Application of Nano Technology in Disease Prevention Through Pharmacy Interventions

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KEYWORDS

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ABSTRACT

India spent more than 50 years working to combat tuberculosis. When the National Tuberculosis Programme of India (NTP) was first launched in 1962, it was intended to treat patients at home with self-administered conventional medication regimens. The key to a successful formulation is getting the active ingredient to the desired location with the least amount of discomfort and adverse effects. Controlled release technologies and drug delivery systems are helpful in a variety of therapeutic procedures. For instance, the focused therapy approach effectively delivers the medication while lowering treatment costs. To make a drug delivery system successful and sensible, factors including a preset release pattern, drug stability in the system and in the environment in which it is released, biodegradability, and penetration across a particular biological barrier for targeted administration are important to consider. This work developed a medication delivery model based on a cubic structure.

1. Introduction

The National Institutes of Health (NIH) defines nanomedicine as highly specialised medical intervention at the molecular scale for the diagnosis, prevention, and treatment of a variety of disorders [1]. Nanomedicine is one of the most significant fields of nanotechnology. The word "nano" comes from the Latin word "dwarf." A nanometre is one thousand millionth of a metre. The ideal size range provided by nanotechnology is one thousand millionth of a certain unit. The scientific field that focusses specifically on molecular and nanoscale processes is known as nanotechnology. Current investigations into nanotechnology in pharmaceutical and medical sciences have successfully improved traditional medication delivery methods [2]. The science of materials with a size of between 109 and 107 of a metre is known as nanotechnology. The performance is improved in a range of dose forms by the nanometre size range. Formulations made at the micro and nanoscale may be able to administer the medication at the necessary release pattern over the necessary length of time to improve the drug's stability and bioavailability while lowering its side effects. Currently, one of the most appealing fields for drug delivery research is designing nanosystems that can transport drugs to the correct location at the right time in the right dosage. During their creation, medications with limited therapeutic indices provide a significant challenge to preformulation scientists. This issue can be greatly resolved by applying nanotechnological techniques to the delivery of such medications. When creating nanoscale materials for medical research, researchers must take biosafety into account as it is a significant concern in the design of innovative medications [3]. The possible toxicity of nanoparticles is connected to their physicochemical characteristics, which include size, shape, charge, colloidal stability, and interactions with surrounding substances. Preformulation scientists are focussing more on colloidal drug delivery systems because of its biodegradability. These formulations offer an alternate method for enhancing solubility, guaranteeing better dissolving, and offering choices for managing or maintaining drug release that targets particular sites and can be customised to alter the pharmacokinetics and dynamics. Colloidal medication delivery is now at the forefront of drug development due to its numerous advantages [4][11]. Lately, the development of biological frameworks for drug delivery has led to the development of cubic drug delivery systems.

2. Literature Review

Numerous colloidal formulation techniques have been developed, investigated, and used in therapeutic settings. Aerosols, microemulsions, procolloidal systems, liposomes, nanocarriers, liquid crystalline phases, and micelles are important thrust areas. the cornerstone of all developments in the science of colloidal drug delivery based on the application of lipids, polymers, and surfactants. There is a direct or indirect application of these in nearly all of these drug carriers [5]. Colloidal drug delivery methods, including micellar solutions, vesicles and liquid crystal dispersions, and nanoparticle dispersions made up of tiny particles with a diameter of 10–400 nm, exhibit considerable promise [6]. The objective in

creating these formulations is to create systems with low toxicity, extended shelf life, and optimal drug loading and release characteristics. The integrated medication engages with the system's microstructure and may potentially have an impact on it through molecular interactions, particularly if it has mesogenic or amphiphilic qualities [12]. To prevent embolism in blood arteries, the system that must be administered intravenously only accepts a small number of particles between one and five micrometres and none larger than five micrometres. Only the subcutaneous or intramuscular methods of administration are available for solid specific systems; intravenous treatment may cause vaso-occlusion [8]. Depending on the size, number of layers, and existence of vesicles, colloidal drug delivery can be classified as liposomes (multilamellar: MLV, large unilamellar vesicles: LUV, small unilamellar vesicles: SUV, oligolamellar large vesicle: OLV, multivesicular vesicles: MVV), mixed micelles, colloidal liquid crystalline structures, microemulsion, nanoemulsion, nanocapsules (oil-containing capsules), polymer nanoparticles, solid nanoparticles, and nanostructured lipid carriers. An anisometric molecule shape is a prerequisite for the production of liquid crystalline phases and is typically linked to a significant anisotropy of the polarisability. Mesogens are molecules with the ability to create mesophases [7]. The latter are frequently drug excipients, such as surfactants. The substances that make up drugs themselves, such as bases or organic acid salts with anisometric molecular shapes, may meet the conditions for the production of liquid crystals.

