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Utilization of Lipids, Polymers by Modern Techniques for Innovative Pharmaceutical Formulations and Medical Devices

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ABSTRACT

With advancing science and technology, new futuristic technologies have been upcoming that are having a greater impact on the pharmaceutical and biomedical fields. Many lipids and polymer of natural and synthetic origin have spread horizons enabling to reach in fabricating delivery systems for unmet medical needs. In this modern biomedicine era, we must outline and scrutiny the roles of these biomaterials and the modern technologies that are shaping up the advancing medicines. The real challenges in modulating, fine-tuning the biomaterials for their bioactive properties are vital for assessing the in-vivo performance of the developed systems. Therefore, the present review discusses the detailed analysis of the current research reported in the technologies of utilizing the lipids, polymers, and their role in delivering the drugs, genes, and designing advanced implantable medical devices. The scrutiny also focuses on key optimization tools, analytical methods, formulation, and biomedical techniques helpful in developing the solutions that can be administered different routes in different therapeutic indications.

Keywords: Lipids; Polymers; Drug; Gene; Biomedical; Technology; Formulations.

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INTRODUCTION

In the current scenario, many efforts are utilized to use the power of many lipid and polymer based drug delivery systems, as it gives the proper means for site-specific targeting; with time specific controlled delivery of genes/ drugs having various molecular weights, either medium or large, along with bioactive [1,2]. Furthermore, sparingly water-soluble drugs (II/IV) are real challenges for the formulation specialist about solubility, dissolution and bioavailability. Lipid

or polymer-based delivery systems are effective in size dependent attributes therefore gained a lot of attention. Also, these biomaterials or lipids or polymers have taken the lead due to its advantages of having great degree of biocompatibility, biodegradation and tunability. These systems are commercially viable to formulate pharmaceuticals for topical [3], oral [4], parenteral route delivery [5]. Lipid formulations can be modified into different formulations such as Proliposomes [6], Microparticles [7], Solid lipid Nanoparticles [8], Nanoemulsion [9], Nanocrystals [10], Nanowires [11,12], Self-nano emulsifying drug delivery system (SNEDDS) [13], In-situ gels [14], Nanofibers [15], Nanoethosomes [16], various that meet the requirements as per the disease, route of administration. They really safeguard the total cost, long-term product stability, severe toxicity, and better efficacy. Lipid oriented carriers are safe, efficient therefore right candidates for the formulation of drugs, as well as vaccines, diagnostic, and nutraceutical [17]. Therefore, lipid based delivery systems have gained more importance in current years due to their capability to improvise the solubilities and bioavailability's of various drugs and chemical compounds (Figure 1).

Success of lipid-based delivery carrier is upon the empirical experience. Systematic physicochemical investigation of structures and stability's does not help to pace up the progression of newer and improve formulation but helps to know complex mechanism that

governs the interactions between the lipid's carrier and the human cell [18]. Therefore, they are considered as safer, efficiently for carrier designed for both drug and gene delivery. (ii) They are being evaluated to be used for protein and peptide, DNA, siRNA and cell specific deliveries [19]. Lipids are recognized as versatile excipient class that provides the formulator with much option for improvising and to control the absorption of many poorly soluble drug. (iii) Lipid-based formulations, that are end products of innovations, those have not only exhibited their use for overcoming the poor and altered GIT absorption of poor soluble or lipophilic drug, but even minimized the effect of food on the absorption, distribution, metabolism and excretion of many active drugs. In spite of these factsheet, oral marketed products having lipid oriented dosage form are being out-numbered 26 to 2 by traditional formulations [20].

Many accountability needs to be made to the characterize different lipid based formulations that are available so that protocols and process methods are established that help to identify the key moiety formulation at a beginning stage. Various technologies needs to be jotdown for handling the solubility state of the drugs in-vivo, and importantly in-vitro method are required for identifying the turbulent changes that are anticipated in the GIT. Careful considerations are required in terms of both physiochemical drug stability within lipid carriers and their interaction with capsule shells is important to be established. Whilst these present challenges there is a great potential in the use of lipid formulations [21]. The preference for futuristic research is to conduct bioavailability study in preclinical model and to perform more applied studies on understanding the mechanisms of action of these lipid formulations.

Role of biomaterials in controlled drug delivery

The progress in innovative strategies for controlled/sustained or prolonged drug delivery is vital tool for enhancement of local drug activity at target site. Basically, the transition time of fluids and pH value in GIT represents a characteristic behavior with increase in pH from the stomach (pH 1-2.2) to small-intestine (pH 4.5-5) and along the jejunum /ileum (lower part of the small intestine, pH 6.2) and further reaches a pH 7.0 in the colon system [22]. The protonation provided by the stomach (low pH region) improves the water solubility of drugs while the high pH at the intestine induces deprotonation and subsequent decrease in the solubility of the drug. The encapsulation of drugs by enteric coating contributes with a complementary behavior: at low pH, the solubility of enteric coating is negligible, provoking a strong reduction in the permeability of drugs along with the coating. At high pH, the enteric coating becomes water-soluble in association with a reduction in the drug solubility. As a consequence, the profile of drug release tends to be independent [23].

