoformulations in chemotherapy for cancer treatment is a facile modality that improves existing curcumin therapies by targeting tumors and by reducing the dose required. Safe toxicological profiles of the various curcumin nanoformulations and their efficacy in the cell-line models highlight their potential for evaluation in vivo models. Human trials need to be conducted to establish their effectiveness in clinical applications as an improved therapeutic modality for cancer treatment[22].

A demonstration of curcumin as well as curcumin-nanoparticles distribution to the liver, heart, spleen, lung, kidney and brain has reported. Polyesters such as poly (lactic-co-glycolic acid) PLGA nanoparticles encapsulating curcumin were prepared by the high-pressure emulsification-solvent evaporation technique could significantly raise the AUC and t1/2 of curcumin in all these organs, except the heart[23]. Distribution levels in regions of the brain showed that curcumin accumulated in the hippocampus for both formulations of curcumin. The retention times of curcumin in the cerebral cortex and hippocampus were significantly extended. These results provide information to help more effectively in employing curcumin and to clarify its formulation in therapeutic applications[24].

Improvised Antimicrobial activity of metal NPs

Bio- synthesized silver nanoparticles (SNPs) are being widely using in the field of medicine. Extracellular biosynthesis of silver nanoparticles was carried out by using medicinal plant extracts for the reduction of aqueous silver ions in short period. The present study included the bio-reduction of silver ions through medicinal plants extracts and testing for their antimicrobial activity.

The aqueous silver ions exposed to the extracts, the synthesis of silver nanoparticles were confirmed by the change of colour of plant extracts. These environmentally benign silver nanoparticles were further confirmed by using UV-Vis spectroscopy. The results indicated that silver nanoparticles have good antimicrobial activity against different microorganisms. It is confirmed that silver nanoparticles are capable of rendering high antifungal efficacy and hence has a great potential in the preparation of drugs used against fungal diseases[25].

Another study conveys Chenopodium album leaf extract was preparation and successful usage in the single-pot biosynthesis of SNPs and GNPs in the size range of 10–30 nm. Only spherical particles were observed at higher leaf extract concentration, as infer from the TEM imaging. The stability of NPs was evaluated at different pH with zeta potentiometer without adding any stabilizing agents. The results shown that this pristine method is rapid, facile, convenient, less time consuming, environmentally safe and can be applied in a variety of existing applications.[26]

Extracts of Plants for Phytolayer

Phtolayer has got its utility in various field of medicine; especially it finds itself in dentistry. Medicinal phytolayer found applications in various fields of practical medicine. Development phytolayer formed as an independent field of pharmaceutical technology. Development of nanocompositions based plants of biologically active substances with the polymers and trials of their physical-chemical properties for high dosage drugs has been performed[27]. The plant extracts Halimodendron halodendron (Pall) Voss, genus Halimodendron of the family Fabaceae; Barbarea vulgaris genus Barbarea R; family Brassicaceae Burnett, Vicia cracca L genus Vicia of the family Fabaceae were used. As a result of microbiological investigations revealed that the phytolayer has good antimicrobial activity and can be used in medicine[28].

Antibiotic Nanoparticles to combat Infectitious diseases

Quite a lot of classes of antimicrobial nanoparticles (NPs) and nanosized carriers for antibiotics delivery have proven their effectiveness for treating infectious diseases, including antibiotics resistant ones, in vitro as well as in animal models. Substantial emerging efforts in combating against infectious diseases were already in place, particularly using antimicrobial NPs and antibiotics delivery systems as new tools to tackle the current challenges in treating infectious diseases. The mechanisms of nanoantibiotics towards MDR were shown in Fig. 4. Antimicrobial nanoparticles (NPs) offer many distinctive advantages in reducing acute toxicity, overcoming resistance, and lowering cost, when compared to conventional antibiotics[29,30]

Employing nanotechnology as a new paradigm in controlling infectious diseases, especially in overcoming antimicrobial drug resistance, in the context of research and clinical prospective of this novel and promising strategy[31].

Sensing and Damaging of DNA- A Herbal Repairing Role

The electrochemical method to detect DNA damage caused by the photovoltaic effect of nano-TiO2 has been common. Meanwhile, we have found that resveratrol, a Chinese Traditional Medicinal Herb species, can have a repairing effect to the oxidized DNA, Resveratrol (3,5,4-trihydroxy-trans-stilbene), as phytoalexin present in some food products including grapes, has recently been reported to have cancer chemopreventive properties[32]. It is concluded that the ROS produced from TiO2 nanoparticle can oxidatively damage DNA and the herb resveratrol has a repairing effect to the oxidized DNA[33]

Green synthesis of metal NPs using Leaf Extracts

Novel methods involved in the preparation of nanoparticles of noble metals like gold has gained importance due to its remarkable size-dependant optical and electronic properties. Gold nanoparticles are unique due to their tunable Surface Plasmon Resonance (SPR); hence they are used in bio-labeling [34], biosensors devices for the detection of viruses and bacteria [35], biomedical science including drug delivery [36], tissue/tumor imaging, photo thermal therapy and immuno-chromatographic identification of pathogens in clinical specimens [37]. Due to the recent awareness of green chemistry, it has been concluded that

gold nanoparticles are biocompatible, inert[38]. The aqueous extract of plant leaves are increasingly used to attain the metal nanoparticles[39].