3. Methodology

Due to their stability and unique, skin-friendly structure, lyotropic liquid-crystalline systems are employed as delivery systems in the chemical, cosmetic, and medicine fields. These lyotropic mesophases are typically produced in a reasonably straightforward and energy-efficient manner using water, one or two surfactants, and perhaps cosurfactants in very specific proportions and low energy input or by spontaneous structural organisation. They can be kept unaltered for extended periods of time without phase separation because they are thermodynamically stable [9]. It is important to discuss the function of liquid crystals in protein chemistry. Many proteins combine to generate liquid crystal structures. Poly-B-benzyl-L-glutamate and poly-n-methyl-L-glutamate are two examples. Arteriosclerosis and transitions of mesomorphic chemicals are most likely related. Liquid crystals at body temperature are formed when combinations of β-lipoprotein complex with several unsaturated esters of cholesterol are mixed. Drug compounds' thermotropic and/or lyotropic liquid crystalline mesophases interact with human liquid crystalline structures as well as mesomorphous vehicles. NSAIDs containing amphiphilic organic acids, such as ibuprofen lysinate or diclofenac diethylamine, can produce lyotropic mesophases with water at body temperature or even at room temperature [13]. Reverse hexagonal and bicontinuous cubic phases, which are viscous reverse lyotropic liquid crystalline phases in excess of water, can offer incorporated active compounds a slow-release matrix. These substances offer a complex matrix with separated lipidic and aqueous sections. Hydrophilic, lipophilic, and amphiphilic materials, or a combination of them, can be incorporated into this heterogeneous structure as long as their presence doesn't cause the lyotropic phase structure to change [10].

Materials

The medications, polymers, excipients, and other substances utilised in the creation and assessment of enteric-coated pellets and cubic bulk phase formulations based on monoolein

Methods

Differential scanning calorimetry (DSC), infrared spectroscopy, and ultraviolet spectroscopy were used to confirm the medicines.