The use of electrospun nanofibers for controlled drug-release provides wide advantage comparative to the loading of various active drugs in the polymer templates by electrospinning technology. The enhancement in the bioavailability of the active drug is linked with reduction in side effects (such as nausea, diarrhea, pain). In this prospection, electrospun nanofibers are been progressing and applied in soft/hard tissue engineering, wound-dressing, and drug/gene delivery [24]. The popularity for a particular application is attributed due to the high-surface to volume-ratio; small-diameter; and high-porosity; that aid for the growth of absorption of water by lipophilic drugs [25].

Polymers are incredible being utilized in various cross functional technologies aid to their robust nature, versatility, and ease to process. They act as good host substrates for nanocomposites and nanomaterials and tunable as per requirement. Polymeric nanocomposite require filler in the nanoscale and exhibit significant specific characteristics than in bulkness because of the changes in the interplay by host substrates; morphology and aids huge interests in non-profit academia and profitable industries. As common features of polymer, they have low-strength, coupled with reduced impact-strength, that can be improved with the upcoming polymeric nanocompositions. Many reports have addressed the progressions in the nanocomposite's applications [26].

Polymers in Biomedical applications

Biodegradable biomaterials or polymer exhibit a wide history that can overcome the synthetic products use. The field of synthetic polymers is existed since the 1981s. From that time, there is a slow and gradual growth because of its outputs that are potentially connected to the major of popular products. This multidisciplinary area has components of material sciences, synthetic biology, chemistry, modern medicine, soft/ hard tissue engineering. The advantage of polymers in this area is that they can be tailored from the viewpoint of their chemical, physical, and surface properties, to enable good cell adhesion and proliferation in vivo, maintenance of their properties for a given time, and then degradation with no harmful effects in the body [24]. These are opted for a wide application, but majority of applications are in tissue engineering and drug delivery. Biomaterials with enhanced biocompatibility are effective to be used as nanoscaffolds for body application. In spite of the success of renewable source polymer, such as chitosan [27], alginates [28], PLGA [29], okra [30] in the last years, majority of biomaterial are in the commercial scale up. In the process of improving chemical, physical and thermo-mechanical properties, nanofibers are incorporated into biological based polymer substrates. This review highlights

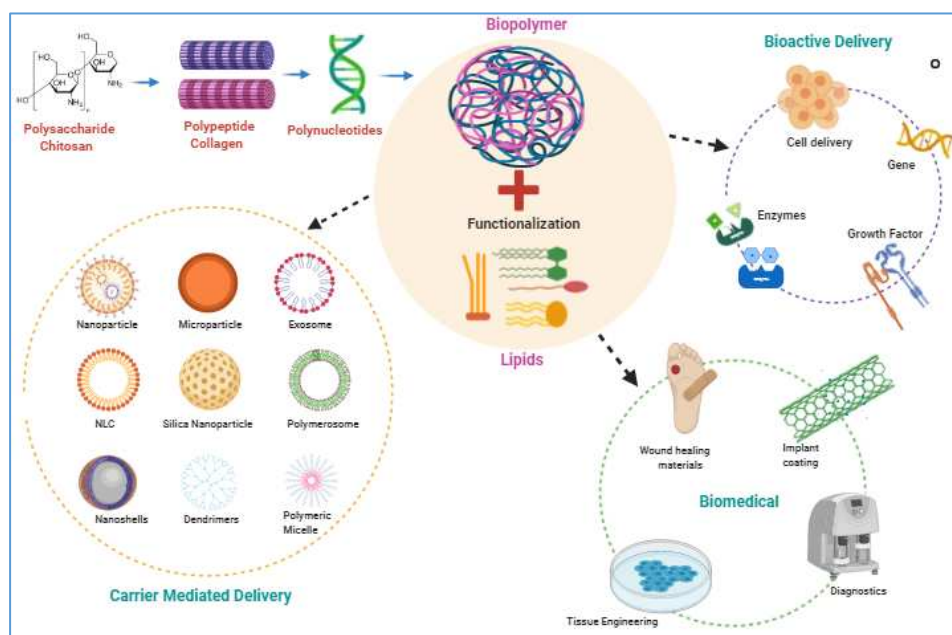


Figure 1: Scheme representing the wide uses of lipids and polymers in drug delivery applications and medical devices

provides a wide platform for junior scientist and senior researcher's in the fields of biological origin polymers and nanocomposites to establish their state-of-the-art work concerned to the transformation of natural resources into value-added drug formulations, implantable medical devices. Further modifications and specific preparations of these new bio-origin polymers/ lipids, and their characterizations and applications are profound. This review article even uncovers the development of biological source lipids, polymers and nanocomposites that are procured, including newer technologies that are related to their extraction, isolation, synthesis, processing's, characterizations and applications [31].

CONCLUSION

Therefore, the present study is focused on upbringing the usefulness and important aspects of how best the lipids and polymers can greatly help in formulating multiple solutions for delivering gene, drug, via different routes. There are several other biomaterials such as alginates, chitosan, that needs extensive analysis for their applications in medical device industries. Overall, the article explains the importance of these materials for framing useful strategies that can greatly effect the health care of the humans.

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