Nanocapsules: A Novel Nano-Drug Delivery System

Dineshkumar B *, K. Krishnakumar, Anish John, David Paul, Joseph Cherian, L. Panayappan
St James College of Pharmaceutical Sciences, Chalakudy, Thrissur, Kerala - 680307
Email: dinsbiotech@gmail.com

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Abstract
Dispersed polymer nanocapsules can be used as nano-sized drug carriers to get controlled release as well as efficient drug targeting. Drug-loaded polymeric nanocapsules have showed possible applications in the field of drug delivery systems. Enormous research efforts have been performed in order to develop modern nano-particulate drug delivery systems. However, newly developed drug molecules with moderate biopharmaceutical profile are still missing. The entrapment of this drug molecule can protect them from the biological environment and facilitate their transport through biological barriers. Therefore nano-carriers especially nanocapsules (NC) can give the promise for therapeutic benefits in the field of drug delivery system. The present review article mainly focused on applications of nanocapsules as carriers in drug delivery systems.

Introduction
Nanoparticles are solid colloidal particles that include both nanospheres and nanocapsules. One of their fundamental characteristics is their size, which is generally taken to be around 5–10 nm with an upper size limit of ~1000 nm, although the range generally obtained is 100–500 nm [1]. Benefits of nanocapsule: Nanocapsules have been developed as drug delivery systems for several drugs by different routes of administrations such as oral and parental. Reduce the toxicity of drugs. Improve the stability of the drug either in biological fluid or in the formulation [2]. Nanocapsule show promise as active vectors due to their capacity to release drugs; their subcellular size allows relatively higher intracellular uptake than other particulate systems. They can improve the stability of active substances [3]. Nano-encapsulated systems as active substance carriers include high drug encapsulation efficiency due to optimized drug solubility in the core, low polymer content compared to other nanoparticulated systems such as nanospheres, drug polymeric shell protection against degradation factors like pH and light and the reduction of tissue irritation due to the polymeric shell [4]. Some newly developed powerful drug molecules are strongly limited by their inadequate biopharmaceutical profiles. Moreover, it is sometimes difficult to synthesize new drugs with adequate stability and permeability properties. In this condition, the drug is incapable to reach adequate biological compartment. Therefore, development of appropriate delivery system for these drugs would be a step forward for their clinical exploitation. Not only the entrapment of drugs in nanocapsules protects them from the biological environment, it also makes possible their transport through biological barriers [5, 6]. The present review article described about applications of nanocapsules as carriers in drug delivery systems.

Nanocapsules
Nanocapsules are vesicular or reservoir system in which oil/water is essentially confined to cavity surrounded by tiny polymeric membrane [Figure 1]. The nanocapsule can be targeted to specific cells and locations within the body after intravenous and subcutaneous routes of injections.

Preparation of nanocapsules
Solvent displacement method or interfacial deposition method
Both solvent (organic phase) and non-solvent phases (aqueous phase) are used in the synthesis of nanocapsule [Figure 2]. Solvent phase containing solvents (ethanol, acetone and hexane), polymers (natural or synthetic polymer), the drug molecule and oils. On the other hand, the non-solvent phase consisting of a non-solvent or a mixture of non-solvents for the polymers, supplemented with one or more naturally occurring or synthetic surfactants. The solvent is an organic medium, while the non-solvent is mainly water. In the solvent displacement method, the nanocapsules are obtained as a colloidal suspension formed when the organic phase is added slowly with continuous moderate stirring to the aqueous phase [7]. In the Solvent displacement method, commonly used biodegradable polymers are poly-e-caprolactone (PCL),...
poly (lactide) (PLA) and poly (lactide-co-glicolide) (PLGA). The nanocapsule core is mainly composed by a w/o surfactant and oil chosen should have standard such as highest possible drug solubility, absence of toxicity, low solubility of oil in the polymer. Capric or caprylic triglyceride has been used because of their wide range of solubility for drug substances. Poloxamer 188 or polysorbate 80 has been used as stabilizer in the nanocapsule preparations [8].

Nanocapsules in Targeting Drug Delivery System

The possibility of silencing miRNA was investigated using nuclease-resistant locked nucleic acid (LNA) conjugated-lipid nanocapsules (LNCs) as miRNA-targeted nanomedicines in U87MG glioblastoma (GBM) cells. Treatment of LNA-LNC complexes with U87MG cell in an in vitro model showed that marked reduction of miR-21 expression and it was assessed by RTqPCR [9]. The isoflavone genistein (GEN) is a natural product and can be used in skin cancer treatment. But it has limited clinical use due to its high lipophilicity and chemical instability. Therefore, GEN loaded-PLA nanocapsules (GEN-NC) were developed by interfacial deposition of preformed polymer and were incorporated into semi-solid formulations and permeation experiments were performed using porcine ear skin. Permeation experiments showed that higher amount of GEN reaches deeper layers of the skin. This study indicated that GEN-NC semi-solid gel formulation might be effective for skin cancer treatment [10]. The anti-glioma effect of trans-resveratrol-loaded lipid-core nanocapsules (RSV-LNC) was investigated based on in vitro (C6 glioma cell line) and in vivo (brain-implanted C6 cells) models of the disease. The in vitro study indicated that RSV-LNC decreased the viability of C6 glioma cells to a higher extent than resveratrol in solution. In the in vivo studies, when RSV-LNC (5 mg/kg/day, i.p.) treated with brain implanted C6 tumors cells for 10 days exhibited a marked decrease in tumor size. This study suggested that RSV-LNC nanoformulation could be effective in the treatment of gliomas [11]. The plitidepsin-polyamino acid nanocapsules were prepared using solvent displacement technique. The nanocapsules showed an average size of 200nm, a negative zeta potential and a large capacity for the encapsulation of plitidepsin. In vivo studies indicated that plitidepsin-polyamino acid nanocapsules provided the drug with a prolonged blood circulation and reduced toxicity in cancer-induced mice model. This study showed that plitidepsin-polyamino acid nanocapsules might be useful in nano-oncological therapy [12]. The antiproliferative effect of indomethacin-loaded lipid-core nanocapsules (IndOH-LNC) was investigated in C6 and U138-MG glioma cells. IndOH-LNC reduced the cell viability by inducing apoptotic cell death in C6 and U138-MG glioma cell lines. IndOH-LNC also induced G0/G1 and/or G2/M phase arrest and IndOH-LNC promoted glioblastoma multiforme (GBM) cell differentiation and downregulation of nestin and CD133. This study suggested that indomethacin-loaded lipid-core nanocapsules (IndOH-LNC) could be effective in controlling of glioma growth [13].

Conclusion

One of the greatest challenges in drug delivery system is to maximize the effectiveness of the active agent while reducing its systemic adverse effects. Many drugs present poor physicochemical properties (low solubility, lack of biological stability) that limit their therapeutic applications. All these issues may be overcome by designing adequate drug delivery systems; nanocarriers (nanocapsules) are particularly suitable for this purpose. Drug encapsulated nanocapsule can be used for targeted-drug release especially in the field of neuroscience and cancer biology.

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References


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