Nanotechnology Approaches to certain Herbs to augment bioavailability

Genistein has been shown to possess anticancer activities in different experimental systems, yet the same effects could not be translated in the clinical setting due to its poor bioavailability. Newer formulations of genistein such as diindolylmethane (BDIM) from Bioreseponse Inc. has shown some enhanced bioavailability[41].The incorporation of genistein into topical nanoemulsion formulations composed of egg lecithin, medium chain triglycerides (MCT) or octyldodecanol (ODD) and water by spontaneous emulsification marked an improved bioavailability[42]. Resveratrol (3,5,4'-trihydroxy-trans-stilbene) is a phytoalexin produced naturally by several plants when under attack by pathogens such as bacteria or fungi. Resveratrol and its effects is currently a topic of numerous animal and human studies. The natural chemopreventive agent, resveratrol also has a very short half life and is rapidly glucoronated and sulfonated, aiding its rapid turnover and excretion. In nano formulation of resveratrol, they prepared resveratrol chitosan nanoparticles with free amine groups on the surface so as to conjugate ligands, which will actively target to special tissues or organs[43].

Evaporative precipitation of nanosuspension (EPN) was used to fabricate nanoparticles of a poorly water-soluble antimalarial drug, artemisinin (ART), with the aim of enhancing its dissolution rate. EPN prepared artemisinin nanoparticles were found to be 100–360 nm. The dissolution of EPN prepared ART nanoparticles markedly increased as compared to the original ART powder[44.] Artemisinin was made into carbon nanotubes surface without alteration in drug properties. Hence, capability of carbon nanotubes to have synergistic effect on the bioavailability of artemisinin attained.[45] The effect of eugenol on intestinal absorption of colchicine in an oral administrative nanoemulsion formulation was also demonstrated in vivo. The procedure indicated that the intestinal absorption of colchicines was enhanced significantly by eugenol in the tested nanoemulsion.[46] Berberine hydrochloride is a conventional component in Chinese medicine, and is characterized by a diversity of pharmacological effects and hydrophobic in nature. The pharmaceutical preparation of berberine hydrochloride has improved to achieve good prospects for clinical application, especially for novel nanoparticulate delivery systems[47]. The curcumin has great potential abilities to prevent and treat a wide spectrum of incurable and chronic diseases. The low bioavailability of curcumin has been attributed to its very low aqueous solubility that means one has to swallow 24 to 40 curcumin capsules of 500mg each. The nanoparticle-encapsulated form of curcumin, nanocurcumin, which can be readily dispersed in aqueous media, readily absorbed into the bloodstream was absorbed[48].Besides polymer-encapsulated curcumin, other nanobased drug delivery systems being employed for curcumin include curcumin nanocrystals, curcumin nanoparticles, nanoemulsion nanoliposome-encapsulated curcumin, curcumin-loaded polymeric micelles, cyclodextrin or curcumin self assembly, curcumin nanosuspension, and solid-lipid nanoparticles[49].

CONCLUSION

Viable potential are come into bud for the improvising the bioavailability of poorly herbal drug constituents like flavonoids, glycosides and so on. The effectual stratagem of accomplishing the considerable solubility of the components, would lend tremendous opportunity for the scientific explorers to head towards the targeting delivery. Delivering the technology of drug targeting at the repaired site and circumlocutioning the actives around it, rather avoids the serious side effects, as in case of non harming cells are inhabited undesirably in cancer treatment. Recent approaches and progressions forecasts the need for the clinical application of herbal nanomedicines in the treatment of diabetes, cancer, various infections would come in handy if there are more platforms for nanoherbal formulation and widespread standardization of the practice. With the quite a lot of proven records for feasibility of the formulation, effective bio availability, analytical techniques to standardization and various optional fabrication of nano-materials into formulation is the cutting edge for many innovations to be made further is of great emphasis.