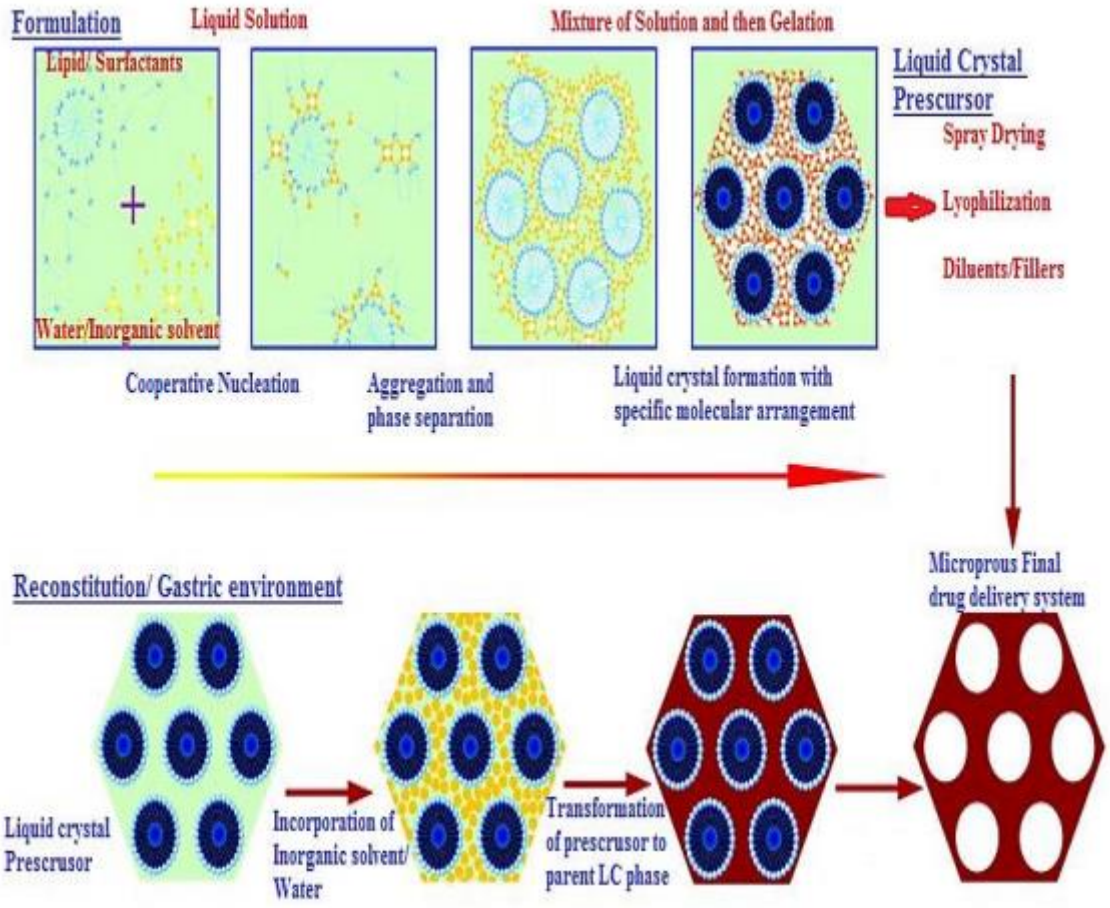

Figure 1. Complete process of cubic phase and cubic dispersed phase

The drug samples' monographs were used to assess the legitimacy of the samples. The colour, smell, and physical characteristics of the drug samples were noted. Ten milligrammes of each medication were dissolved in 100 millilitres of methanol for the UV spectrum of R, Z, E, and H. Using methanol, another 1 ml of the solution was diluted to 10 ml. The infrared spectra of medications was examined in a solid state in a dispersion of potassium bromide. Using an agate mortar and pestle, 20 mg of the respective drug sample and 200 mg of IR grade potassium bromide were combined individually. Using a motorised pellet press (Kimaya Engineers, India), potassium bromide discs were pressed at a pressure of 15 tonnes. The infrared spectra of the four medications were acquired by scanning the samples between 400 and 4000 cm-1 using an FTIR spectrophotometer (FTIR 8400S Shimadzu, Japan), and the results were compared to the reference standard IR spectra of the medications. The hydrotrope method or solvent precursor was utilised to prepare the cubic bulk phase; however, adsorbent/filler was utilised in place of spray drying or freeze-drying procedure for the stabilisation and management of the viscous bulk phase.

4. Results and Discussion

Male wistar rats were used in the in vivo investigation. Animals participating in the study had to weigh a minimum of 200±15 grammes. The study was carried out in compliance with the guidelines set forth by the "committee for the purpose of control and supervision of experiments on animals" (Care, 2003) and approved by the institutional animal ethics committee of the institute wide letter no. IAEC/RCPIPER/2017-18/02. Three random groups of rats were created. Group 1 was administered without any medicine; Group 2 received a drug-loaded cubic phase; and Group 3 received distilled

water (Patil et al., 2015). The animals were kept in cages made of polypropylene and had unrestricted access to tap water and pelletised feed. The animals were subjected to 12-hour light and dark cycles in alternation. The temperature was kept between 26 and 28 degrees Celsius. Using Puget and Barns conversion formula (dose × 0.018 equals animal dosage), the animal dose was determined. 150 mg of R, 100 mg of H, 500 mg of Z, and 270 mg of E were administered for the animal investigation. Using an oral feeding needle, rats were given 3 mg of R, 2 mg of H, 9 mg of Z, and 5 mg of E orally after the conversion formula was applied (0.35 ml for RZE and 0.2 ml for H). The rats were put to sleep with ether, and at 0 (pre-dose), 1, 2, 4, 6, and 8 hours, 1 ml of blood was taken from each rat's tail vein and placed in tubes coated with EDTA. The drawn blood was thoroughly combined with anticoagulant and centrifuged for 20 minutes at 5000 rpm. After the plasma was separated, it was kept at -21°C until HPLC was used to analyse the drugs (Xia et al., 2010). The medication was separated from the plasma using the protein precipitation procedure. After taking 0.5 ml of the plasma and mixing it for 30 seconds with 0.5 ml of acetonitrile, the tube was centrifuged for 10 minutes at 5000 rpm. The supernatant was then filtered through a 0.2 µm filter and fed into an HPLC.

5. Conclusion and Future Scope

Cubic phase refers to the nanostructured liquid crystalline particles that are created by amphiphilic or surfactant-like molecules self-assembling to form a liquid crystalline phase with cubic crystallographic symmetry. Since the bulk phase has a low viscosity, a wide interfacial area, and both hydrophilic and hydrophobic regions, it has been highly suggested as a carrier for active compounds. Moreover, cubic phase is suited for oral administration because to mesophases' excellent biocompatibility and bioadhesivity; these phases are also thought to be innovative lipid-based delivery vehicles with the ability to transport all BCS class medications. The stability of rifampicin increased when the isoniazid was administered in the gut. The FDC will become more efficient than the current one as a result. This aids in lowering resistance and accelerating the illness's recovery.

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