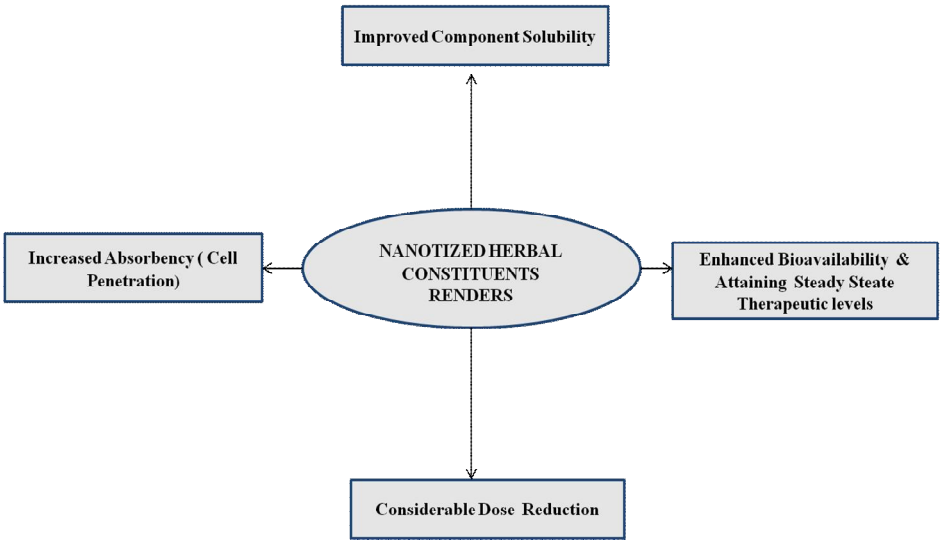

Fig. 1: Pivotal role of nanotechnology in herbal drugs

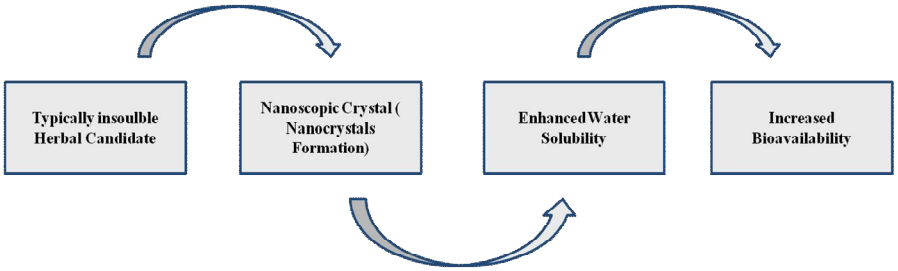

Fig. 2: Nanocrystals of Active Herbal Components

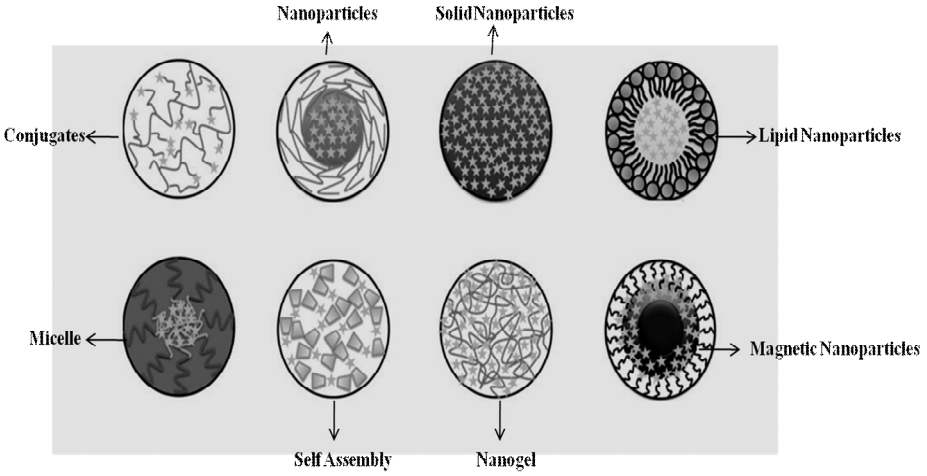

Fig. 3: Various Nanoformulations of Curcumin nanoparticles

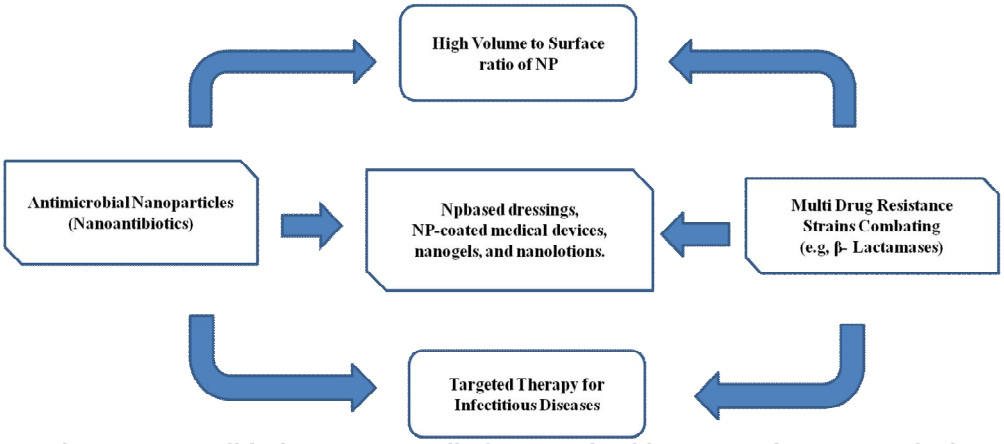

Fig. 4: Nanoantibiotics turns Hostile for MDR (Multi-Drug Resistance Strains)

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